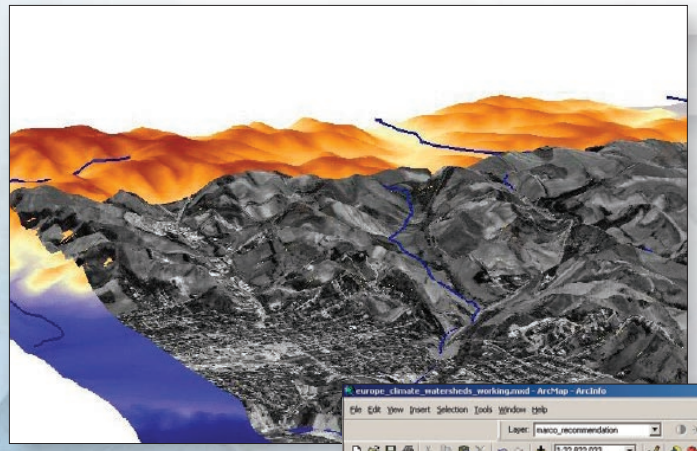
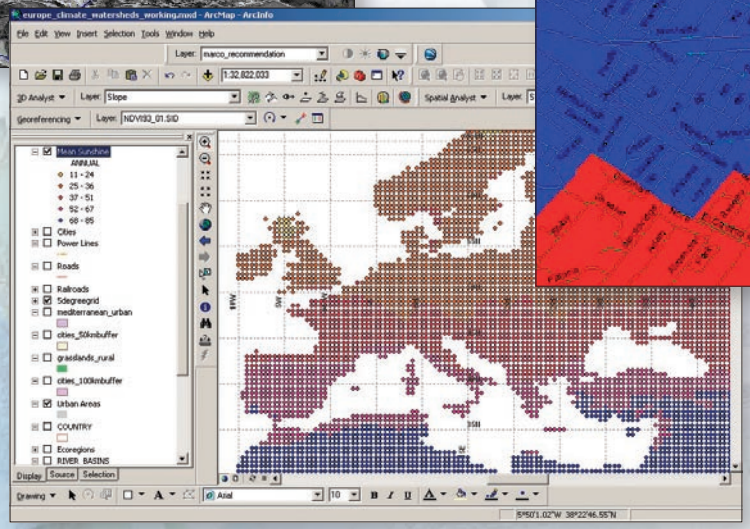
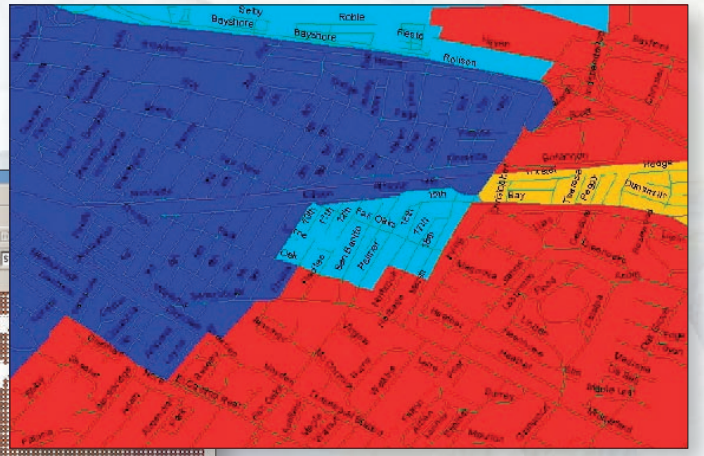
GIS Best Practices

Education







December 2007

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What Is GIS?

Making decisions based on geography is basic to human thinking. Where shall we go, what will it be like, and what shall we do when we get there are applied to the simple event of going to the store or to the major event of launching a bathysphere into the ocean's depths. By understanding geography and people's relationship to location, we can make informed decisions about the way we live on our planet. A geographic information system (GIS) is a technological tool for comprehending geography and making intelligent decisions.

GIS organizes geographic data so that a person reading a map can select data necessary for a specific project or task. A thematic map has a table of contents that allows the reader to add layers of information to a basemap of real-world locations. For example, a social analyst might use the basemap of Eugene, Oregon, and select datasets from the U.S. Census Bureau to add data layers to a map that shows residents' education levels, ages, and employment status. With an ability to combine a variety of datasets in an infinite number of ways, GIS is a useful tool for nearly every field of knowledge from archaeology to zoology.

A good GIS program is able to process geographic data from a variety of sources and integrate it into a map project. Many countries have an abundance of geographic data for analysis, and governments often make GIS datasets publicly available. Map file databases often come included with GIS packages; others can be obtained from both commercial vendors and government agencies. Some data is gathered in the field by global positioning units that attach a location coordinate (latitude and longitude) to a feature such as a pump station.

GIS maps are interactive. On the computer screen, map users can scan a GIS map in any direction, zoom in or out, and change the nature of the information contained in the map. They can choose whether to see the roads, how many roads to see, and how roads should be depicted. Then they can select what other items they wish to view alongside these roads such as storm drains, gas lines, rare plants, or hospitals. Some GIS programs are designed to perform sophisticated calculations for tracking storms or predicting erosion patterns. GIS applications can be embedded into common activities such as verifying an address.

From routinely performing work-related tasks to scientifically exploring the complexities of our world, GIS gives people the geographic advantage to become more productive, more aware, and more responsive citizens of planet Earth.

GIS for Education

In the struggle to help students of all ages find their way in life, teachers use many tools. No single tool can ever accomplish all things for all students. But every now and then, a new tool appears that can change the course of education for many students of all ages by introducing new ways of thinking, seeing, and working. A GIS is such a tool.

GIS is as dynamic as the teachers and youth group leaders who use it to enhance the education experience. In this document, underlying strategies are explored showing the diverse ways educators have implemented GIS in the curriculum.

4-H Clubs Inventory Trees in Hillsboro, Oregon, and Park Conditions in St. Louis, Missouri

Making the Environment Better, One Clover at a Time

The small green clover modestly placed in the corner of every 4-H member's blue shirt symbolizes more than involvement; it epitomizes the dedication, motivation, and leadership necessary to make a positive change in communities across the United States. The National 4-H Club's countless endeavors include projects that improve environmental conditions in local communities, as well as national parks. Disappearing greenery and dwindling species are the main focus of members as they expand their knowledge of community issues and technology.

In 2003, the National 4-H Program created the GIS GPS leadership team to provide leadership in promoting the use of GIS and related technologies in various 4-H programs that rely on a "learn by doing" approach. The programs develop skills in communication, community service, citizenship, leadership, teamwork, and record keeping, as well as specific content-based expertise and skills. The groups use a variety of technology, including ESRI software, to make their vision of a better future a reality.

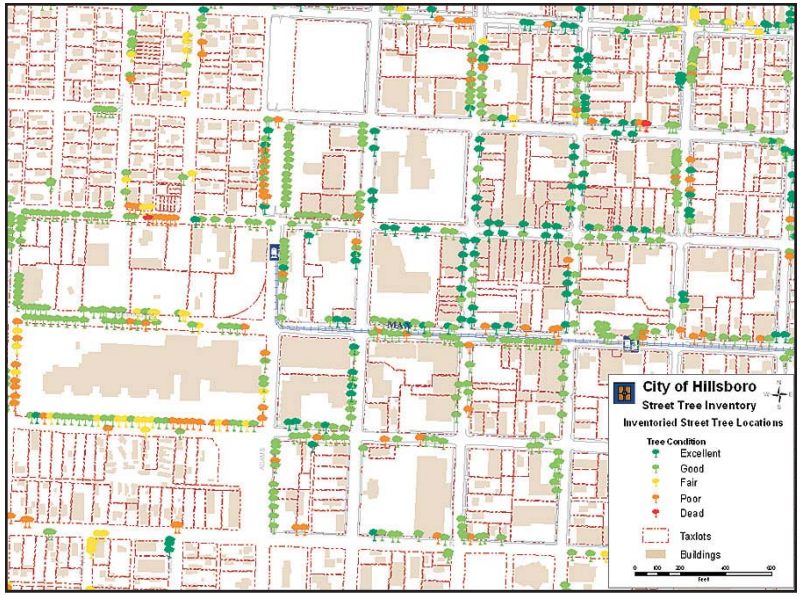
City of Hillsboro Planning Department, Washington County, Oregon

From climbing them as a kid to enjoying their environmental benefits as an adult, trees are an integral part of any community. The health of a community's urban forest depends on regular maintenance (including removal, as necessary) and planting new trees. The Planning Department in the city of Hillsboro, Oregon, is developing an Urban Forestry Management plan to address these issues.

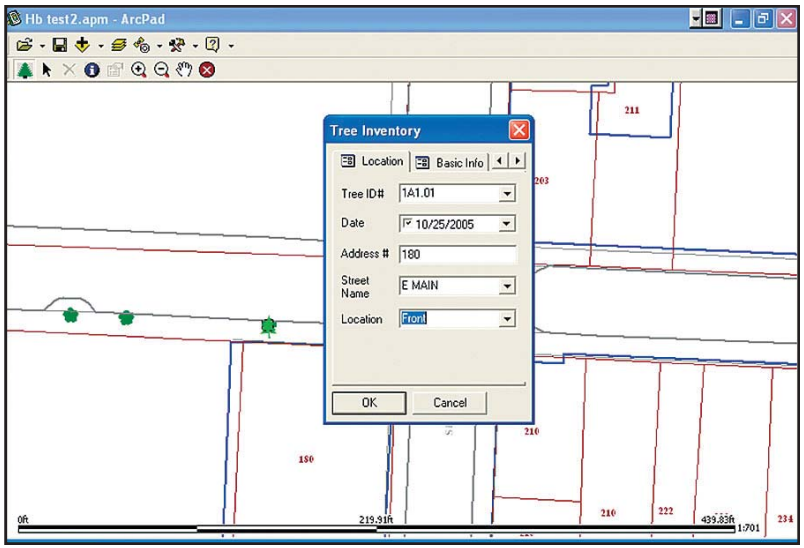
"The city is working with 4-H coordinator Lisa Conroy and the local 4-H GIS-GPS Tech Wizard youth to develop a street inventory," says Doug Miller, Hillsboro city planner. "The inventory is an important first step to understand what we have in the urban forest in order to effectively manage it."

In the beginning of 2005, the city received a $4,980 grant from the Oregon Department of Forestry to conduct an inventory of street trees using community volunteers. To get the project started, Miller and the 4-Hers worked with Conroy and trained more than 400 volunteers to gather tree data, which they plan to complete in summer 2006. The youth and volunteers use ArcPad software to catalog the type, condition, size, and location of approximately 12,000 street trees in Hillsboro.

"I downloaded a street tree inventory script from the ESRI Web site, then modified it using ArcPad Studio so that it fits Hillsboro's geography and data needs," says Miller. As it gathers the information, the group simply loads the field data into the citywide GIS at the end of each day, eliminating the need for double entry.



The Planning Department in the city of Hillsboro, Oregon, is developing an Urban Forestry Management plan with 4-Hers. Hillsboro sees the program as an important resource to help organize city tree management and education about tree care



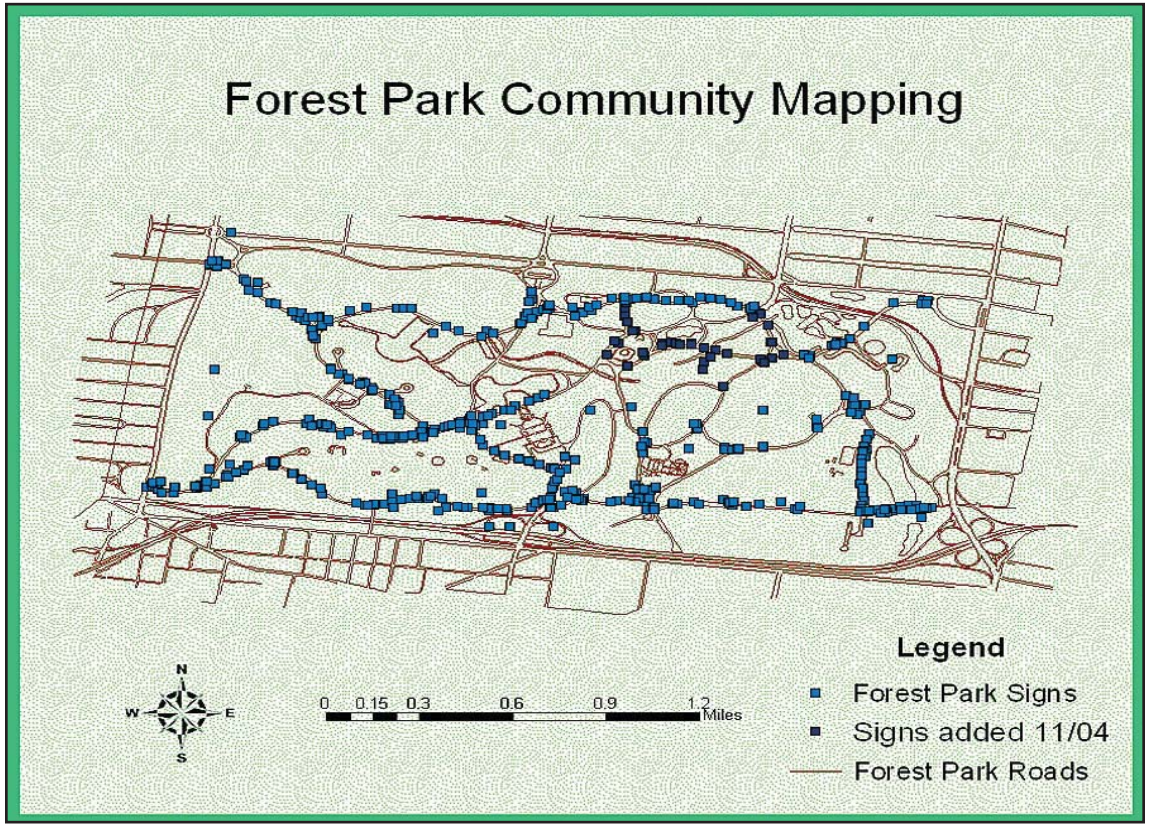
Once the data collection stage is complete, Miller and the 4-H members will work in ArcView to create easy-to-read maps that will help the city qualify for Tree City USA, a program sponsored by the National Arbor Day Foundation in cooperation with the United States Department of Agriculture Forest Service and the National Association of State Foresters. Tree City USA provides direction, technical assistance, public attention, and national recognition for urban and community forestry programs in thousands of towns and cities. Hillsboro sees the program as an important resource to help organize city tree management and education about tree care. The project results will also help the city identify potential hazards and plan for future budgetary needs.

"This is an example of a terrific community partnership and a win-win situation for everyone," says Conroy. "The city needed help with data gathering and processing. The 4-H youth benefit from learning about geospatial technologies and careers in a real-world project, and the community benefits from having trees better selected and maintained."

The group had support from several community sponsors: Hewlett-Packard, city of Hillsboro, Hillsboro School District, Intel Corporation and Foundation, Oregon State University Extension Service, PGE Foundation, the Washington County 4-H Leaders Association, and ESRI.

Forest Park, St. Louis, Missouri

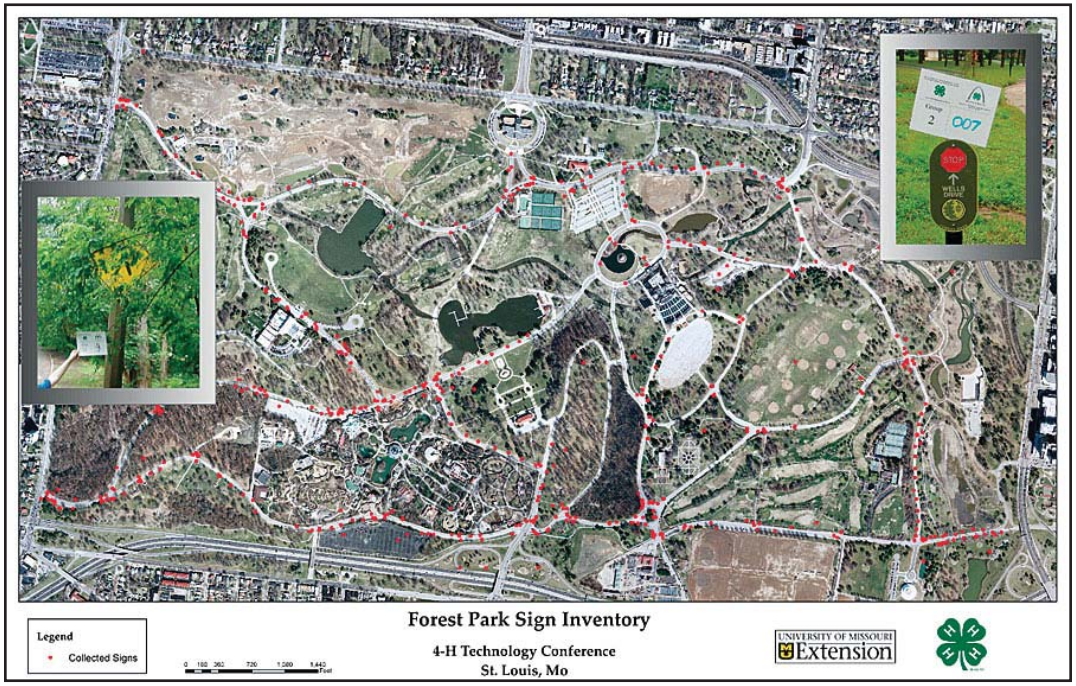
The unique landscape of Forest Park, Missouri, boasts 1,293 acres of diverse wildlife, prestigious monuments, and historical buildings. The park, open to the public since 1876, is one of the largest urban parks in the United States, attracting more than 12 million visitors a year. With large numbers of visitors comes the problem of facility and land management. Many areas of the park need repaired signage and improved trails—a daunting task for the St. Louis Department of Parks, Recreation, and Forestry given that it maintains 150 other city parks. However, to a group of 330 4-H teens and adult leaders from 43 states, as well as Japan and Korea, the task was just what they were looking for. Frank Wideman, a natural resources engineer with the University of Missouri, eagerly helped organize the 4-Hers.



The Forest Park activity commenced during the third National 4-H Technology Leadership Conference, cohosted by Missouri 4-H and attended by 42 Missouri 4-H youth and leaders. "A

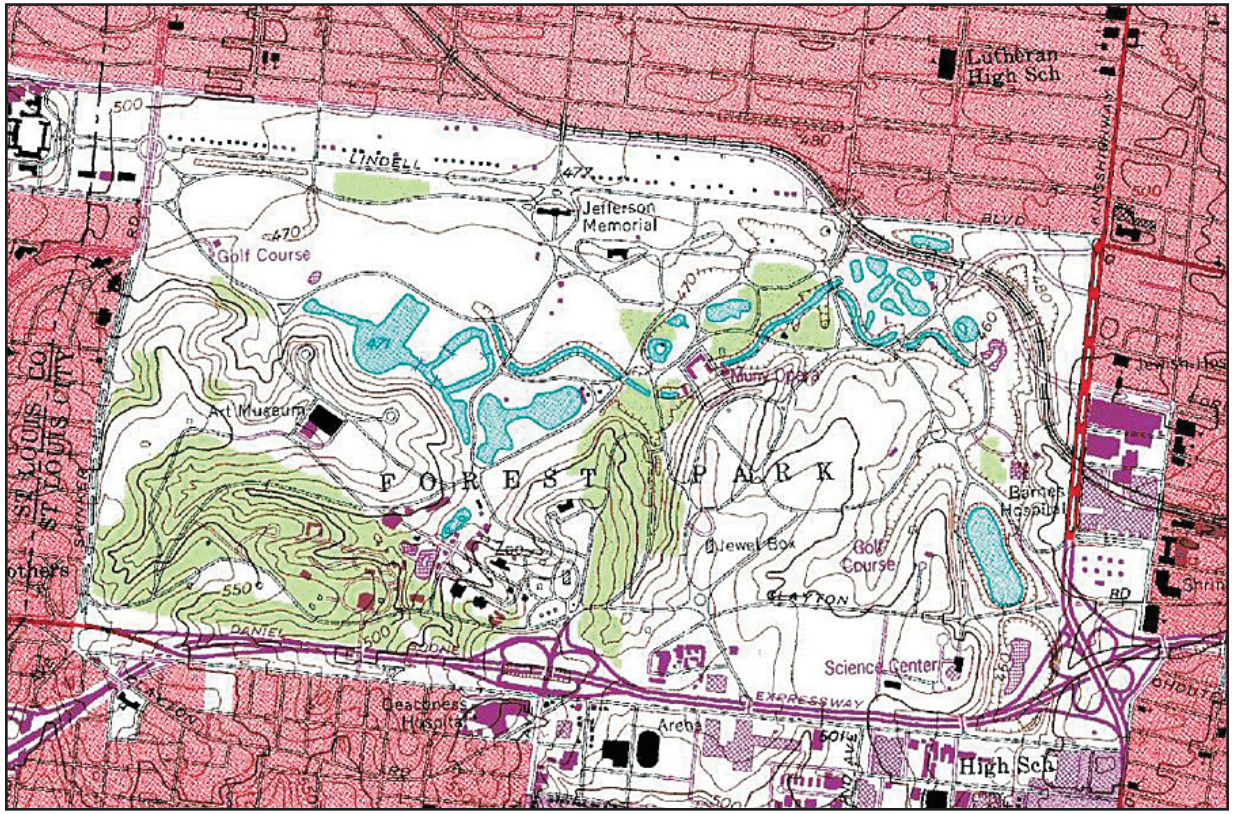
service project has always been a part of the past technology conferences," says Wideman. "With the support of ESRI and the interest the youth had in GPS and technology in general, it was decided that a mapping project would be the service project."

To begin the project, the large group broke into teams and scattered throughout the park, technology in hand. The teams, consisting of four to eight people each, used digital cameras, GPS units, and clipboards to gather data about the condition of park signs, particularly around picnic sites, parking zones, and statues and monuments. Team members recorded their condition, material, distance from the curb, any obstructions in their way, and other key elements that would give the St. Louis Department of Parks, Recreation, and Forestry the necessary information to make improvements. "All the information the park requested was recorded on data sheets that allowed even the low-resource groups an opportunity to take the process home and adapt it to local projects," says Wideman.



Team members recorded each tree's condition, material, distance from the curb, any obstructions in their way, and other key elements that would give the St. Louis Department of Parks, Recreation, and Forestry the necessary information to make improvements.

The data collection took one-half day of the three-day conference. For the remainder of the event, a group of 4-Hers learned to incorporate the data and photos into a GIS project using ArcGIS technology. Team members brought their data collection sheets into the lab and entered the data into a Microsoft Access database. The resulting data set was imported into a single database, then put into ArcView. The completed project was handed over to the city of St. Louis Department of Parks, Recreation, and Forestry to add to the Forest Park plan.



"The outcome of this activity was positive on a number of fronts," says Wideman. "Forest Park and the city of St. Louis received a no-cost photographic and location survey of park signage. The 4-H youth involved were introduced to geospatial technologies and given the opportunity to practice those skills in a real-world application. GIS professionals and those communities collecting GIS data were introduced to another potential resource for accomplishing their goals."

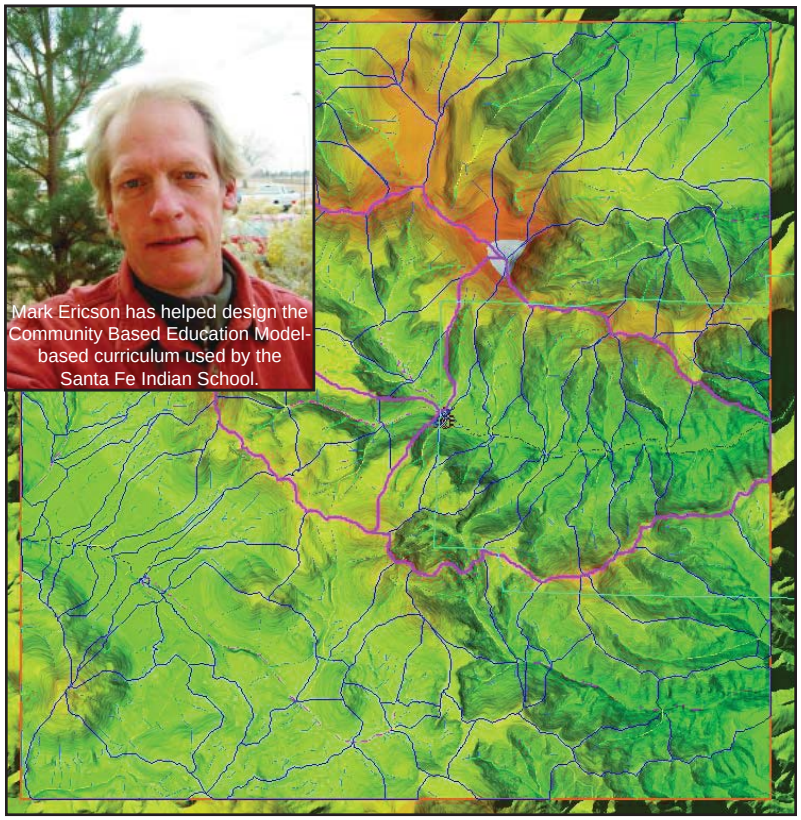
For more information about the 4-H program and to learn more about 4-H community technology projects across the country, visit www.4-h.org. More information about the National 4-H Program is available at www.fourhcouncil.edu.

(Reprinted from the Winter 2005/2006 issue of *ArcNews* magazine)

The Learning Is Exponential

Using a Community-Based Approach

Mark Ericson's students at the Santa Fe Indian School (SFIS) have mapped roads and tribal boundaries and participated in wetlands restoration and environmental projects as part of a program that uses a new approach to motivating students. The Community Based Education Model (CBEM) strengthens learning by involving students in real-world issues that require math and science skills. The program helps students become involved in their communities and encourages them to continue their education and return home to work.



Students use GIS and hydrologic modeling to visualize the extent of the watersheds that feed their reservations.

Over its 110-year history, SFIS evolved from a federally run school to the nation's first self-run school for Native Americans. Owned and operated by the 19 Pueblos of New Mexico, the middle school and high school accommodate both day and boarding students from tribes all over New Mexico. While the school offers coursework in Native American history, it also prepares students with technical skills for the modern world. SFIS students learn computer skills, scientific research concepts, and how to work with professionals and tribal community elders.

When Ericson helped design SFIS's first CBEM curriculum in 1996, he already had almost a decade of experience teaching at SFIS. He had a good understanding of local education and community issues. He was also the catalyst for using GIS to bring students and the surrounding communities together. For the past five years, under Ericson's instruction, SFIS students have been using the GIS skills they have developed to participate in environmental and water management programs in their communities.

"I was looking for something that could be used as a foundation to create an expandable base that students could add to based upon their work in the community," says Ericson. "The use of GIS has been the technological core." He and other CBEM curriculum developers worked with community members as equal partners to select relevant projects.

Because many issues were based on the environment, Ericson investigated combining computers and geography as a way to use the computer laboratory that Intel Corporation had provided for CBEM. Program funding came from the U.S. Department of Energy. Through contact with local agencies involved in land management, Ericson heard about ArcView software. He began teaching himself how to use it and later took training at the ESRI Learning Center in Redlands, California.

Ericson's course teaches students GIS skills. Over the past seven years, CBEM students have used GIS to map back roads and tribal land boundaries. They have participated in wetlands restoration projects, ground and surface water monitoring, and longitudinal aquatic habitat assessments. They created a master map using the ArcGIS Spatial Analyst extension and data about the reservations and surrounding watersheds along with digital elevation model data from the U.S. Geological Survey. The master map provides a base for further learning such as using a hydrologic modeling extension for ArcView to derive stream channels and watershed basin flows. In the process, they learn skills that they can use in college or the workplace.

"When students wade through a stream trying to get a clear GPS signal to map study area boundaries, the learning is substantial; when the data is then realized in a multidimensional mapping database, the learning is exponential," says Ericson.

He adds that students also discover new things about themselves such as their ability to understand and apply technical concepts, communicate these ideas to others in a public setting, and contribute as citizens to their communities. "Mark's use of GIS has given the CBEM students the opportunity to learn in high school at the highest level in terms of computers and technology," says CBEM community liaison Matthew S. Pecos. "The communities get the direct benefit of the skills and knowledge these students have acquired."

"The kids are proud of what they can do, they are lifting their heads up high because they know they have a skill that many other people do not have, and they have progressed in other areas because of that," says Theresa Chavez, past CBEM coordinator and currently SFIS middle school coordinator. Many students have worked summer jobs doing community GIS projects such as mapping utility manholes and georeferencing house addresses.

As a measure of the school's success, in 1987 the United States Department of Education listed the school as one of 270 outstanding secondary schools in America. Of the 70 to 90 students graduating each year, about 90 percent of them plan to go on to attend postsecondary schools.

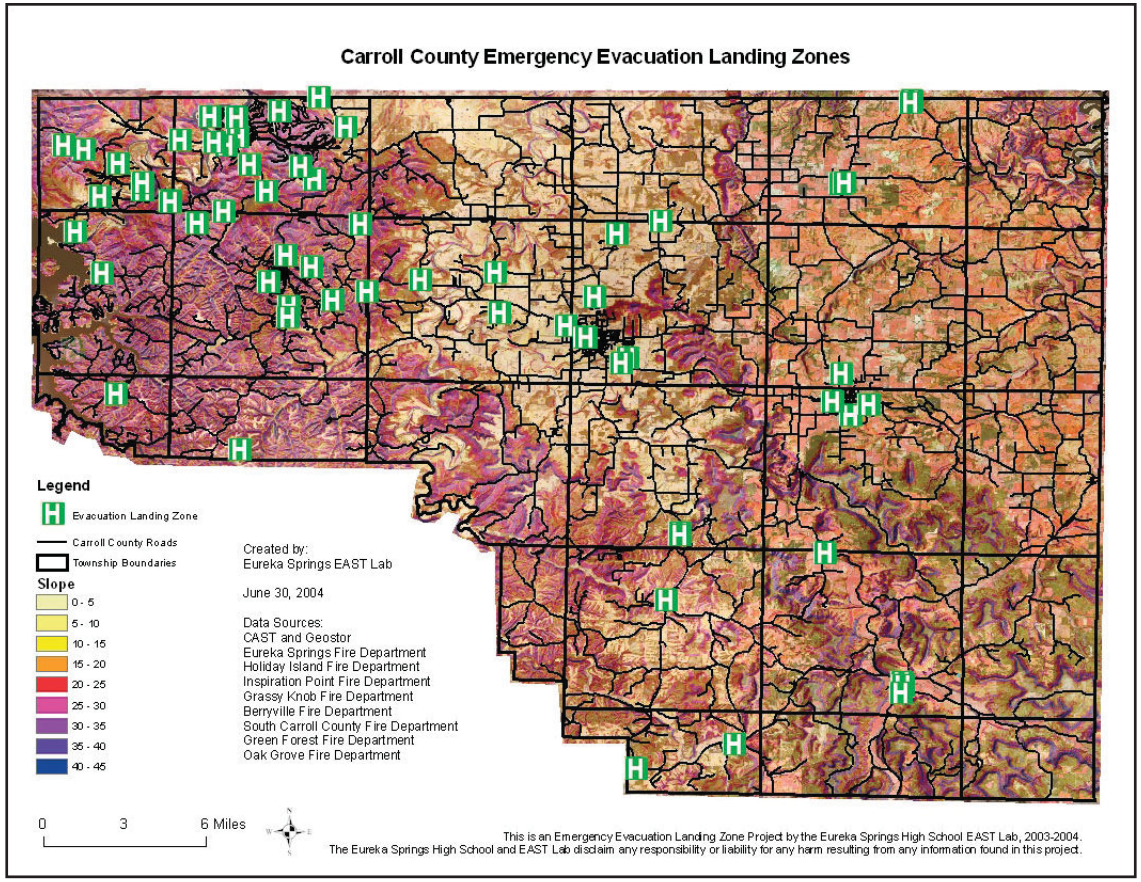
(Reprinted from the Fall 2006 issue of *GIS Educator*)

Arkansas Students Trek the Land to Make a Difference for Emergency Services

The Environmental and Spatial Technology Program

The rural area of northwestern Arkansas boasts a wooded, mountainous terrain that has enticed many to call the region home, making it the sixth fastest growing region in the United States. However, the very elements that make the area appealing also contribute to the difficulty its citizens face in a time of emergency or disaster. Boone, Carroll, Searcy, and Washington Counties make up the 3,000-square-mile region, and all are inhabited by citizens who are dependent on helicopters to evacuate the area during a natural disaster or medical emergency. In turn, the helicopters are dependent on a 10,000-square-foot unobstructed area for their landing zone. With vast stretches of land that include lakes, rivers, and hills, it is critical that emergency workers know the location of usable helicopter landing zones.

Carroll County recognized the need for all public safety departments to have access to accurate and current data on all of the available helicopter landing zones in the area. Although many of these departments already had their own coordinates for local zones, there were discrepancies in their information. The Carroll County 911 Department turned to Eureka Springs High School in Eureka Springs, Arkansas, for help. Students in the school's Environmental and Spatial Technology (EAST) program were eager to help the county identify and map acceptable landing zones. The EAST Initiative is a nonprofit organization, operating in more than 200 high schools in seven states, that emphasizes using advanced technology applications to conduct community service projects. Led by Mila Powell, EAST facilitator, at Eureka Springs High School, the Eureka Springs EAST students excitedly put their skills to work for the community. The program, which covers an array of technical disciplines, included GIS/GPS projects that prepared the students for the rigorous emergency evacuation landing zone project. With a grant from the Winthrop Rockefeller Foundation and the additional forces of neighboring EAST students in Alpena, Fayetteville, and St. Joe, the students embarked on their journey across the northwestern Arkansas land armed with Trimble GPS units and ArcView and ArcEditor software.



This is the completed map the Eureka Springs EAST group gave to the emergency personnel of Carroll County: Slope data is included to give an idea of where the flat areas are (slopes 0–5 percent, which are ideal for helicopter landing sites).

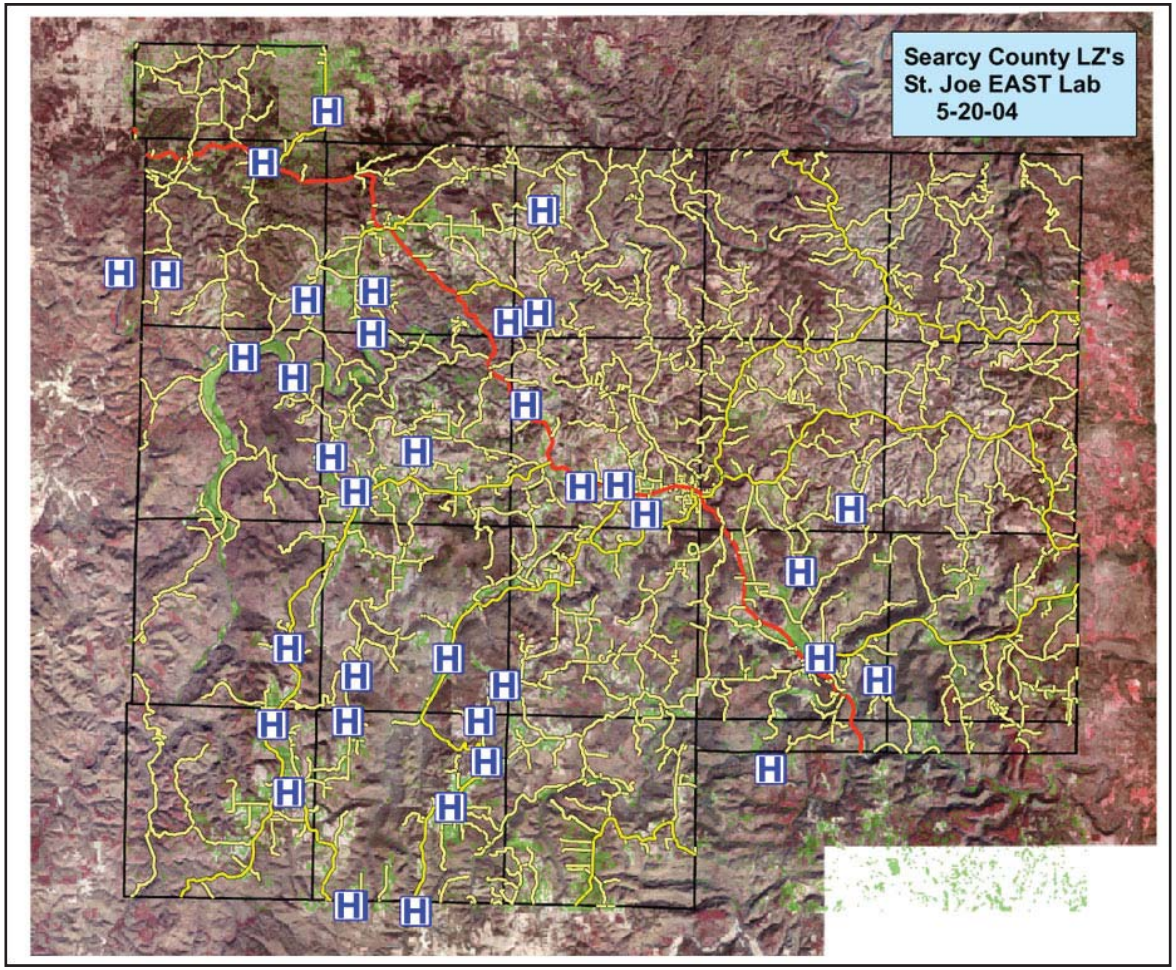
"Once we started the project, we wanted a lot of sharing of data as well as sharing of skills among the students," says Powell. "There were different lists of landing zones in the area from different sources. We set out to combine the lists from firefighters, paramedics, helicopter evacuation services workers, county officials, and 911 personnel. Our original task was to combine all these lists into a centralized database using the ArcGIS software we had already used, so we invited different people from these organizations to our EAST conference at Eureka

Springs in October 2003 to explain what we wanted to do. We quickly discovered that almost all of the coordinates they had were wrong; we're talking more than 750 coordinates in Carroll County alone."

The initial setback in their plans did not affect the students' purpose. Approximately eight students from each high school teamed up with police, firefighters, and other emergency personnel to visit each landing site in the four counties. Using Trimble GeoExplorer 3 handheld GPS receivers, the students began researching and mapping areas that met all the requirements of a landing zone. They used 100-foot measuring tapes, a clinometer (slope measuring tool), and the GeoExplorer 3 rovers to record the exact GPS locations. Landing zones that had obstructions were removed from the maps, and other pertinent information was collected, including the name of the landing zone; terrain data, such as slope level and elevation; names of and distance to the nearest roads and distance from trees, fences, bodies of water, and other obstacles; the addresses and phone numbers of the nearest homes; and other information that would aid emergency workers in executing the fastest evacuation.

To begin the mapping process, Eureka Springs EAST students downloaded data for Carroll County, township boundaries from the University of Arkansas' Center for Advanced Spatial Technologies' GeoStor, and road data provided by the Arkansas Geographic Information Office. Using ArcGIS Spatial Analyst, the class converted elevation raster data to slope data through the Surface Analysis tool. Once they added the data, the students analyzed the information for the necessary landing zone conditions; a 100- by 100-foot area; 0 to 5 percent slope; and any possible hazards, such as trees, fences, power lines, buildings, or other obstacles. The St. Joe EAST lab found an efficient way to add all the landing zone information by creating a consolidated shapefile and adding it to the underlying map. Using the ArcEditor software's ArcCatalog application, the students corrected the coordinates until the landing zone data was correctly placed. Students, accompanied by emergency personnel, verified the coordinates using Trimble GeoExplorer 3 rovers.

"Once the students collected the necessary data, they returned to the lab and used ArcView and ArcEditor to create layered maps," says Powell. "During this process, the students not only learned how to collect the data, they also learned the GIS software necessary to create the detailed maps. ArcGIS 9 played a valuable role in the project. It enabled the students to easily learn how to use GIS technology with such comprehensive data."



This map details the helicopter landing sites for Searcy County as created by the St. Joe EAST students. The landing zone project consisted of five monthly conferences funded by the Winthrop Rockefeller Foundation that enabled all the EAST students from the four schools to help each other.

After the students transferred all the data into the ArcGIS application, they used the Identify tool to get the correct coordinates and create another consolidated shapefile, which was the final data of the landing zones. After adding the corrected shapefiles, students zoomed into each town, labeled the landing zones with the zone name and coordinates, and created the maps.

Upon completion, they printed 8- by 11-inch and 2- by 3-foot versions of the maps for local fire and police departments, the Carroll County 911 Department, and the Air Evac personnel.

Nine months after the Eureka Springs and St. Joe EAST students stepped foot into their surrounding wilderness, they completed their county map. As a result of their efforts, the county's emergency vehicles contain hard-copy maps of each landing zone complete with the name of the zone, latitude and longitude readings, and major roads and highways in the area. Landing zone wall maps for each county enable emergency services personnel to clearly locate landing zones during emergency situations. Future plans include a Web site that will contain all the landing zones for the four counties, giving local residents necessary information about the closest landing zones in their area in the event of a medical emergency or natural disaster.

"This project allowed kids to work with other kids outside their normal clique," explains Powell. "They learned to appreciate and understand kids from other towns, which was one of my goals from the beginning. There was also a lot of technical sharing and interpersonal understanding. The students who knew more about GIS/GPS would guide the other students through the processes."

The impact of the project has already been felt by emergency workers. "In August, I was at the county fair and a firefighter came up to me and told me that just last week they had an emergency and they used our map to find a landing zone," says Powell. "We helped save a person's life. I felt fantastic, and the kids were thrilled to know we had such an impact. It's incredible."

The success of the project has prompted the community to enlist the EAST students in other important projects. The fire marshal recruited the Eureka Springs EAST students to help the city get FireWise certification. The students were asked to provide assessment teams with maps, which included houses, roads, and other information required by the program. "This program is preparing the students for a future where they'll be good, productive citizens," says Powell. "They get to pick the technology and project they work on, as long as it is helping the community. It can be a lot of work, but it is worth it when it is for a good cause."

(Reprinted from the Winter 2004/2005 issue of *ArcNews* magazine)

Rhode Island Girl Scouts Embark on a GIS Adventure

Bringing Together Geography, Environmental Concerns, the Outdoors, and Science

Girl Scouts of America was founded in 1912 with the purpose to help girls everywhere build character and gain skills for success in the real world. Since that time, the organization has molded itself to the needs and requirements of the changing world. With its purpose of inspiring girls and instilling strong values, leadership abilities, social conscience, and insight about their self-worth, it is inevitable that teaching technology has become an important part of the Girl Scouts' goals.

The Girl Scouts' work led to the creation of the first GIS badge (see above) in the state of Rhode Island. The scouting system is a perfect place to introduce GIS and GPS technology to young girls who might not be otherwise exposed to its importance. The technology brings together the Girl Scouts' core themes of geography, the environment, outdoors, and science, which become more crucial as society develops under the influence of technology.

"This is especially important in a time when technology is an intrinsic part of society, yet there continues to be fewer women in technology-based fields than men," says Peter August, professor of natural resource science at the University of Rhode Island. "To combat this problem, it is important to teach girls the value of technology at an early age."

The sixth grade girls of Rhode Island Girl Scout Troop 207 and their troop leader, Lou Finan, stepped up to the technology challenge by integrating GIS and GPS with a skill that has long been essential for Girl Scouts--orienteering with a map and compass. In February 2004, the troop, located in Matunuck Beach, Rhode Island, sharpened their technological abilities and added to their portfolio of outdoor skills. They turned to August, whose daughter is a member of the troop, to learn about the technologies.

"As a Girl Scout leader, I naturally am aware of the unique challenges girls are facing today, not only socially but also academically, as they prepare for their futures," says Finan. "I learned about Girl Scouts and the Ad Council's Girls Go Tech campaign and initiatives that point out the fact that girls are shying away from careers in science, math, and technology even though careers in these areas are the fastest growing and most highly paid. I believe girls would aspire to science and technology if social pressures were not in their way. My role is to open the doors and lower those unnecessary thresholds. As we were thinking of how to make science and technology one of our troop's themes for the year, Peter August brought up the idea of a GIS badge, which is a concept combining traditional outdoor Girl Scout activities with science and technology. Since there was no such thing as a GIS badge at that time, we decided to create our own."

The girls eagerly embarked on their mapping journey at the Girl Scouts of Rhode Island Camp Hoffman led by August. Before they could experiment with the technology hands-on, August demonstrated the basics of GIS by displaying a digital map of the camp in ArcView with a digital orthophoto with a variety of data, including roads, schools, libraries, and lakes and ponds in the community. August displayed the zoom and pan tools by zeroing in on areas the girls could easily identify and asked them questions about that specific locale. They also identified areas in the camp where they held activities, such as campouts, parades, day trips, and instructional programs. The exercise not only demonstrated how GIS allows users to zoom and pan with a map but also the software's ability to overlay themes and view different data to help get oriented with the map.

After their beginners' GIS exercise, it was time for the troop to apply the technology in a real-world situation. The girls hit the field with a GPS receiver and recorded the geographic coordinates of locations in the camp where they noted certain vegetation characteristics. After the fieldwork was complete, they returned to the camp lodge and saw how the coordinates they measured with GPS were in the precise locations on an orthophoto of the area.

August says, "This got them used to seeing GIS work and helped them understand the relationship between things in nature and things in the database."

The second part of the day turned the girls into cartographers as they made maps of their own. August took the troop to the University of Rhode Island's teaching lab where 15 computers were set up with ArcView and data for the camp and the community. Alyson McCann, an ESRI authorized trainer and GIS instructor for the University of Rhode Island's Water Quality Cooperative Extension Program, assisted in instructing the girls in how to make maps of their favorite areas in town.

"The girls of Troop 207 are natural mappers," says Finan. "They immediately grasped the concept of GIS and created some exceptional maps of the neighborhoods around their homes." This time, the girls used ArcView software's zoom and pan tools on their own and experimented with turning different layers on and off. Once the girls were comfortable maneuvering around the map, McCann and August took them through the process of constructing their own GIS projects. They integrated vector data and orthophotography and used data sets August prepared for them, which included familiar information, such as the location of their schools, libraries, streets, and popular lakes. August and McCann helped the girls put text labels on their maps and led them through the process of drawing primitive graphics.

"When the day began at one o'clock in the afternoon, these kids had little experience with a computer and didn't know what GIS was," says August. "By three o'clock they had made maps of their homes and other areas they were familiar with. They loved working with the software and the computers."

The successes of the day went beyond the personal enrichment each of the girls experienced. Their work led to the creation of the first GIS badge in the state of Rhode Island (see above). "I understand that it had been seven years since a troop submitted a badge proposal to the Girl Scout Council of Rhode Island," says Finan. "Once I understood that this is not a common procedure, it seemed to be a breeze getting it approved. Perhaps we had no problem because

the badge we proposed was so unique compared to other badges and it is highly compatible with Girl Scouts of America's science and technology initiatives."

The girls of Troop 207 clearly demonstrated that given a small amount of instruction, GIS and GPS can be part of the scout's portfolio for technology and orienteering skills. The scouting system is a perfect place to introduce GIS and GPS technology to young girls who might not be otherwise exposed to its importance. The technology brings together the Girl Scouts' core themes of geography, the environment, outdoors, and science, which become more crucial as society develops under the influence of technology.

(Reprinted from the Winter 2004/2005 issue of *ArcNews* magazine*)*

Students Locate Old Aqueduct Using Geospatial Tools

Editor's note: High school students in Santa Barbara, California, mapped the largely undocumented water system of one of California's missions. These students, members of the Environmental and Spatial Technologies (EAST) class at Santa Ynez Valley Union High School, use GIS, GPS, and other technologies to solve real problems.

In September 2003, Mike Loehr, who helped Mission Santa Inés obtain its National Historic Landmark District status, asked if members of the EAST class could map an underground aqueduct that was built to supply water to the mission. Little was known about the mission's water system and uncovering it was becoming an increasingly challenging task owing to construction projects in the area. Most of the sites that were known had been uncovered in 1980 when new homes and access roads were built.

Students used the contour lines and aqueduct elevation information to predict and subsequently locate the dam site.

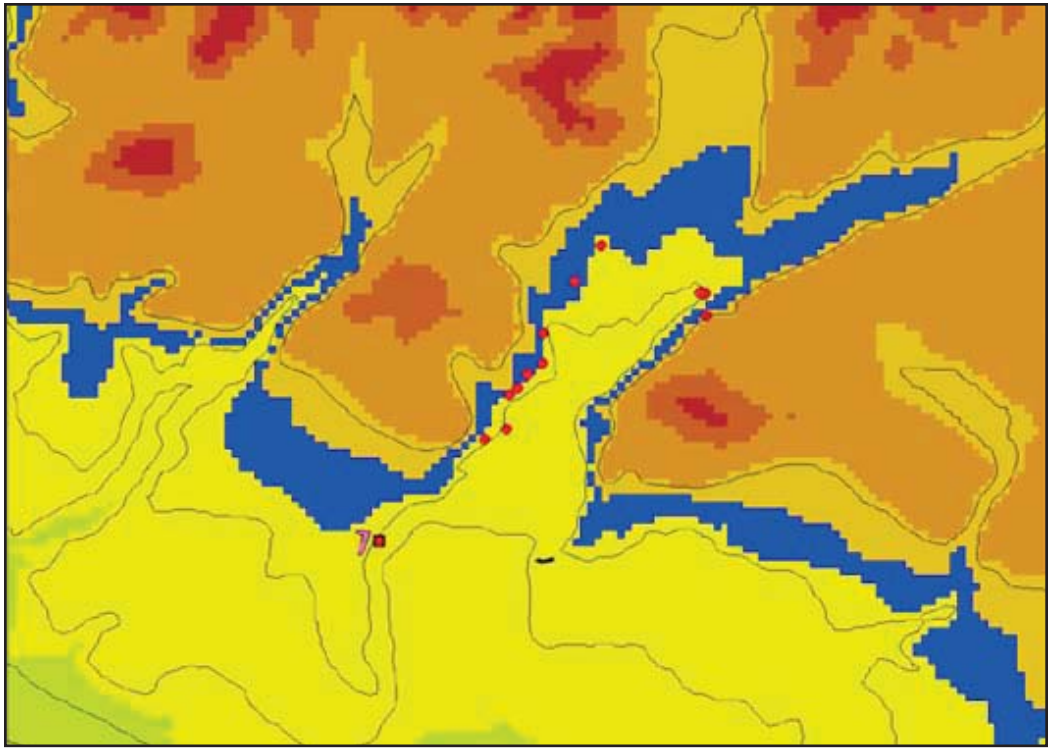
The high school students accepted the challenge and began by researching the mission using materials in archives, databases, and libraries. Student teams acquired coordinates for the known aqueduct sites using GPS. Back in the classroom, student team leaders with GIS expertise began extrapolating the location of the aqueduct using ArcView and United States Geological Survey (USGS) topographic maps. Although students were using ArcView for the first time, they were able to successfully plot points and use elevation data.

Students believed that the Alamo Pintado Creek was the source of the mission's water. The creek runs year-round; was listed in old Spanish documents about the mission; and was the site of Chumash Indian settlements and, later, Santa Ynez Valley towns.

A buried section of the aqueduct, previously unknown, was discovered because erosion had caused a small arroyo to form and pieces of the aqueduct washed down to the street. Based on rock and fragments of mortar and tile, students discovered where the aqueduct crosses Alamo Pintado Road. These sites, located at elevations between 490 and 500 feet, were mapped in ArcView.

Back in the EAST classroom, Tim Manchester, Erin Gnekow, and Clay Garland, assisted by Erik Glendinning, drew a buffer delineating the 500-foot contour line overlaid onto a current USGS topographic map to help visualize the path of the aqueduct and locate the dam.

Using this data, students extrapolated a possible route. All known sites fell on this route. After obtaining permission to work on the site, the class dug a small trench on a section of land west of Alamo Pintado Road. They found a portion of the aqueduct in the location predicted. However, a troubling fact remained. The aqueduct's route came near the only known source of water, Alamo Pintado Creek, far upstream of any known aqueduct features.



Students buffered a 500-foot contour line overlaid onto a current USGS topographic map to help visualize the path of the aqueduct and locate the dam.

The students, guided by teachers Ronald "Chip" Fenenga and Kim Merz, subsequently began collecting reference information from journals, texts, photographs, etchings, and interviews. To solve this mystery, the class obtained a copy of a 1905 USGS topographic map that showed a 500-foot contour line running through Alamo Pintado Creek nearly 5,100 feet northeast of the mission. This would have allowed water to flow to the mission using the underground aqueduct. "That was so cool—getting that image—as I could see the pieces falling together," noted Garland. "Suddenly, history made sense and you could feel the connection to the past."

In 2004, the project was nominated and received the California Governor's Award for Historic Preservation. Santa Ynez Valley Union High School was the first high school to receive this award.

The students still wanted to map the complete water system including the dam. After the heavy rains in the winter of 2004–2005, the students began a second search for the original dam. Of the 21 missions in California, Mission Santa Inés was the only one for which the location of the dam was not known. "We wanted to finish the story we started last year," said Glendinning.

"This is the best example of the use of historical research, geophysics, and archaeology to solve a particular problem that I have EVER seen!"

Dr. Robert Hoover, Professor Emeritus
California Polytechnic State University, San Luis Obispo

In 2004, the EAST class project was nominated and received the California Governor's Award for Historic Preservation.

All known sections of the aqueduct had elevations between 490 and 500 feet. In ArcView, students used the contour lines and the elevation information for the aqueduct to predict where the dam site should be located. Six students, armed with GPS units and cameras, ventured into the creek bed in March 2005 near a housing development to find the dam. Kenny Wilkens, Tim Manchester, and Greg Bridgeman found the dam and collected images and GPS location data. A few low sections of cement and river rock are all that remain of the dam. An unknown portion of the dam lies buried beneath almost 200 years' accumulation of sediment.

"You can't imagine how much work these kids put into this and the level of confidence they display in problem solving," noted Fenenga, who helped obtain funding for the EAST program. "It is also the only class I know where you have such diversity. Many of these kids have gone to Sacramento for advanced training from CAST [Center for Applied Special Technology], and they really are a credit to their community and school."

(Reprinted from the Fall 2005 issue of *GIS Educator*)

A Fun Way to Promote Geography

Can you name the world's most spoken primary language?

Which country is the largest consumer of oil?

What is the current U.S. population?

These and other questions were posed by the 2006 National Geographic-Roper Survey of Geographic Literacy to test the geographic knowledge of a randomly selected sample of 18- to 24-year-olds designed to represent young adults across the United States. The results highlighted the limited geographic knowledge young Americans possess.

A new program from the National Geographic Society will offer today's youth a valuable resource to increase their geographic knowledge and embrace the world around them. ESRI is sponsoring a Web site, My Wonderful World, that promotes geographic awareness to students in grades K–12 and provides tools for teachers and parents.

"Geography matters to everyone, whether they consciously realize it or not," says Jack Dangermond, ESRI president. "When we better understand how nature, people, and businesses relate, we can make better decisions. ESRI's mission is to build software that helps people see the patterns, find the relationships, and understand more clearly this wonderful world we share. ESRI is proud to support the National Geographic Society's My Wonderful World program in its efforts to improve geographic literacy among our nation's youth."

My Wonderful World is at the heart of the campaign. The site's resources help youth better understand the world around them. It suggests outdoor family activities; provides links to geography games and online adventures for kids and teenagers; and provides classroom materials for educators, global IQ tests, and other tools.

"Geographic illiteracy impacts our economic well-being, impacts our relationships with other nations and the environment, and isolates us from our world," said John Fahey, National Geographic Society president and CEO. "Geography is what helps us make sense of our world by showing the connections between people and places. Without geography, our young people are not ready to face the challenges of the increasingly interconnected and competitive world of the 21st century."

In addition to ESRI, many businesses, nonprofit groups, and education leaders are sponsoring the campaign. Sponsors include 4-H, American Federation of Teachers, Anheuser-Busch Adventure Parks, Asia Society, Association of American Geographers, Committee for Economic Development, Council on Competitiveness, iEARN-USA, Lindblad, National Basketball Association, National Council for Geographic Education, National Council of La Raza, National Council for Social Studies, National Parent Teacher Association, Sesame Workshop, the United Nations Foundation, and the World Affairs Councils of America.

To learn more about the My Wonderful World program and to start taking advantage of its rich features, visit www.mywonderfulworld.org.

My Wonderful World.org

A National Geographic-led campaign

(Reprinted from the Fall 2006 issue of *GIS Educator*)

Since 1969, ESRI has been giving customers around the world the power to think and plan geographically. The market leader in geographic information system (GIS) solutions, ESRI software is used in more than 300,000 organizations worldwide including each of the 200 largest cities in the United States, most national governments, more than two-thirds of Fortune 500 companies, and more than 5,000 colleges and universities. ESRI applications, running on more than one million desktops and thousands of Web and enterprise servers, provide the backbone for the world's mapping and spatial analysis. ESRI is the only vendor that provides complete technical solutions for desktop, mobile, server, and Internet platforms. Visit us at www.esri.com.

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