October 2013

Return on Investment

Ten GIS Case Studies

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Introduction

Thousands of organizations in both the public and private sectors have incorporated geographic information system (GIS) technology into their daily operations. Many can't imagine working without it, and the uses for this technology continue to evolve at a rapid rate.

Return on investment, commonly referred to as ROI, has become a recurring theme in management publications and the topic of seminars and conference presentations. Why should a government agency or business care about its ROI on GIS or any other technology?

There are many reasons for exploring ROI. These reasons relate not only to how an organization is perceived by others but what it knows about itself. This kind of self-examination encourages improvements in processes that keep businesses profitable and government organizations effective. Justifying expenditures is an accepted part of good business practice in the private sector and, increasingly, in the public sector. In an era marked by budget tightening, ROI analysis can answer the question that plagues managers everywhere, "What have you done for me lately?" ROI analysis also provides a self-check on job performance that boosts the confidence of workers as well as constituents or investors.

Workflow events, whether in business or government, generate tasks that result in products. Geography provides a context for relating workflow events, tasks, and products. As the language of geography, GIS provides a framework for organizing and maintaining data, improving workflows by streamlining tasks, and generating products more efficiently. GIS uses a knowledge-based approach that abstracts and serves geographic information, and it supplies the common link between departments in an organization or between organizations. GIS has continued to keep pace with the demands of information technology and now delivers benefits across and beyond organizations.

Canadian Hardware Heavyweight Builds Market Intelligence

Creating an In-House Solution Based on GIS Has Decreased Marketing Costs and Increased Sales

For a direct mail campaign to succeed, it must be targeted. It takes research, careful planning, and customization to ensure that the right message reaches the right individuals—those most likely to become repeat buyers. Nobody understands this better than Canada's largest hardware, home renovation, and gardening products retailer, RONA.

This map shows the highest-performing promotional flyer route for the store pictured based on the number of flyers delivered and sales generated.

RONA is headquartered in Boucherville, Quebec, with administrative centers across Canada in Surrey, British Columbia; Calgary, Alberta; and Toronto, Ontario. The company was founded in 1939 by a group of independent Montreal-area hardware retailers to compete with larger wholesalers to get the best prices from manufacturers. Today, there are more than 800 corporate, franchise, and affiliate stores of various sizes and configurations across the country. All these stores are serviced by RONA's Geomatics and Market Intelligence department.

Tightening Up Direct Mail

Like many successful companies, RONA reaches out to its customers with direct mail that is delivered to a customer's door. After some initial research, RONA discovered that a high volume of flyers was being sent to areas that was not necessarily developing into sales. Since paper and direct mail campaigns are expensive, a more targeted approach to flyer delivery was required.

In the past, RONA had been working with an external firm that provided a global view of the entire distribution network so that delivery areas could be planned strategically. While this approach facilitated a targeted distribution plan, working with an external firm had its own set of challenges. The process was difficult to manage, and there were costly delays. As a result, RONA decided to take matters into its own hands and develop an internal application that would optimize flyer delivery.

After assessing many solutions available, RONA decided to implement its own mapping system, based on ArcGIS and Microsoft Access. To analyze customer information, RONA used many different datasets from Statistics Canada, Canada's central statistical office that conducts a country-wide census every five years and produces statistics that are made available to individuals and organizations throughout the country. RONA also combined city maps and information from a popular national loyalty rewards program, AirMiles, to generate a nationwide snapshot of customers.

The system RONA developed allows staff to closely monitor customers through individual profiles linked to specific trade areas. By displaying information visually and effectively analyzing relationships between people, places, and behavior, new patterns and trends were revealed that would not have been evident using traditional business systems.

RONA also leveraged Esri's ArcGIS to develop analysis tools that provide market intelligence at the touch of a button. For example, users can analyze store market areas to see where markets overlap, find out which customers subscribe to newsletters, pinpoint neighborhoods that contain a high concentration of customers, and then print off their data in usage reports.

"We continuously scan Canada's markets, and using GIS lets us quickly develop distribution strategies for new, expanded, or relocated stores," says Simon Généreux, manager, Geomatics and Market Intelligence at RONA. "As a result, we're distributing 10 percent fewer flyers, which is saving us thousands of dollars per year."

Up to 100 Percent Cost Savings

Data can be extracted and shared with RONA's suppliers and distributors. Within minutes, RONA can determine the quantity and version of flyer that is needed for each trade area and provide this information to suppliers. A distribution module is directly integrated with ArcGIS so that the supplier can strategically plan the most effective flyer distribution runs using easy-to-understand map views. Flyer orders are then placed directly through the application.

With a more targeted approach to marketing, RONA is better able to serve its store network of 800 stores located across the country. By leveraging an in-house customized ArcGIS application, staff can analyze geographic areas and match the best flyers to the correct stores. This has virtually eliminated accidental shipping of promotional flyers to areas where the promotion was not occurring.

RONA's Geomatics and Market Intelligence department now finds it easier to create and adhere to annual budgets because it can see at a glance the precise number of flyers that will be distributed in the coming year. The company has saved money by eliminating promotional flyers in underperforming zones and by focusing energies on areas of high customer concentration. By no longer relying on an external company to conduct data analysis, RONA has also been able to save costs. In fact, by bringing the flyer distribution process in-house, RONA has reduced its external consulting budget by 100 percent.

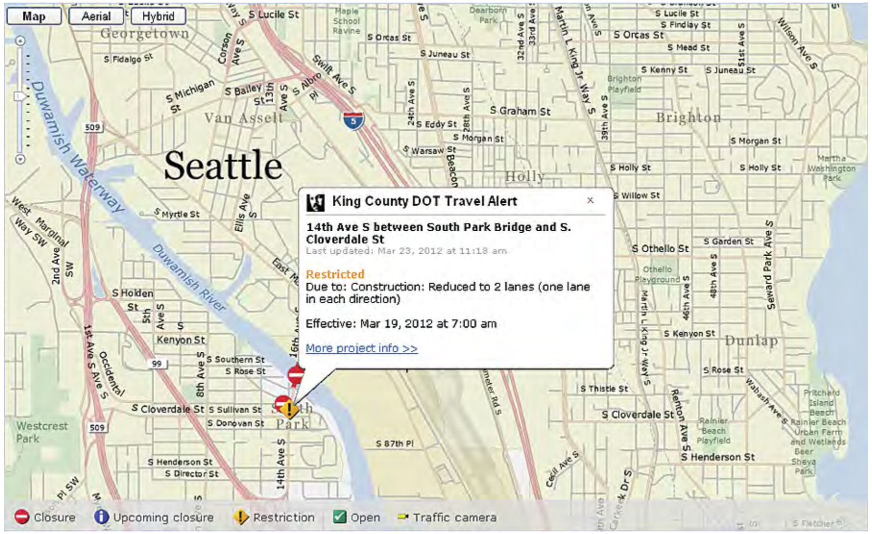
(This article originally appeared in the Summer 2013 issue of *ArcNews*.)

King County Documents ROI of GIS

$776 Million Saved During 18 Years

Home to Microsoft, Amazon.com, and Starbucks, King County, Washington, has a population close to two million people. GIS is critical to serving these citizens. Today, King County's GIS program supports an estimated 1,000 county employees in 42 agencies who use GIS data and applications in their daily work.

An economist at the University of Washington recently conducted a study measuring the return on investment (ROI) of the



King County's My Commute map keeps citizens up-to-date on road closures and traffic conditions.

enterprise GIS program, which the county has operated for the past two decades. The study indicated that the county has accrued net benefits between $776 million and $1.7 billion during an 18-year period, with costs of about $200 million.

GIS applications help staff improve operations in a wide range of departments, including the Department of Natural Resources and Parks (DNRP) and the Department of Community and Human Services. Citizens also use GIS frequently through public-facing maps like My Commute, which shows road closures and traffic conditions. The county estimates that its popular iMap, which allows users to create customized views of spatial information, receives almost 15 million hits a month from 150,000 user sessions.

In addition to traditional GIS applications, the county uses GIS to support key campaigns like the Equity and Social Justice initiative. This agenda aims to ensure that the county distributes services equitably and that all citizens experience fairness and equal opportunity. For example, GIS services help county leaders determine whether communities have enough parks and if social services are distributed fairly to all neighborhoods. GIS is also used to site waste transfer stations to ensure equity for county areas by not overloading them with certain types of facilities.

"Waste transfer station siting and disaster debris planning are important," says Gary Hocking, King County Information Technology service delivery manager, who oversees GIS for the county.

Like Hocking, Greg Babinski, King County GIS Center finance and marketing manager, knows the GIS program provides value to users, the county government, and citizens, but he wanted to see numbers.

This simulated aerial view over Seattle can provide King County planners with an eye in the sky wherever they need one. (Created by Victor High, senior GIS analyst)

Determining Value

Babinski began talking with fellow URISA board member and Oregon geographic information officer Cy Smith in 2008 about doing a return on investment study with an independent economist to measure the ROI that has accrued as a result of the King County GIS program.

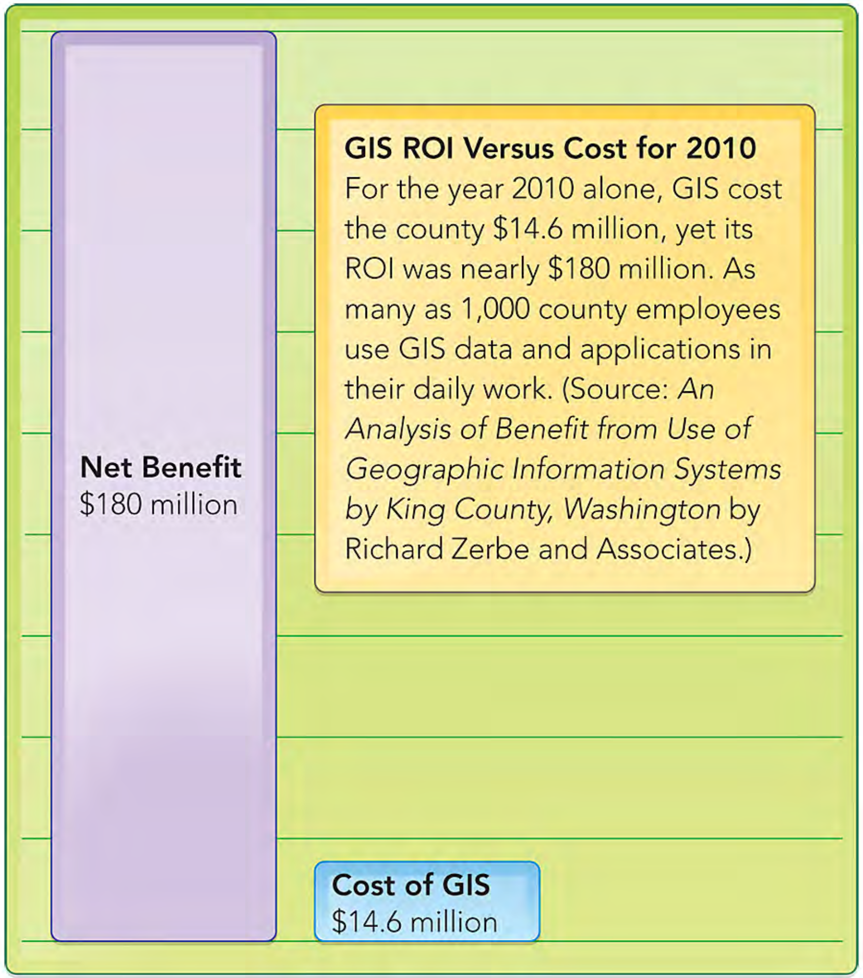
Those discussions led Babinski to the cost-benefit analysis work of Dr. Richard Zerbe, a renowned economist at the University of Washington and director of the UW Benefit-Cost Analysis Center at the Evans School of Public Affairs. Zerbe agreed to conduct an ROI study on the county's GIS program. He and his associates studied the 18-year period from the beginning of the GIS program in 1992 until 2010, with Babinski participating in the study as the project manager. King County and the State of Oregon cofunded the study. Smith explained that an extensive literature review conducted for the study indicated that no such study to measure the accrued ROI for an enterprise GIS program had been done before.

To begin their research, Zerbe's team met with county staff. They conducted face-to-face interviews with 30 county employees to gauge the role of GIS in various agencies and to better understand the kinds of work GIS facilitates. The team then sent a survey to employees to determine current production levels and the pre-GIS levels. One hundred seventy-five GIS professionals and users responded to the survey.

The savings in time and effort were monetized based on salary figures and full-time employee statistics to determine what it would cost agencies to replicate their pre-GIS level of output with GIS technology as well as the cost of replicating current GIS-aided production levels without GIS technology.

For 2010, for example, they determined that the cost of GIS was $14.6 million and the net benefit was approximately $180 million. The study by Richard Zerbe and Associates used a "with versus without" approach. While costs for all years were available, estimating benefits for the 18-year period was challenging. How opportunity cost was calculated had a substantial effect on the resultant ROI value. In addition, benefits are measured in outputs that are quantitatively and qualitatively better with GIS, leading to increased demand for these outputs. Assigning a dollar value to these more useful outputs is difficult. These factors were expressed in the three estimates in net benefits between 1992 and 2010: a conservative estimate of net benefit of approximately $776 million, a less conservative benefit level of $1.76 billion, and the least conservative estimate of almost $5 billion. *(See the original report [PDF] for a complete description of the methodology used.)*

"It's important in this day and age in government to be able to validate your benefits and provide cost-benefit analysis for investments," says Hocking. "We had our own anecdotal



evidence of the value of GIS, but now we have solid evidence of that value."

King County chief information officer Bill Kehoe agrees and views the GIS service as a trailblazer for IT-based county services. "Our GIS service is an example of a high-performing IT service that is providing a large amount of customer efficiency for the investment," he says. "The GIS service is a model that we want all our services within King County IT to aspire to."

The ROI study doesn't just validate King County's investment in GIS; it also provides strong evidence other governments can use to show that GIS improves government operations and delivers significant value.

To view the full ROI study, visit esriurl.com/KCROI [PDF]. For more information about King County Information Technology, visit www.kingcounty.gov/operations/it.aspx.

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The Big Sky State Finds Gold in Statewide Cadastral Database

Montana's GIS-Based Cadastre Layered with Riches

As the fourth-largest state in the United States, Montana is synonymous with *frontier*. Under the state's famous "big sky" are 145,552 square miles of sparsely populated open land. Running in a diagonal line from northwest to south-central Montana, the Continental Divide splits and roughly defines the topography of the Big Sky State. West of the divide stand the northern and central Rocky Mountains, while east of the divide are mostly prairies and plains. Meanwhile, rivers; lakes; forests; national parks and monuments; long, lonesome highways; Canada; and four other US states divide, dot, and border Montana's 56 counties.

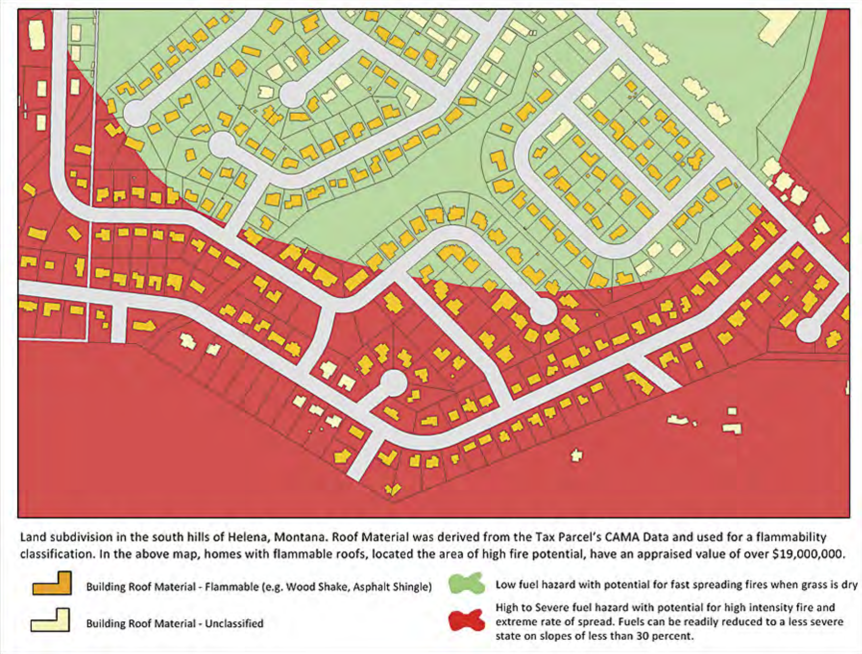
Lost Lake in Montana.

Managing all the geographic data associated with a territory as immense as Montana is no small task. The state recognized this challenge and pioneered a GIS-based statewide cadastral database. Montana's spatial data infrastructure, as recognized by the Montana Land Information Council, consists of 14 layers, with the cadastral layer being one of the most mature. The layer is based on the tax cadastre, a legal repository of land records that identifies the owner, location, boundaries, description, and property rights associated with a parcel of land. Montana's cadastral layer is most closely associated with the property assessment processes, but usage of the data goes far beyond the state Department of Revenue (DOR).

"More than half of government business processes are associated with parcels," says Montana Base Map Service Center (BMSC) chief Stewart Kirkpatrick. "Questions like, Who owns that parcel? or What features are associated with this parcel? are a constant at the local and state levels. It made sense that we, the State of Montana, had a standardized digital cadastre system that everyone could access."

According to the US Office of Management and Budget's Federal Enterprise Architecture framework, Kirkpatrick is right. The framework states that 74 percent of government data is location based, and that number is even higher at the state and local levels. Back in 1996, Montana hired Kirkpatrick as the project manager to explore the concept of a statewide cadastre, build a project plan, and obtain funding to collect and maintain tax parcel data in a standardized format using ArcGIS technology as the platform. Recognizing how their organizations could benefit from a statewide cadastre, Burlington Northern, Montana Dakota Utilities, Montana Power, and the United States Department of the Interior Bureau of Land Management (BLM) all signed on as major contributors to the project.

With initial funding in place, the conversion of paper records to digital format commenced in 1998, and in 2003, when the new digital tax parcel framework was complete, Montana had the only statewide cadastral database in the nation. Although the data was available by then, full benefits, such as a return on the state's $3 million cadastre database investment, were not realized until 2005. That initial investment included the development of the cadastral database. It also included the five-year task of paying contractors and state staff to convert, standardize, and integrate mostly paper-based data from approximately 900,000 parcels into the new ArcGIS software-based cadastral database.



Overview of roof material derived from tax parcel data.

By 2009, the state estimated the minimum annual value of its digital parcel and cadastral data at just over $10 million. It figures that the annual return on investment (ROI) is $9,335,700. ROI figures came from a Montana state study that focused on the value and costs associated with the cadastral system, including an evaluation of the IT investment in the cadastral layer; identification of business processes, users, and beneficiaries that depend on the cadastral layer; identification of the relationship between the cadastral framework and the other 12 framework layers; and development of a financial analysis that documents the current and ongoing costs and benefits of the cadastral layer.

An abundance of government agencies lend data to the system. DOR and eight counties collect the tax parcel data, while other agencies and interests collect ancillary data on conservation easements; municipal and school district boundaries; special districts like water, sewer, and mosquito abatement; and other data that conveys rights and interest on the land. It is BMSC's responsibility to integrate the tax parcels and related data into a statewide database monthly and link the tax parcels to DOR's computer-assisted mass appraisal system, ORION. BMSC also integrates BLM's geographic coordinate database as the digital representation of the public land survey (PLS) in Montana, since the PLS is the foundation of landownership in the state.

All cadastral data, including parcels and other spatially coincident feature classes, is stored in an Esri geodatabase by BMSC, while DOR's tabular data is moved to an Oracle database linked to the parcels. The data is housed in ArcGIS Server, then distributed as shapefiles and geodatabases where businesses, organizations, and other interested parties can go for cadastral data and maps.

Citizens, private organizations, and various state and county agencies use the cadastral information in a wide variety of ways. BMSC distributes the information to the public through the Montana Cadastral Mapping Application website, while the Montana State Library's GIS portal web page is the distribution point for metadata describing the state's cadastral database.

Esri Partner POWER Engineers Inc., a global engineering firm based in Hailey, Idaho, is an example of a private organization that appreciates the ease and speed of acquiring data from Montana's cadastral websites. Over the years, the firm has downloaded copious amounts of data for various Montana infrastructure projects, such as routing transmission and telecommunications lines and subsequent management of rights-of-way acquisitions.

POWER Engineers' recent business in Montana includes replacing old 115-kilovolt (kV) transmission lines with the larger 230 kV lines. The new transmission system may utilize the same corridor, but in some cases, the upgrade requires that more rights-of-way are acquired to accommodate the bigger structures. When routing a proposed power transmission corridor, the cadastral data can be used to minimize easement acquisition costs.

"We get data straight from the Montana cadastre websites and plug it into our own GIS," says POWER Engineers consultant Scott Chapman. "It's as easy as going to the website and selecting the county we're working in, then downloading the data."

State, county, and local municipalities can access the system, and they can link their own GIS solutions. The ArcGIS software-based cadastre has proved to be a significant time-saver for all kinds of small and large government tasks. In addition, BMSC provides hundreds of hours of assistance annually to local governments maintaining their own cadastral databases and holds educational workshops and seminars to expand cadastral knowledge.

Montana's Butte-Silver Bow is just one of the many local governments to reap the rewards of the digital cadastre. As the director of Butte-Silver Bow's planning department, Jon Sesso oversees a residential metals abatement program. Having cadastral data easily accessible in a GIS is important to the city-county government, especially when a property is sold. It's a high priority to test for and abate the presence of toxins, especially on properties where children live, because youth are extremely susceptible to dangerous chemicals, such as lead, found in or around a home.

When a property is sold, it gets recorded in the county's GIS, which then alerts Sesso's department. If the property has already been tested, no action is taken. However, when a property that has not been tested changes ownership, performing a test becomes a high priority, since the new owners could have children.

Says Sesso. "Having these land records digitized in the cadastral system has been a tremendous help for us. We have a legal obligation to keep track of where we have tested, where we've done abatements, and where we haven't."

For more information, visit gis.mt.gov.

(This article originally appeared in the Summer 2011 issue of *ArcNews*.)

Philadelphia Saves $1 Million per Year

GIS-Based Traffic Light Project

The City of Philadelphia, Pennsylvania, is using ArcGIS software to implement its LED Traffic Lights Project, an ambitious traffic light replacement program funded in part by an American Recovery and Reinvestment Act of 2009 grant. With ArcGIS, the city's Department of Streets will track and manage the project, which will replace 87,000 incandescent light bulbs with energy-saving light-emitting diode (LED) bulbs. Estimated operational savings, resulting from significantly lower use of electricity, the greater longevity of LED bulbs, and the fixed department costs to replace bulbs, are expected to top $1 million per year.

In addition to saving money and field personnel time, Philadelphia's enterprise implementation of the system provides data access to other departments within the city, resulting in a significant return on investment.

Andy Mehos, GIS manager for the Department of Streets, says, "The opportunity to capture the asset data for the light replacement project, use it for other applications within the Department of Streets, and share it with other departments saves the city a considerable amount of time and money. It is significant enough to offset any cost of software development and the purchase of equipment. After observing our success in implementing this project, other city departments are considering similar GIS projects of their own."

The department employed Esri Partner geographIT to develop a customized GIS application integrated with ArcGIS that supplies a spatially enabled mobile solution for tracking street-related city assets. The application's bar code scanning capability provides a quick way to add an LED bulb record to the geodatabase while in the field. In addition to LED bulbs, the department is capturing asset data about traffic heads, traffic control boxes, and light and sign pole attachments with the application.

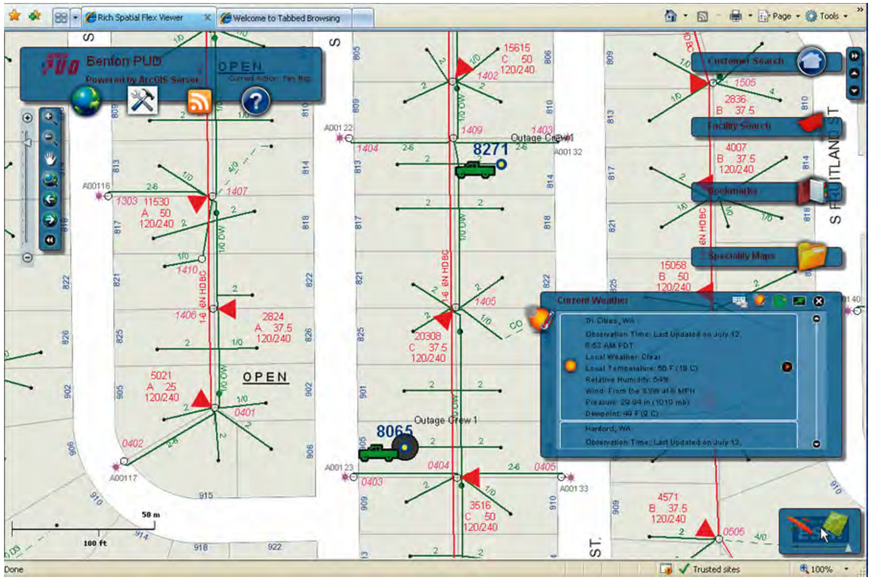
A video about Philadelphia's light replacement program, *The Recovery Act Is "Lighting Up" the Streets of Philadelphia*, can be seen at esriurl.com/1726.

For more information about Esri's public works solutions, visit esri.com/publicworks.

(This article originally appeared in the Spring 2011 issue of *ArcNews*.)

Fiber Network in View for Benton Public Utility District

Benton Public Utility District (PUD) now has a single, real-time picture of its entire fiberoptic and electric networks available electronically to all staff. That picture includes data stored in a database and integrated from disparate systems, such as SCADA and customer information. Additionally, the Benton PUD database offers version management so multiple users can work simultaneously. The system supports network tracing that enables field crews to see accurate asset information and identify affected customers during an outage.



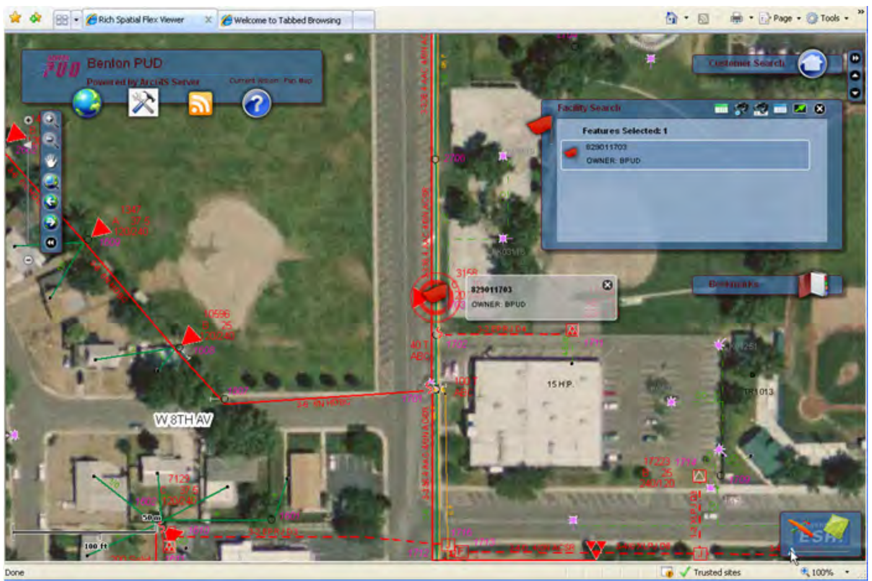
A real-time display of data from the outage management system shows a single customer outage, identifies that the customer called the after-hours call center, and notes that Benton PUD has assigned a crew to the incident.

Benton PUD supports broadband services to more than 800 wholesale customers covering more than 900 square miles of service territory, as well as transmission and distribution of electric energy to more than 48,000 electric customers.

A municipal corporation of the State of Washington, Benton PUD was established in 1946 and is headquartered in Kennewick. The company manages more than 150 miles of fiberoptic cables, 37 substations, approximately 90 miles of 115 kV transmission lines, and 1,590 miles of distribution lines.

The company selected ArcGIS technology because of its ability to provide staff in the office and field with an accurate picture of PUD's networks. Benton PUD was able to integrate ArcGIS with other internal and external systems using a realtime service-oriented architecture that includes SCADA; an off-site after-hours call center; customer information; light and transformer asset data; financial and Federal Energy Regulatory Commission accounting data; and time, labor, and work order information. Now, users access any necessary data, bring it to ArcGIS, and work with a personal or enterprise geodatabase.

One person on a mobile device can send updates to asset or customer data in the field as another person analyzes this information on the desktop using a web browser. ArcGIS also comes equipped with the version management and network tracing capabilities that Benton PUD desires.



In this screen shot, a Facility Locate widget helps Benton PUD locate a specific transformer along with pertinent data. This widget allows users to search for nearly every type of electric and broadband facility in the geodatabase including poles, vaults, switches, lights, and sectionalizers. Aerial photo transparency can be adjusted by a slider bar in the lower left corner using a widget available from ArcGIS Online. All widgets used by Benton PUD are developed by Esri or the user community and can be downloaded for free.

"During the year following implementation, we saved $240,000 in labor and materials," says Chris Folta, Benton PUD manager of applications and integration. "The intangible return on investment is how quickly we can access data and turn it into actionable information. The operations team can see, at any time, the current state of the electric and fiberoptic networks, the location and scope of engineering projects, where outage crews are working, and how customers are affected by interruptions to the system."

Utility field crews and office staff can now access the most current information from a mobile or desktop computer. In the field, workers are able to trace the network to see, for example, which customers would be out of power if they opened a switch. Aerial photographs and GPS data bolster the utility's customer and asset information. With a completely electronic system, the utility no longer prints copies of network maps—a change that saves time and resources.

Benton PUD's data is kept in sync in near real time. Before upgrading its technology, the company averaged a five-week turnaround time for information updates on the map. Now, the average is three days.

"We have been able to lower the duration of customer outages, improve crew response time, and reduce labor and overtime costs that were a result of inaccurate information in the legacy paper maps," says Folta. "Instead of looking for physical copies of work order and mapping information, staff can use the GIS tools to find the information they need. The field crews go out each day with an updated facility map that includes customer information, usage history, and work orders to accomplish their tasks."

(This article originally appeared in the Spring 2012 issue of *ArcNews*.)

The Healthy Model for Nursing Workforce Management and Planning

Stanford University Medical Center Estimates a $22.5 Million Potential Cost Savings Over Two Years

For many years, health care administrators and hospital human resources (HR) departments in particular have had difficulty finding solid business intelligence for workforce planning. Hospitals acknowledge a heavy reliance on their nursing workforces, as well as on a direct relationship between the strength of those workforces and patient care outcomes. Hence, the development of workforce planning methods and tools is crucial to helping hospitals not only solve the puzzle of successfully recruiting and retaining top-caliber teams of nurses but also be prepared to successfully provide staff and operate during regional emergencies (e.g., earthquakes, fires, pandemics). An additional factor has been recent media coverage of potential nurse shortages, which has increased pressure to detect and plan for any such lack of availability.

Stanford University Medical Center, located in Palo Alto, California, on the Stanford University campus, comprises three main components: the Stanford School of Medicine, Stanford Hospital and Clinics, and Lucile Packard Children's Hospital. With 885 licensed beds, the Stanford University Medical Center also serves as the primary teaching environment for the Stanford School of Medicine and provides a clinical backdrop for world-class research. The nursing staff occupies the largest clinical workforce category, with approximately 2,700 registered nurses. Long-range workforce planning for maintaining an adequate nursing staff is therefore an essential administrative challenge.

"By drawing the analogy to epidemiology and emergency planning," says David Schutt, principal planning analyst, HR Programs, Stanford University Medical Center, "I was able to convince hospital leadership that GIS would be ideal for workforce planning because it introduces a geographic approach and provides visual, map-based results. In actual practice, we discovered that, while a GIS has the ability to access, manipulate, and analyze internal and external data on any type of workforce, it has an almost uncanny hand-and-glove fit with health care, especially relative to hospitals."

Schutt explains that this is because just about every external clinical professional at any hospital, especially nurses, must be state licensed and registered, making their geographic location easy to map. ArcGIS Desktop, which was selected at Schutt's recommendation, enabled HR to analyze and map this external data combined with internal HR workforce data, providing an overview of the hospitals' nursing supply and demand, as well as information about employee commute patterns and distances traveled to work.

With internal and external data for nurse populations mapped, ArcGIS, with its buffering functionality, and the ArcGIS Spatial Analyst extension help answer just about any question as it relates to workforce planning. Queries have included

- If the nursing population living within a six-mile radius of our hospitals is projected to retire in 10 years, but the average home price in the area has become far too expensive for just about any clinical professional, how will we be able to attract new entrants to our workforce to this location?
- What if we experience an earthquake in the middle of the night, and the majority of our nurses live on the other side of a major bridge affected by the quake?
- Many hospitals around the rest of the country are or will be experiencing a nurse shortage. Do we or will we have a shortage in our metro area?

"We have been able to ask and answer all these questions and many more," says Tony Redmond, director, Nursing and Allied Health Talent Acquisition Programs, Stanford University Medical Center. "Our HR and hospital leadership is no longer experiencing a business intelligence deficiency as it relates to the development of actionable workforce plans." Answers to these kinds of questions also help workforce planning for the medical school staff and allied health professional workforces, such as pharmacists, clinical lab professionals, and physical therapists.

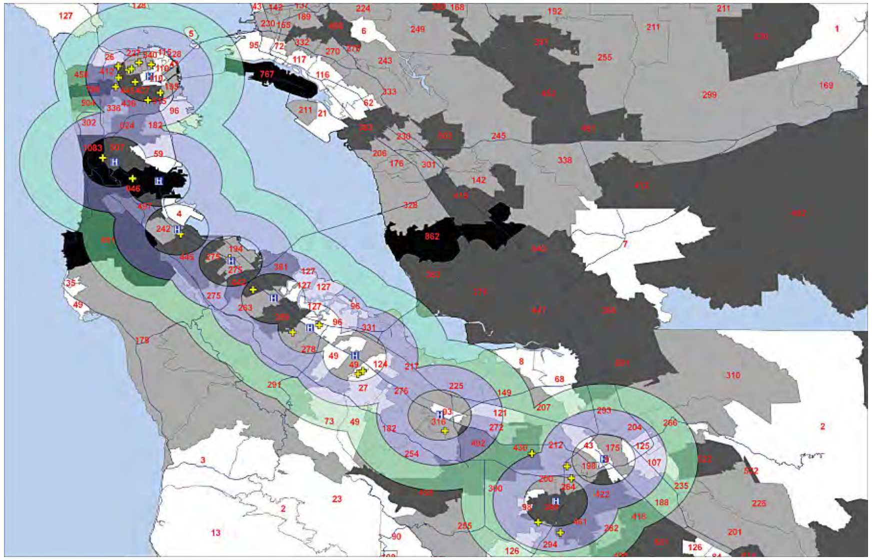
Schutt says, "While recruiters have had hunches for decades about what may or may not be attractive recruitment features for nurses—such as pay, shift, and location—GIS analysis has, once and for all, laid the location controversy to rest. The nurse comfort zone for Stanford University Medical Center is about a 12-mile radius. Looked at another way, this is also a retention factor. When close proximity to the hospitals is coupled with nurses surpassing the milestone of three to five years of service, they are more likely to stay on board until they retire."

Real Savings and Better Coordination

While long-term planning must always be a work in progress, large returns on investment are already being realized. The recruitment advertising budget has been reduced by at least 50 percent, a monumental amount considering the San Francisco Bay Area is one of the most expensive advertising regions in the United States.

"GIS enables the hospitals to identify places where there are too few nurses or too much competition and to stop wasteful advertising in those areas," says Schutt.

GIS also allows the hospitals to precisely target candidates and use direct mail to reach them. In addition, mapping and analysis of workforce retention data provide insight into why nurses leave



The entire San Francisco Bay Area external registered nurse population with hospital points buffered at two, four, and six miles up and down the San Francisco Peninsula, showing the ease with which nurses can establish their careers by leapfrogging from one hospital to another.

the medical center to work elsewhere. For example, when Schutt compared the medical center location to latitude-longitude points of all other hospitals on the San Francisco Peninsula, applying a buffer at two, four, and six miles and comparing it to other internal retention data, it became visually obvious that nurses just starting their careers could actually leapfrog from one hospital to another, up and down the peninsula, until they were able to locate the right pay and the right shift, as most of these other locations are potentially within their comfort zone.

This knowledge helps hospitals anticipate and mitigate potential interruptions to continuity of care and avoid the astronomical costs associated with hiring and retraining replacements. Schutt estimates that this knowledge could free up approximately $22.5 million over the next two years that would otherwise be spent on replacement/retraining costs.

In the Works

The Stanford University Medical Center HR department has established ongoing dialogs with other medical center departments; the Stanford School of Medicine; and Stanford University GIS labs, libraries, and administrative offices, all of which are also using ArcGIS and ArcGIS Server. Plans are in the works to develop and support coordinated efforts relative to both people and places throughout the campus community, including potential disaster preparedness planning.

(This article originally appeared in the Fall 2010 issue of *ArcNews*.)

Lidar, Building Information Modeling, and GIS Converge

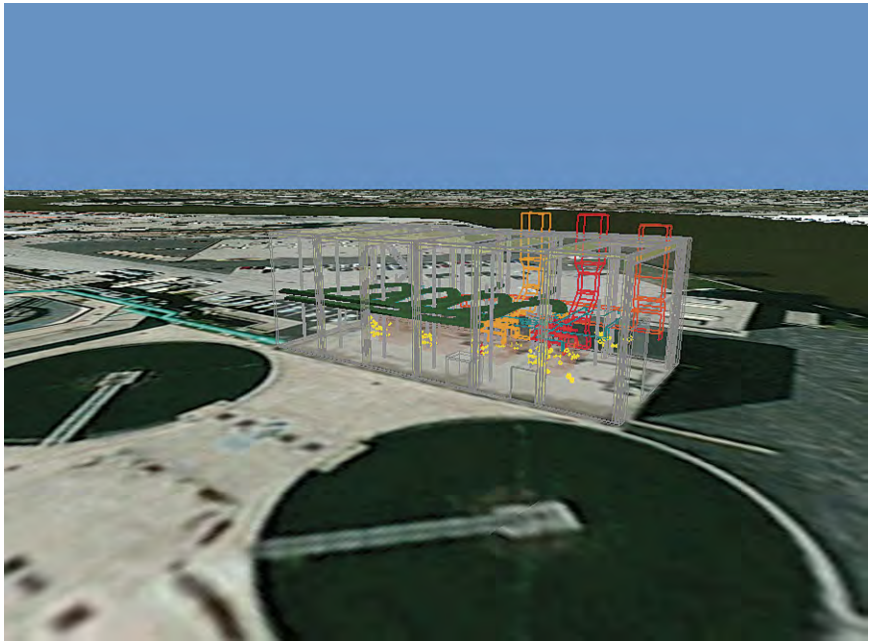
Bringing Business Efficiencies to Milwaukee Metropolitan Sewerage District

Milwaukee, Wisconsin, is the 26th largest city in the United States; its regional wastewater system is among the largest, most sophisticated, and well run in the country. The Milwaukee Metropolitan Sewerage District (MMSD) provides wastewater services for 28 municipalities comprising about one million people. The district's 411-square-mile planning area includes all cities and villages except the City of South Milwaukee. Serving these municipalities requires MMSD to develop spatial inventories and applications that meet internal and external needs for planning and design. Like any large facility, many of these efforts began organically within single departments to answer a specific need for one project.

To ease the consolidation of facilities data information, MMSD called on HNTB of Kansas City, Missouri, a national infrastructure firm and Esri Silver Partner, to conduct a practical research project that pilots a data management approach for lidar and building information modeling (BIM) data. The project specifically studied the practical business applications integrating 3D design and construction data from an aeration system rehabilitation project into MMSD's enterprise GIS environment.

Put the Money Where the Return on Investment Is

As part of this research and development project, return-on-investment estimates were generated for distinct use cases, focusing on integrating lidar and BIM technology with GIS to greatly improve access and retrieval of as-built conditions for



Interactive viewing of the 3D geodatabase in the ArcGIS Engine application, including dynamic symbolization of features.

MMSD employees and their consultants. A number of different application development platforms and existing software solutions were considered for the project. Each software package was evaluated based on criteria defined by MMSD. ArcGIS Engine was selected as the platform that met all these requirements. ArcGIS Engine is a collection of GIS components and developer resources that can be embedded into other applications, allowing dynamic mapping and GIS capabilities in many different environments.

An Expandable Enterprise System

MMSD was already a user of Esri technology, having adopted ArcGIS for Desktop software in 2003 for department-specific solutions. In 2009, MMSD consulted with HNTB to help facilitate the move into an enterprise environment using ArcGIS for Server. This was a multiphase implementation that included the development of a business data model. The data model focused on existing data inventory and application user needs at the time, including improving mapping and organizational efficiencies, as well as bringing added value to MMSD business operations. In 2011, MMSD completed the project, developing several applications that addressed specific areas to map related data to the district's infrastructure resources and to service areas.

"Historically, information regarding water quality, water quality improvements, and physical features of water were located in separate departments at MMSD," says Jeff Siegel, GISP, associate vice president and technology solutions center director, HNTB. "Consolidation of this information took time, money, and executive sponsorship to change priorities. Now, all staff can access and output this information from their desktops without the help or sponsorship of other staff. The staff has the information it needs to make better and faster decisions, which was another of our guiding objectives."

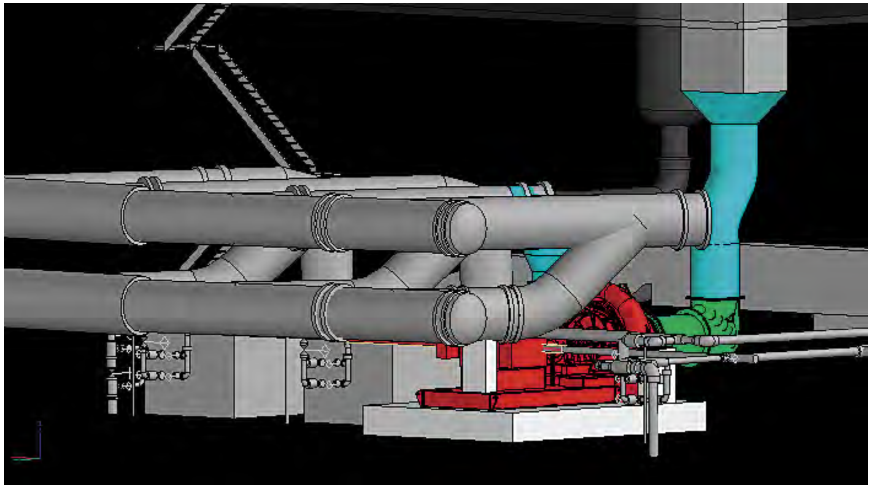
For this pilot project, among the many criteria MMSD had, data and document access was again selected as a high priority. "In this scenario, a 3D model was created and integrated into GIS," says Siegel.

Again, the objective was for users to view and select features on their own. In this case, the 3D model would be displayed within an environment they are familiar with—the ArcGIS environment. Using this model, staff can access related data in external databases, including documents relevant to the 3D model feature the user selected.

Modern Technology Studies a Historic Facility

The study area included Jones Island Water Reclamation Facility, one of two wastewater treatment facilities within the district's service area. Jones Island is located on the shores of Lake Michigan in Milwaukee. On average, the Jones Island facility collects and treats a maximum daily flow of 300 million gallons of wastewater, returning clean, clear water to Lake Michigan.

As part of the Milwaukee Metropolitan Sewerage District 2020 Facilities Plan, HNTB was tasked with developing design improvements for the Jones Island Water Reclamation Facility aeration system. The project will lead to a reduction of electrical energy usage through gains in aeration system blower and diffuser efficiencies, as well as enhancements to controlling air distribution to aeration basins and channels.



The application employs dynamic linkages from the geodatabase to the building information model (BIM) for viewing greater 3D design detail.

To gather accurate and precise as-built conditions of the aeration system, HNTB engineers decided to collect internal facility data to derive a BIM from static lidar point clouds. This approach quickly brought dependable and accurate existing conditions information to the designers in an interactive 3D design environment.

"Because static lidar scanning is a direct line-of-sight method of data collection, the entire interior of a facility required enough scans for every single feature to be captured," says Siegel. "The estimated number of scans required increases based on the number of floors and the complexity of the building."

A typical static lidar scan takes about 10 to 15 minutes. So a crew of two has the ability to scan anywhere from four to six locations—typically a room or hallway—in just one hour. For this project, more than 100 scans were collected in one day to gather point clouds of the entire facility.

The decision to use BIM to manage the design process allowed many different disciplines to collaborate at different phases of the facility design project. BIM is defined as a process using a combination of technologies and resources to capture, manage, analyze, and display a digital representation of physical and functional characteristics of a facility.

Realistic 3D Models for Everyday Use

Integrating lidar and BIM data with MMSD's enterprise GIS was thought to offer many benefits to the agency. "In our opinion, this was the most well-organized way to package up and deliver all our 3D design and construction methods to our client," says Siegel.

By extending BIM and lidar into the ArcGIS environment, the district can benefit from the data and integration points between the technologies, realizing significant operational efficiencies. Asset and facilities management is one area where improvements to maintenance management and document management systems can happen. The ability to manage data and keep a record of work orders and maintenance activity is invaluable to managers.

Another area where the district is expected to realize efficiencies is in plant and facilities operations. "There are a number of ways a 3D, geographically based representation of the facilities will help our customer," says Siegel. "From safety and training to creating documentation and just having an operational database, GIS makes it easy to manage and use the collected information and model the facility dynamically in so many ways."

Facility planning is another area where this approach can offer some real payback. From modeling proposed upgrades to capital improvements, the ease of sharing this information in an easily understandable format is a big win. "Since this is a historical landmark for the area, there are many complexities in maintaining the 3D model to the data management standards that MMSD expects," says Siegel. "Viewing a 3D model that is intelligent—meaning we can see more information about the facility picture we are displaying—makes it so much more efficient to answer questions, propose new scenarios, and move the projects along at a quicker pace."

Lessons Learned

The most critical factor preventing more robust integration between BIM and GIS is the native incompatibility of the two data formats. A critical data integration fracture between BIM and GIS is the importance of defining spatial coordinates of the BIM file at the beginning of the project. "The purpose of this is to allow us and our client to accurately locate a building within a site and to give it a physical location context at larger scales that can be overlaid with aerial imagery and topographic and other layers from an enterprise geodatabase," says Siegel.

For information on using GIS for facilities, visit esri.com/facilities.

(This article originally appeared in the Spring 2013 issue of *ArcNews*.)

Charting the Roads of the Vast Navajo Nation

Using GIS to Assess and Manage Tribal Transportation Infrastructure

Spanning approximately 27,000 square miles across three states, the Navajo Nation is the largest sovereign nation in the contiguous United States. It has a strong presence in US government and often leads the way in tribal efforts to promote key areas such as economic development, health care, and education at the national level. Despite its prominence, the sheer size and remote nature of the Navajo Reservation presents unique challenges in managing its infrastructure and resources.

Consider, for instance, the road inventory that tribes submit each year to the Indian Reservation Roads (IRR) program. The IRR program maintains the official inventory of reservation roads in the United States and is designed to allocate federal funding to tribal governments for transportation planning and road maintenance activities.

A component of the broader Integrated Transportation Information Management System program, the Bureau of Indian Affairs (BIA) Division of Transportation maintains the national reservation road inventory in a system called the Road Information Field Data System (RIFDS). Each year, as part of the IRR program, tribes are eligible to submit their road inventory data to one of the 12 BIA regional offices. There are

The sheer size and remote nature of the Navajo Reservation presents unique challenges in managing its infrastructure and resources.

approximately 560 nationally recognized tribes that fall under the 12 BIA regions. The Navajo Nation submits its road inventory to the BIA Navajo Regional Office (BIA-NRO) in Gallup, New Mexico.

The Navajo road inventory was far from comprehensive. In early 2006, its official RIFDS inventory contained approximately 9,800 miles of roads. Roughly 6,000 miles were BIA roads, and the remaining 3,800 were primarily state and county roads, with very few tribal roads mixed in. Navajo transportation officials determined that the road inventory was substantially underperforming in two key areas:

- **Road Mileage Quantity—**The current inventory reflected only a small percentage of the reservation's tribal roads. It was widely believed that there were thousands of miles of tribal public roads that were eligible for the inventory but not yet included.
- **Data Quality—**Of the 9,800 miles of roads in the 2006 inventory, only a portion generated funding in the RIFDS allocation formula. Some roads in the existing inventory were missing key pieces of information, which excluded them from funding. Misinterpretations of program regulations resulted in a lack of quality data, exacerbating the effect of the low mileage numbers.

To address these issues, in April 2006, the Navajo Division of Transportation (DOT) launched a proactive and aggressive campaign that would expand its internal capacities, establish a systematic method for identifying eligible public tribal reservation roads, remove subjectivity from regulations, and build a system to improve both the quantity and quality of the road inventory data. With the support of the Navajo Nation Transportation and Community Development Committee and under the direction of former Navajo Division of Transportation director Tom Platero, the Navajo Inventory Team and consulting project manager Nick Hutton embarked on an innovative and challenging endeavor that would span more than four years.

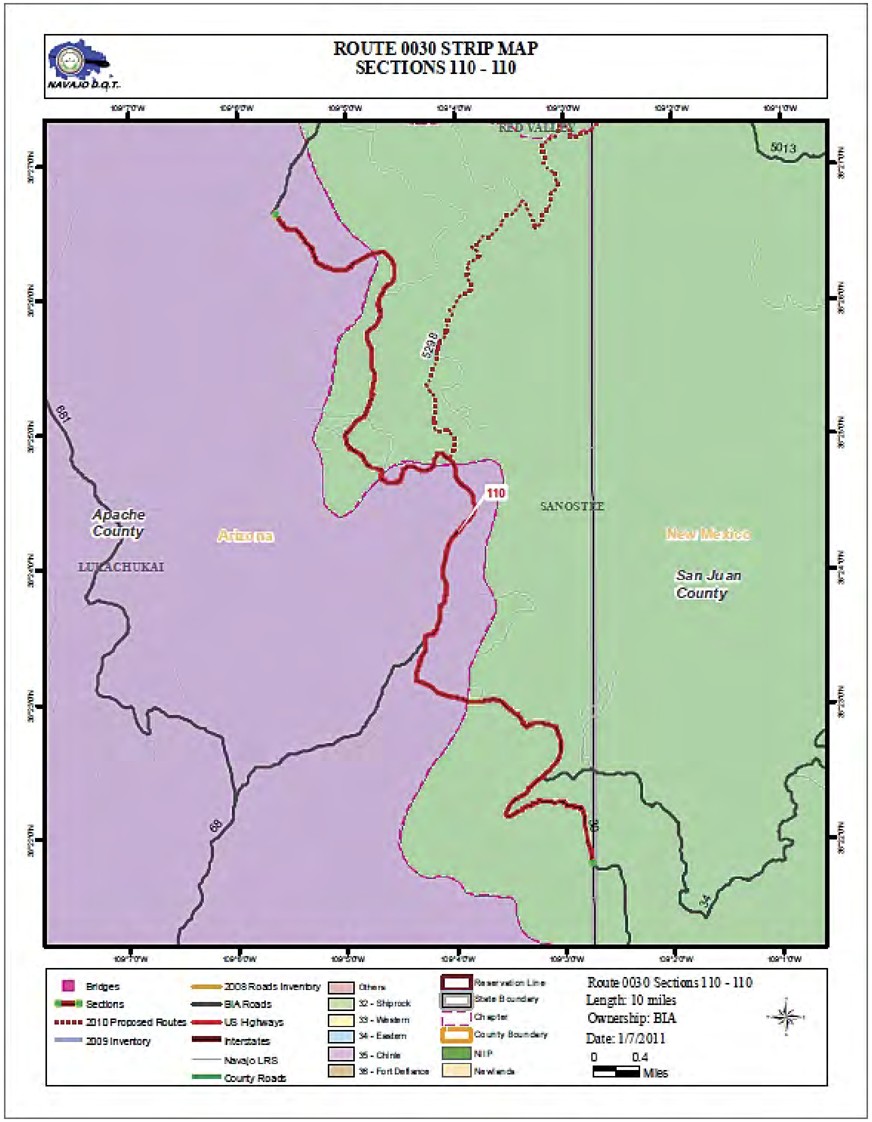
The first step was to fortify the Navajo DOT's existing technology infrastructure. New enterprise-class servers were put into place, network bandwidth was expanded, and new data was collected.

To save time on installation and testing, the Navajo DOT selected a turnkey server offer from Esri preloaded with ArcGIS for Server and Microsoft SQL Server and preconfigured to optimize system performance. This allowed the Navajo Inventory Team to focus on developing core programs and data instead of tweaking the new system. The result was a spatially enabled, multitiered, web-based information architecture supported by an integrated hardware and software solution and powered by Esri technology.

The next step was to obtain and develop the required data. The Inventory Team was able to acquire brand-new, reservation-wide aerial photography captured as part of a joint project between the Department of Interior and the State of New Mexico. Once the imagery was loaded onto the new system, it was time to start digitizing road centerlines.

Digitization was carried out by a team of GIS technicians with the help of Esri Partner Data Transfer Solutions (DTS) of Orlando, Florida, which was selected to facilitate the process. It wasn't until this time that the team realized the full extent of the project. After several months of heads-up digitizing, the team had mapped more than 70,000 miles of roads and trails. While not all the digitized centerlines were eligible for the official IRR inventory, the potential challenges associated with managing these roads were daunting to DOT officials. This realization underscored the notion that automation would be an absolute necessity in the development of the Navajo DOT road inventory system. While the GIS techs continued the digitization process, the programming staff at DTS and the Navajo DOT Inventory Team were busy developing the inventory management system.

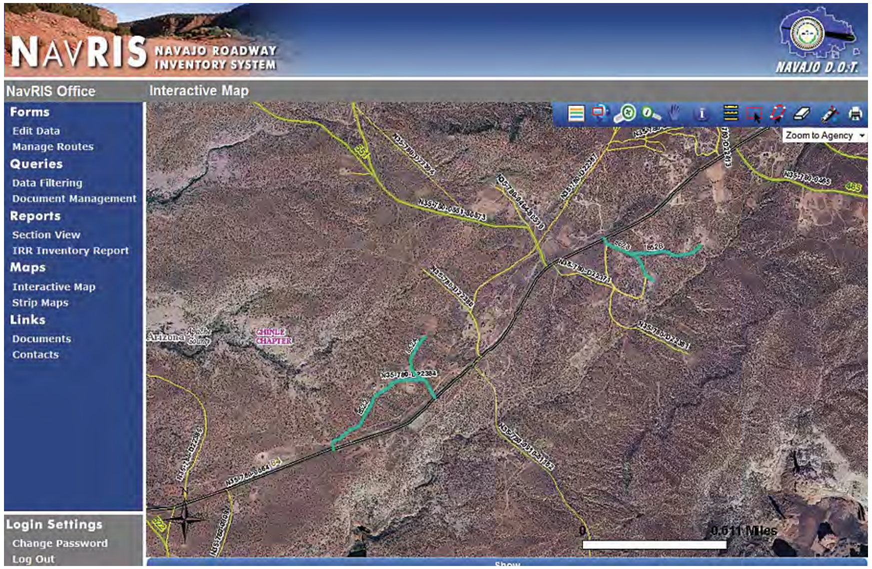
The team concluded that the system must be secure; web based; geospatially enabled; usable by staff members both with and without GIS expertise; and capable of mapping automation—specifically, strip map automation. In addition, the team identified the need for a robust querying component that included bidirectional filtering between the map interface and the filtering page.



The selected route is highlighted in red and labeled with a corresponding section number, and then the map is automatically generated.

What emerged was a system the Navajo DOT calls the Navajo Roadway Inventory System (NAVRIS). In addition to web, GIS, and automation capabilities, NAVRIS incorporates a series of validation scripts to ensure that the data is entered in accordance with program requirements.

One of the most challenging aspects of the project was establishing consistent interpretations of the IRR program regulations between the BIA-NRO and the Navajo DOT staff. This took many months of research in collaboration with BIA-NRO chief engineer Harold Riley and his staff. To the credit of both agencies, considerable common ground was established,



NAVRIS bidirectional filtering of data between the map interface and the filtering page.

and the findings were subsequently programmed into the core automation and validation logic of NAVRIS. As a result, the percentage of roads questioned by the BIA because of missing or incorrect data has declined dramatically.

As of the 2010 IRR submission cycle, the Navajo DOT has significantly increased the number of miles in its inventory. It grew from 9,800 miles in 2006 to nearly 16,000 miles, including approximately 6,000 miles of tribal roads. The additional mileage and updates to the existing data increased the Navajo Nation's IRR funding by an average of 30 percent compared to its 2006 funding level. To date, the Navajo region has received a fifteenfold return on the Navajo DOT's initial investment in the IRR project. This adjusted allocation will allow critical transportation infrastructure improvements, supporting access to education, employment, health care, and other services for the nation's widespread residents.

In addition to the development of the NAVRIS system, the Navajo DOT Inventory Team established a series of programmatic policies and standards to supplement the technology. Due to the rural nature of the reservation, determining the public eligibility of tribal roads has been a historically difficult process. In an effort to establish consistency in properly identifying a public tribal road, the Navajo DOT developed a public roads identification guideline that provides a checklist of characteristics that a road must contain before it can be considered public.

Today, the Navajo DOT continues to develop NAVRIS as part of its ongoing IT strategy. NAVRIS offers the first consistent, verified interpretations of IRR regulations and the ability to programmatically generate the required BIA deliverables. By taking the initiative to build a geospatial road inventory program that helps define and facilitate the IRR process, the Navajo Division of Transportation has become a stronger, more sophisticated tribal entity with more time and resources to support the development and maintenance of its expansive infrastructure.

(This article originally appeared in the Fall 2011 issue of *ArcNews*.)

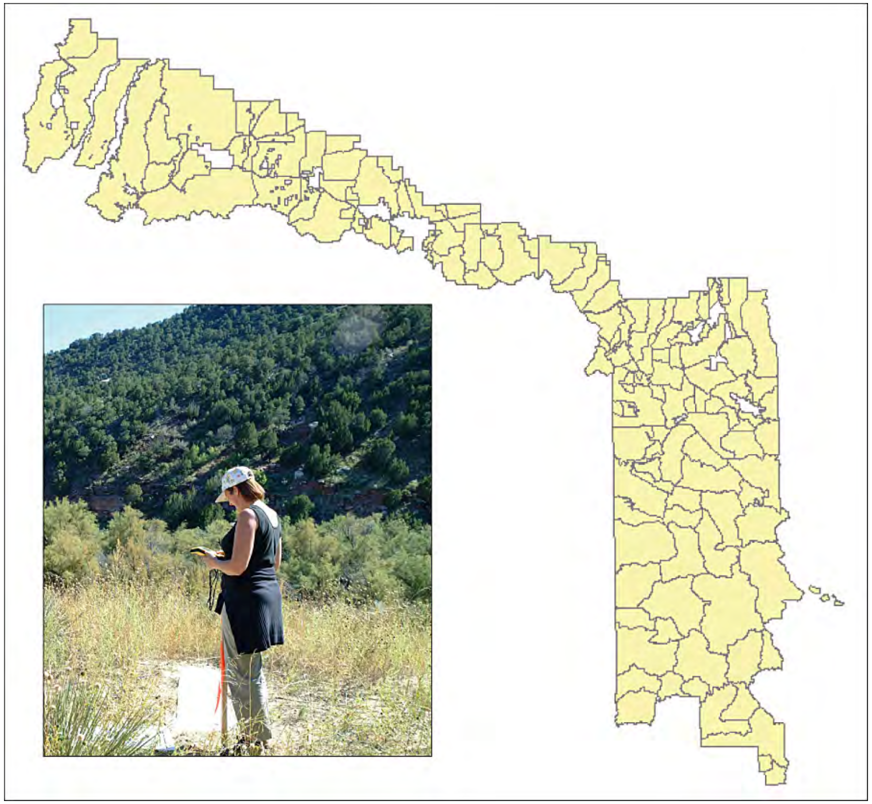
US Forest Service Sees Regional Horizons

Southwest Foresters Round Up Data

The United States Forest Service (USFS) has been using GIS in various forms throughout its nine regions in the continental United States and Alaska. Public lands in USFS' national forests are vast, encompassing 193 million acres. GIS helps USFS meet long-term natural resource management goals for these lands.

The USFS Southwestern Region (Region 3) is the first USFS region to standardize its data by putting it into an ArcGIS geodatabase. The region includes Arizona and New Mexico and parts of Texas and Oklahoma, with a total of 11 national forests and 3 national grasslands. The region's GIS is a strong model for other regions to follow. The reason is that foresters using ArcGIS can better manage data, perform analysis, and generate reports and maps that are useful to managers and resource specialists for making decisions about land management activities.

The region's GIS is a distributed enterprise system, with each national forest having its own GIS geodatabase. Because all these geodatabases have been built using the same standard, forests can easily share data with the regional server, which is located in Albuquerque, New Mexico. This makes it simple for forest managers to quickly access ecological data across the region and develop both local and regional views of forest and grasslands.



The USFS Rangeland Allotment data layer helps foresters understand land use. Inset: Feature coordinates are captured in the field and uploaded to the geodatabase.

This improves project planning, such as campground and road design, long-range planning, and inventory and assessment.

GIS users can monitor land use and natural resources, analyze heritage and cultural sites, assess watersheds, and support other USFS activities and missions.

The GIS enterprise system puts geographic analysis into the hands of forest personnel and provides natural resource data to the public. Getting to the point of reaping these advantages takes time and effort to develop standard data dictionaries and schemas. In addition, shapefiles and coverages must be migrated to the geodatabase.

Working with the Tennessee Valley Authority and Esri Professional Services, the region was able to set up data standards. The GIS program manager for the Southwestern Region, Candace Bogart, explains the work involved. "It took our team of five people three and a half years to complete the data migration. We designed a data dictionary that includes 15 themes. We made all the data digital and put everything in the same format. As for the return on investment—oh my gosh, I can't even quantify it. We are really harvesting the fruit of all that labor."

A geodatabase enables users to maintain integrity of spatial data with a consistent, accurate database. It provides a multiuser access and editing environment. This capability is highly valuable, since each forest agency is responsible for its database management and editing. Quality assurance tools from Esri Production Mapping were implemented for the project.

Today, more than 450 USFS staff members use the enterprise GIS. USFS invited AllPoints GIS, an Esri Partner based in Denver, Colorado, to write a training program and hold workshops. Participants work with their own forestry data in class and are therefore able to start working on their projects immediately. It has been much easier and more efficient for the Southwestern Region to contract with AllPoints for the training program than to have its own staff conduct this training.

Each of the regions' forest supervisors' offices has its own server. The regional office in Albuquerque, New Mexico, has a central AIX server that brings the distributed data together and enables users to access it via an internal network. If, for instance, the GIS team needs to do road editing for an area in the Coronado forest, it accesses the Coronado regional office's geodatabase. Because the structure of each forest's database is the same, data is easy to access and use.

The USFS Southwestern Region puts ArcGIS to work for a variety of forestry purposes. For a riparian mapping project, forest service ecologists wanted to know the location and attributes of the region's riparian vegetation. Because this region has a lot of desert area, it is important to know where the riparian areas are to monitor and preserve them. They used data elevation models in the GIS to calculate valley bottom models and then construct indexes for wetness, adjacency, and steepness to create a data layer of valley bottoms. Another layer contains vegetation data. A relationship of valley bottoms and vegetation was shown for a watershed. Large-scale aerial photography was also added to the project.

Making data available to the public is also an important part of the USFS Southwestern Region GIS staff's work. Using Esri Production Mapping, they export their region-wide and individual forest datasets to shapefiles and post them on their website for public consumption. Scientists, academics, and contractors can go to www.fs.fed.us/r3, click GIS, and use the datasets for research and business purposes. The USFS Southwestern Region is using ArcGIS for forestry inventory and land management planning. An online, interactive map helps staff access this information for developing a forest plan. Forest plan information is posted and viewed by the public via a GIS viewer that provides basic tools for panning, zooming, and layering data. The public can go to maps.fs.fed.us/kaibab/mapviewer.jsp.

Bogart, who provided much of the information for this article, acknowledges the work of Geospatial Services Technology Center and especially Aaron Stanford, who created a template for the forest plan revision site that enabled the R3 data to be dropped into the template and uploaded. She also acknowledges USFS Southwestern Region's planning staff, Reuben Weisz, and the region's GIS staff.

(This article originally appeared in the Summer 2011 issue of *ArcNews*.)

Keeping Traffic Moving during Bridge Repair Project

By Matthew DeMeritt, Esri Writer

With 12 percent of US bridges declared structurally deficient by the Federal Highway Administration in 2006, bridge repair remains a top priority for most states. Three years before that, an extensive investigation of Oregon's bridges conducted by the Oregon Department of Transportation (ODOT) found that 365 of Oregon's bridges had structural problems that necessitated a large-scale bridge repair plan. Implementing that plan required that the department expand its GIS infrastructure and integrate a new traffic modeling application to ease congestion at multiple construction zones along the state's highway system.

Oregon Transportation Investment Act

From 2001 to 2003, Oregon passed a series of funding packages called the Oregon Transportation Investment Act (OTIA I, II, and III) to improve its highway infrastructure. For OTIA III, which included the State Bridge Delivery Program, ODOT turned to engineering consultants Oregon Bridge Delivery Partners (OBDP), a joint venture between HDR Engineering and Fluor Corporation, to create practices that would ensure the project finished successfully and within budget. One of the primary goals of the program was to reduce the impact on commuter and business traffic during large-scale construction on its road system.

The Oregon Department of Transportation repaired the Snake River Bridge on Interstate 84 as part of the OTIA III State Bridge Delivery Program.

Many of the bridges designed during the early development of Oregon's highway system used a reinforced concrete deck girder (RCDG) design specified in the regulations of that time. As specifications became more stringent in the 1960s, Oregon transitioned to pre-stressed and post-tensioned concrete bridges that improved structural integrity at a reduced cost. However, many RCDG bridges remained in service well past their expected decommission date and began to show signs of deterioration on deeper investigation. "In 2001, ODOT inspectors noticed that cracks identified in previous inspections had grown to the point of threatening structural stability," said Jim Cox, assistant manager of major projects at ODOT. "We immediately placed load restrictions on these bridges and started discussion on how to plan repairs with the least impact on commercial and commuter traffic."

GIS and Geodesign

Established in 2004, ODOT's GIS comprised the department's information-sharing infrastructure to plan and manage roadway projects. To integrate with ODOT's GIS, OBDP designed its system on the same ArcGIS platform for flexibility and scalability throughout the project life cycle and beyond. "We wanted easy adoption of tools and practices to smooth transition during project closeout and ensure usefulness beyond that," said Robb Kirkman, GIS Services manager for HDR Engineering. "GIS provided the foundation to start linking program systems, automate tasks, and better mitigate environmental impacts."

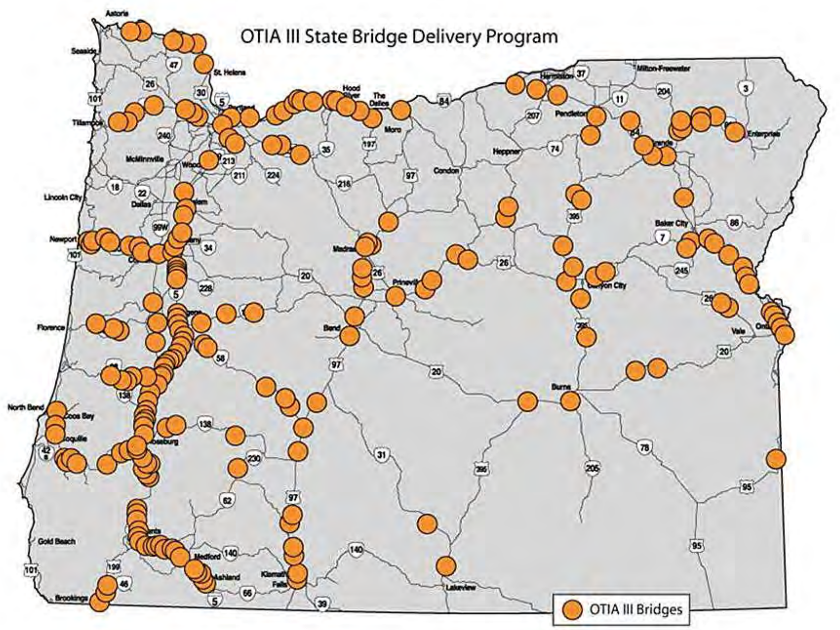
Before any construction work began, ODOT collected comprehensive environmental data on more than 400 of its bridge sites to identify nearby environmental resources. Standard ODOT practice involves consultation with experts such as biologists, wetland specialists, and archaeologists to get a better understanding of the effects of construction zones in ecologically sensitive areas. "We took a different approach for the OTIA III Bridge Program by conducting environmental fieldwork before we did any design," said Cox. "In ArcGIS, we drew a box around a bridge site and identified all the resources inside the box. This allowed the engineers to develop designs that minimized impacts on the surrounding environment."

Improving Work Zone Traffic Analysis

Prior to its collaboration with OBDP, ODOT had been using spreadsheets containing traffic counts and automatic traffic recorder information from across the state to document and predict traffic impacts for its various road construction projects. That process could take up to four hours for each scenario because data had to be searched and collected from multiple databases within the agency and then inserted into a spreadsheet. "Gradually, that process evolved to incorporate GIS processes," Kirkman said. "Using macros and automation tools in ArcGIS, ODOT's traffic group was able to automatically populate the spreadsheets with information from the database."

Although much leaner, the spreadsheet-only approach experienced crashes as the database grew ever larger. The traffic team worked with OBDP to develop a more efficient GIS-based method for running traffic scenarios—one that tightly wove

ODOT's geospatial data into a dedicated web-based analysis tool. Using common protocols, they worked on tying the datasets together to give ODOT staff direct access to the department's databases from a single interface. Called the Work Zone Traffic Analysis (WZTA) tool, the application allowed traffic scenarios to be run and shared in a web browser.



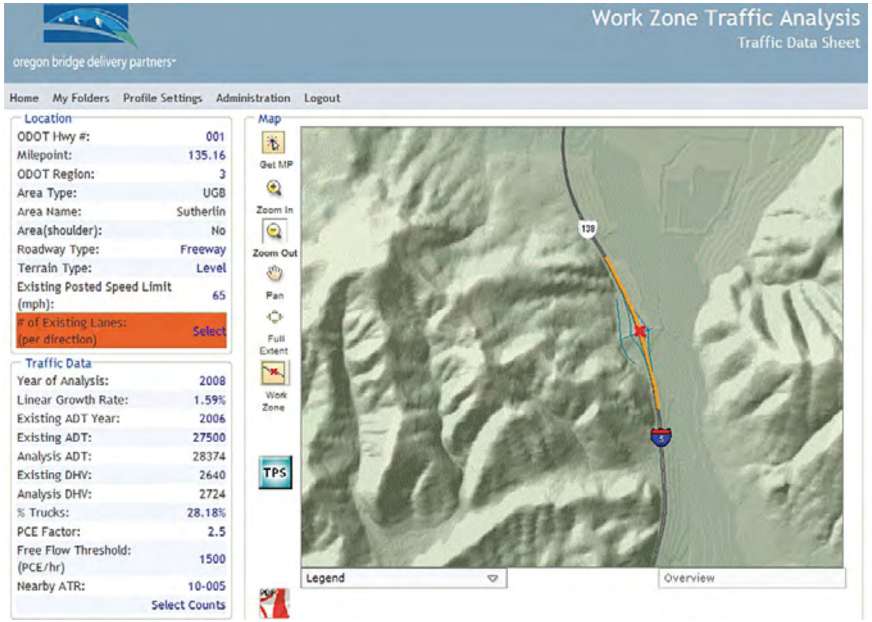
The OTIA III State Bridge Delivery Program is a 10-year, $1.3 billion program that will repair or replace hundreds of aging bridges on Oregon's highway system.

WZTA serves as a repository for information on traffic and road data that can be accessed and queried in a browser. The system allows users to view ODOT data to determine the effects on mobility created by lane closures related to construction and roadwork. Today, the department can run traffic scenarios in a matter of minutes, eliminating redundancy and enabling ODOT engineers to modify traffic plans on the fly.

Using a GIS-based interface also improved accuracy by allowing ODOT analysts to select the location and other information for a specific project site from the map itself rather than tabular lists. "Lookup tables using numbering systems aren't intuitive to all users," Kirkman said. "GIS enabled users to find exactly what they were looking for and verify the correct project information within a more appropriate map-based user interface where spatial relationships are more obvious."

Documented Return on Investment

In 2010, ODOT and OBDP documented their experience with the tools to evaluate the impact of ODOT's investments and determine if they should be used after completion of the bridge program. With the assistance of economic consultant Mark Ford, they analyzed every piece of software OBDP created for the OTIA III Bridge Delivery Program to determine the economic benefits and cost to the department. The study concluded that ODOT experienced a combined benefit-cost ratio of 2:1 for all

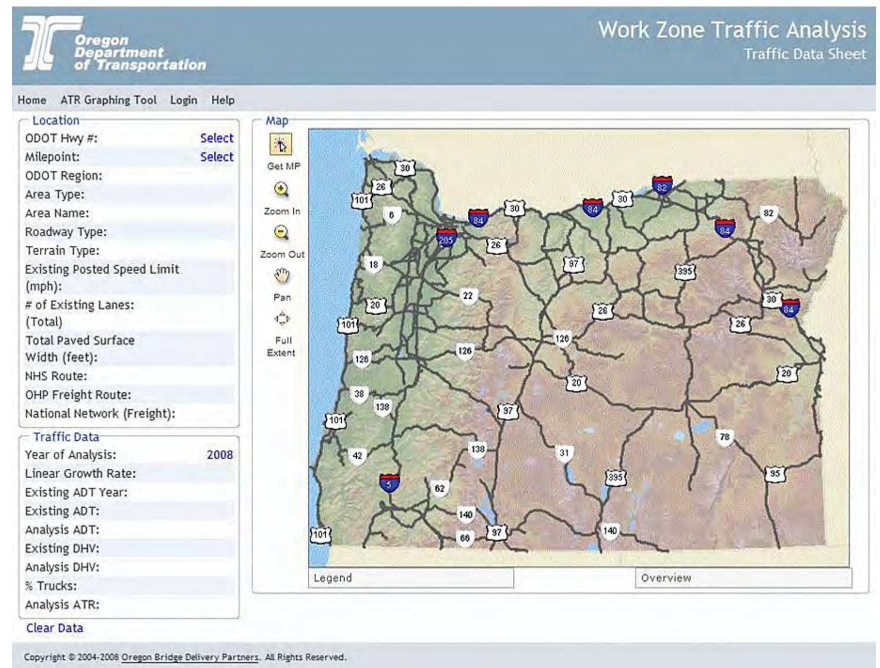


The department can run traffic scenarios in a matter of minutes—rather than hours—enabling ODOT engineers to modify traffic plans on the fly. Easy access to reliable data helped the agency determine how to stage projects with minimal delays.

enterprise IT investments related to management of the bridge program.

ODOT's GIS infrastructure alone returned a benefit-cost ratio of 3:1. "Integration of formats and standards proved to be important in generating value from the investment," said Ford.

In addition to these tangible benefits, ODOT experienced three types of intangible benefits. Migrating the data from disparate sources into a unified system allowed OBDP to employ consistent analysis methods, reducing the risk of calculation errors. The centralized database also made it easier for ODOT to maintain data integrity and reduce the risk that analysts working at different locations could use outdated information. "Systems like ODOT's GIS infrastructure generate accurate, consistent, and timely information for reporting and responding to inquiries," Ford said. "WZTA, and GIS in particular, has resulted in improved



Using a GIS-based interface, ODOT analysts can select the location and other information for a specific project site from the map itself rather than tabular lists. In 2007, WZTA received the Team Excellence Pathfinder Award from the American Association of State Highway and Transportation Officials.

coordination with other agencies and interest groups, increasing the credibility of both ODOT and the bridge program in the eyes of the public and the legislature."

At the beginning of 2011, 351 of the 365 bridges in the OTIA III Bridge Delivery Program were free of construction zone delays. WZTA played a primary role in expediting the construction process by allowing the team to run lane closure traffic analyses in minutes as opposed to hours. The tool is now being used by ODOT on other roadway maintenance and construction projects to quickly determine impacts from lane closures across the state.

(This article originally appeared in the Summer 2012 edition of *ArcUser*.)

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Contact Esri

380 New York Street
Redlands, California 92373-8100 USA

1 800 447 9778
T 909 793 2853
F 909 793 5953
info@esri.com
esri.com

Offices worldwide
esri.com/locations

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