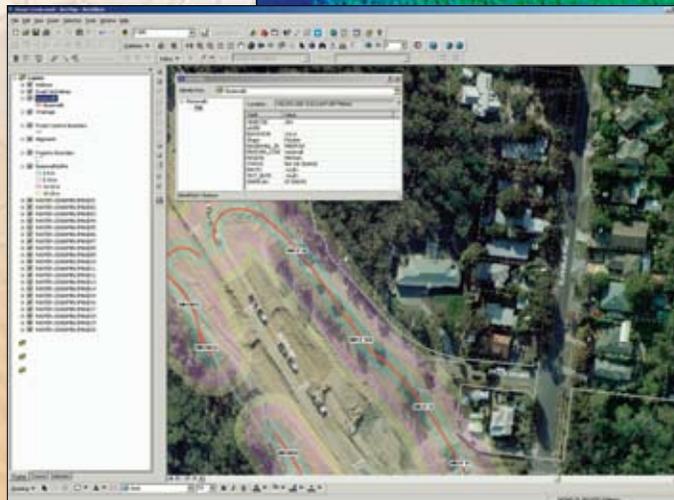
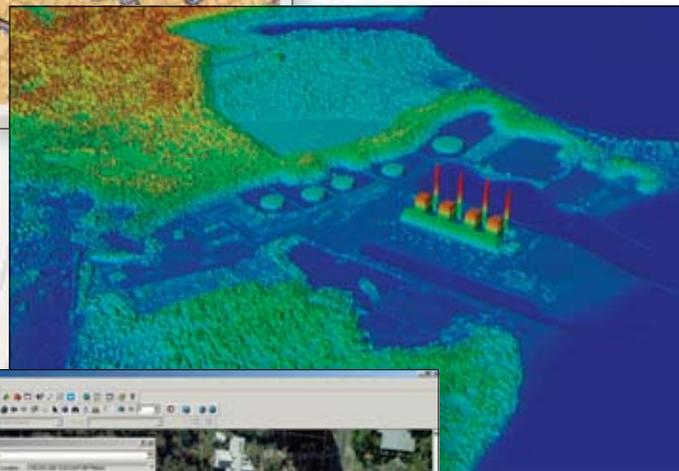
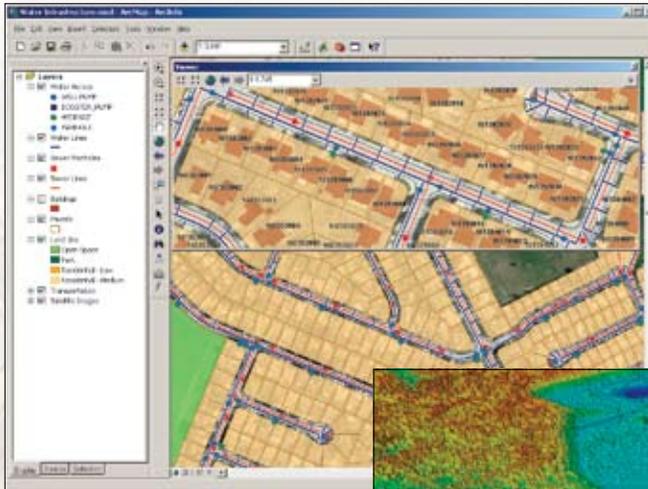


# GIS Solutions for Civil Engineering

The Modern Platform for Civil IT



# GIS Solutions for Civil Engineering

Civil engineering is about developing and sustaining infrastructure. The profession covers many areas of interest and a broad range of expertise. As a result, civil engineers work with a voluminous amount of data from a variety of sources. Geographic information system (GIS) technology provides the tools for creating, managing, analyzing, and visualizing the data associated with developing and managing infrastructure. GIS allows civil engineers to manage and share data and turn it into easily understood reports and visualizations that can be analyzed and communicated to others. This data can be related to both a project and its broader geographic context. It also helps organizations and governments work together to develop strategies for sustainable development. Thus, GIS is playing an increasingly important role in civil engineering companies, supporting all phases of the infrastructure life cycle.

## Why GIS?

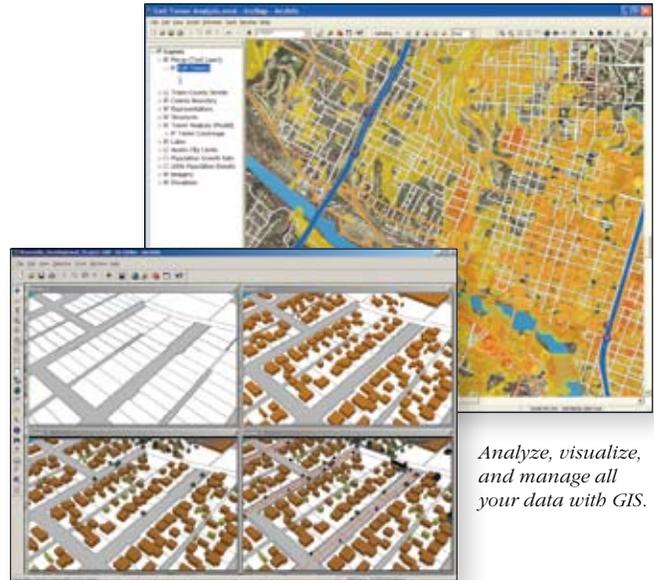
GIS software is interoperable, supporting the many data formats used in the infrastructure life cycle and allowing civil engineers to provide data to various agencies in the required format while maintaining the data's core integrity. GIS technology provides a central location to conduct spatial analysis, overlay data, and integrate other solutions and systems. Built on a database rather than individual project files, GIS enables civil engineers to easily manage, reuse, share, and analyze data, saving time and resources.

## Author, Serve, Use

GIS lets you easily author data, maps, globes, and models on the desktop; serve them to a GIS server; and use them through Web, desktop, and mobile clients.

## Spatial Analysis

GIS provides tools for modeling information to support more intelligent, faster decisions; discover and characterize geographic patterns; optimize network and resource allocation; and automate workflows through a visual modeling environment.



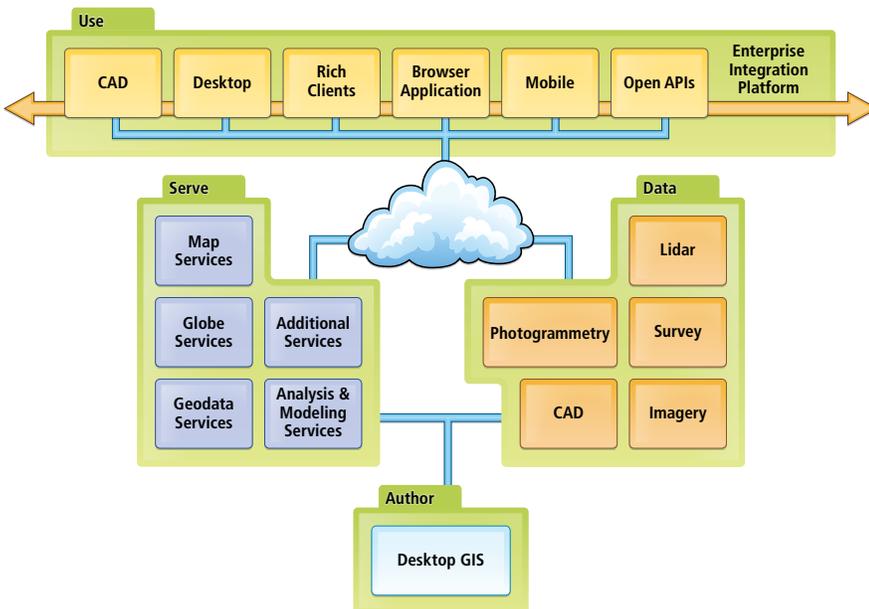
Analyze, visualize, and manage all your data with GIS.

## Visualization and Cartography

Through the use of 2D and 3D clients, you can experience a more interactive way of seeing data, visualizing change over time and space to identify patterns and trends, and disseminate knowledge to engineers, managers, clients, regulators, and field-based personnel.

## Spatial Data Management

GIS organizes and manages geographic information to support fast and efficient visualization and analytic applications, regardless of the amount of data held within an organization. Agencies securely store and manage vast amounts of spatial information and propagate data changes between multiple data sources.



# Infrastructure Life Cycle

A centralized information system based on ESRI® GIS software provides civil engineers with the IT framework for maintaining and deploying critical data and applications across every aspect of the infrastructure project life cycle including planning and design, data collection and management, spatial analysis, construction, and operations management and maintenance.

This architecture provides the tools to assemble intelligent GIS applications and improve a project process by giving engineers, construction contractors, surveyors, and analysts a single data source from which to work. Centrally hosting applications and data makes it easy to manage, organize, and integrate geographic data, including CAD data, from existing databases to visualize, analyze, and make decisions. The system helps combat data communication errors, eliminating the need for multiple, flat files in disparate systems.

## Planning

It contains high-level planning functions for site location including environmental impact mitigation, economic analysis, regulatory permitting, alternative siting analysis, routing utilities, what-if scenarios, visualization of concept options, data overlay, modeling, and benefit/cost alternatives analysis.

## Data Collection

It has specific functions to collect precise site data used for predesign analysis; design; and calculations including field survey, topography, soils, subsurface geology, traffic, lidar, photogrammetry, imaging, sensitive environmental areas, wetlands, hydrology, and other site-specific design-grade data.

## Environmental Analysis

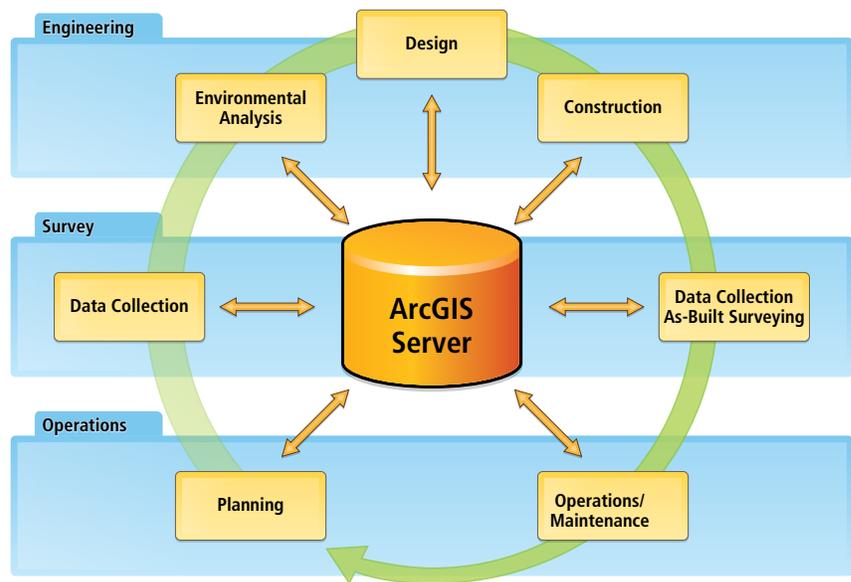
It provides analysis to support design including hydrology analysis, volume calculations, soil load analysis, traffic capacity, environmental impact, slope stability, materials consumption, runoff, erosion control, and air emissions. During environmental analysis, view project maps, site photos, CAD files, survey measurements, and 3D renderings. Analysis of the environment with a GIS allows you to view patterns, trends, and relationships that were not clearly evident without the visualization of data.

## Design

It allows creation of new infrastructure data for new civil works including grading, contouring, specifications, cross sections, design calculations, mass haul plans, environmental mitigation plans, and equipment staging. This includes integration with traditional design tools such as CAD and databases for new design capabilities.

## Construction

It provides the mechanics and management for building new infrastructure including takeoffs; machine control; earth movement; intermediate construction, volume and material, and payment calculations; materials tracking; logistics; schedules; and traffic management.



## Data Collection As-Built Surveying

GIS provides the tools to collect precise site data and document existing conditions. With as-built surveying infrastructure data, operators use defined, operational, industry-standard data models. As-built surveying with GIS technology permits the surveyor to deliver data into operational GIS, eliminating costly data conversion and reducing errors.

## Operations/Maintenance

It models utility and infrastructure networks and integrates other related types of data such as raster images and CAD drawings. Spatial selection and display tools allow you to visualize scheduled work, ongoing activities, recurring maintenance problems, and historical information. The topological characteristics of a GIS database can support network tracing and can be used to analyze specific properties or services that may be impacted by such events as stoppages, main breaks, and drainage defects.

# Workflow

An engineering information system based on enterprise GIS technology streamlines activities from field data collection to project management. With this single relational database, you are connected to all your clients; construction sites; and inventory, network, and maintenance data.

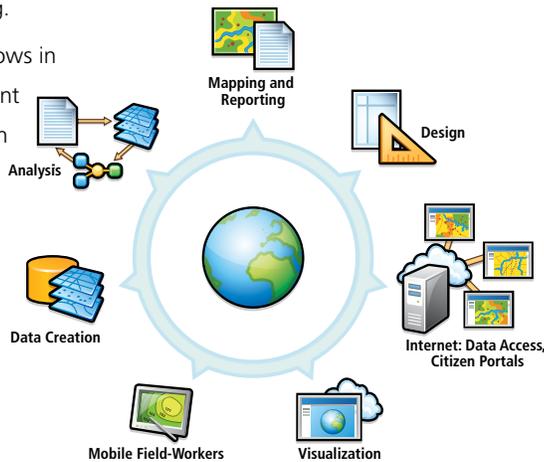
A server-based data management environment leveraging GIS capabilities promotes efficient workflows in data and project management. It allows you to streamline your work processes in data capture, editing, analysis, visualization, and design. With an ability to communicate changes to an entire team rapidly, GIS gives your entire team access to the most current information supporting better decision making.

GIS enhances workflows in

- Project management
- Analysis and design
- Logistics

GIS provides

- Data accuracy
- Data sharing
- Analysis capability
- Modeling

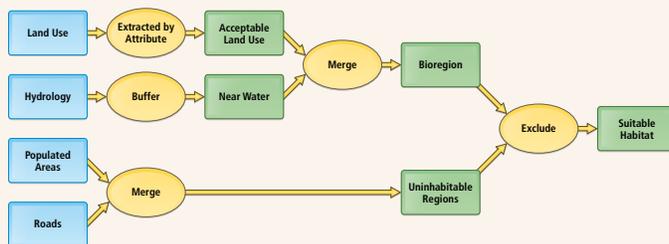


## Modeling and Analysis

Geoprocessing is the framework for modeling and analysis. Some of the common modeling applications include

- Composite overlay models for assessing suitability, sensitivity, capacity, and risk
- Evaluation models for comparing alternatives
- Growth models for assessing future conditions
- Statistical models for assessing trends and generating predictive surfaces

The geoprocessing framework can also be used for integrating external models, sharing models with others, documenting a spatially dependent decision process, and developing interactive decision support systems.



Create new data by combining existing data.

## Case Study—GIS Technology Refines Flood Insurance Rate Mapping Process

In response to FEMA's billion-dollar Map Modernization program to produce Digital Flood Insurance Rate Maps (DFIRMs), Dewberry, a Virginia-based engineering, surveying, and GIS firm, developed GeoFIRM, an enterprise-level automated engineering, map production, and workflow system. GeoFIRM relies on a multiuser centralized GIS geodatabase that makes it possible for DFIRM project members spread throughout the country to instantaneously view data; easily edit the database; and readily access Dewberry DFIRM project data such as digital imagery, orthophotography, scanned paper maps, lidar, and engineering data. Using the geodatabase-centric ArcSDE® technology in ArcGIS®, GeoFIRM is Dewberry's central repository for engineering and mapping spatial and nonspatial DFIRM data. A series of automated toolkits was built using the ArcObjects™ technology inside ArcGIS to assist project members in DFIRM production. The toolkits facilitate the DFIRM modeling process automatically by managing the input and output requirements for each model or task. The custom-created toolkits in GeoFIRM have increased engineering accuracy and quality while drastically reducing Flood Insurance Rate Map product cost and time.

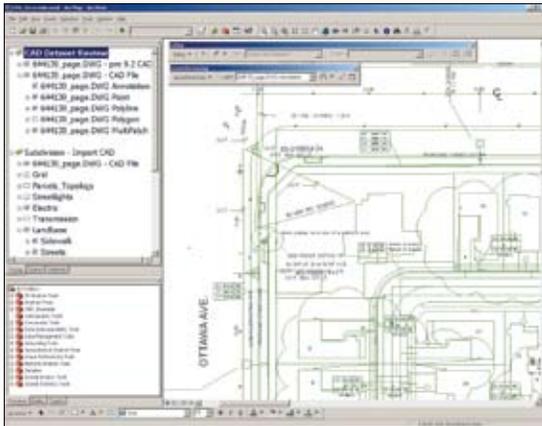


Create 3D views to analyze and view data from any angle or location.

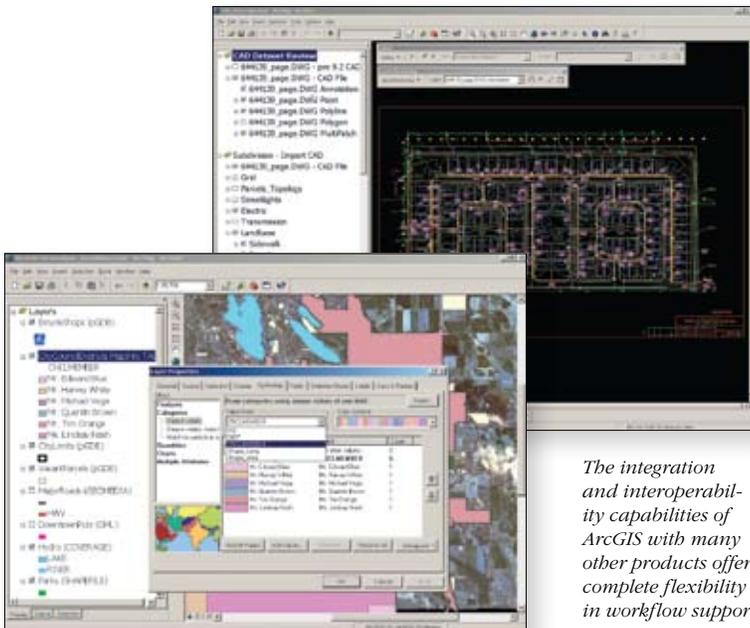
Model and analyze flood zones by combining hydrological, environmental, and geological data.

# Data Integration, Visualization, and Management

You can use GIS to combine and interpret data from many different formats. GIS allows you to integrate satellite images, CAD drawings, and parcel maps to create a visual overview of a project and turn it into easily understood reports. It accepts CAD data without conversion and includes it as a layer in a geodatabase.



A GIS geodatabase gives you the ability to handle rich data types and apply sophisticated rules and relationships. In addition to managing large volumes of geographic data, it also implements sophisticated business logic that, for example, builds relationships between data types such as topologies and geometric networks, validates data, and controls access. Data management tools scale to meet your needs, from the individual to workgroups and large, multiuser enterprises.



*The data management tools in ArcGIS scale to meet your needs, from the individual to workgroups and large, multiuser enterprises.*

## Case Study—GIS System Model Integration Facilitates Storm Water Management

Agencies throughout the country responsible for storm water management generally require drainage reports for development and master plans for overall major drainage improvements. Although agencies have drainage manuals to guide the analysis for the reports and master plans, the consistency of submissions varies considerably, and significant time and effort are required in the review process. KVL Consultants, Inc., has developed database management systems (DBMS) linked to ArcGIS to facilitate the submission process and reduce agency review time. The integration with ArcGIS is automated from the DBMS and contains all the data needed to run specific hydrology and hydraulic models and uses agency default procedures and parameters to provide consistent results. ArcGIS is used as a front-end data loader for modeling and on the back end to show the modeling results. Applications are currently in use by the Flood Control District of Maricopa County, Fresno Metropolitan Flood Control District, and Mohave County and Clark County Regional Flood Control District.



*The data integration capabilities of ArcGIS make it a powerful tool for modeling and for visualizing results.*

*The integration and interoperability capabilities of ArcGIS with many other products offer complete flexibility in workflow support.*

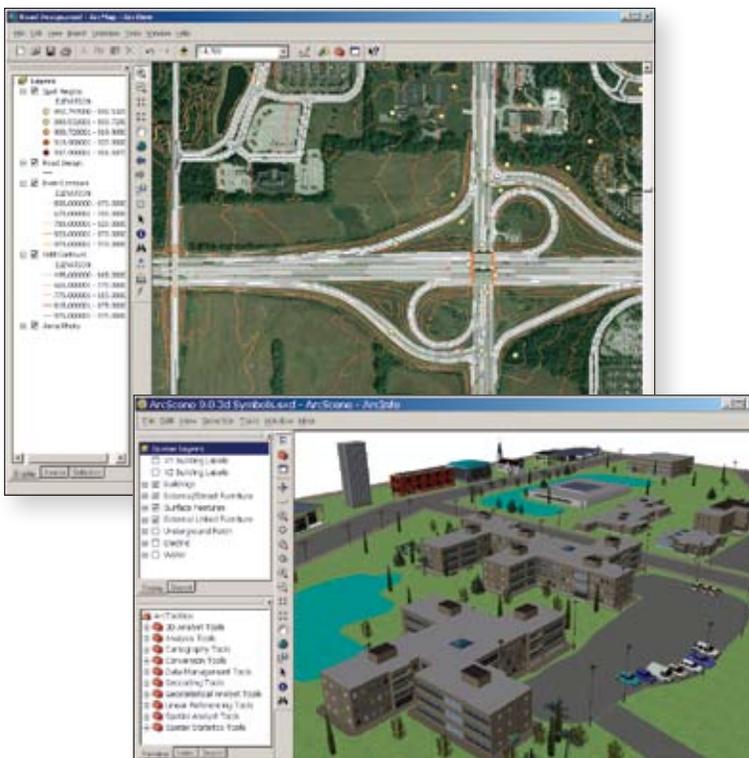
# Infrastructure Management

Visualizing assets and the surrounding environment when you build, upgrade, and repair infrastructure helps you decide how to prioritize your work, convince others of its importance, and make good decisions about how to move forward with your plans. Having an accurate, clear picture of the project helps you better understand needs, reduce problems, and mitigate costs and environmental impacts. These processes are improved when GIS is the core system for data management and visualization.

With all the demands on your time, using tools that streamline your business processes and provide you with the best mapping and visualization makes sense. GIS can help you present information in a straightforward way to partners in your projects, government officials, and the public. With ArcGIS Server technology, you can take maps that you have created with ArcGIS Desktop software and publish them over the Web so you, your partners, and your staff in the field can see how a project is progressing.

Use GIS for more efficient

- Planning and site location
- Environmental analysis
- Infrastructure design
- Construction management
- Data collection and as-built surveying
- Operations and maintenance



GIS integrates multiple data types used in infrastructure management and displays the output in vector, raster, and 3D formats.

## Case Study—GIS Puts Australian Road Project in the Fast Lane

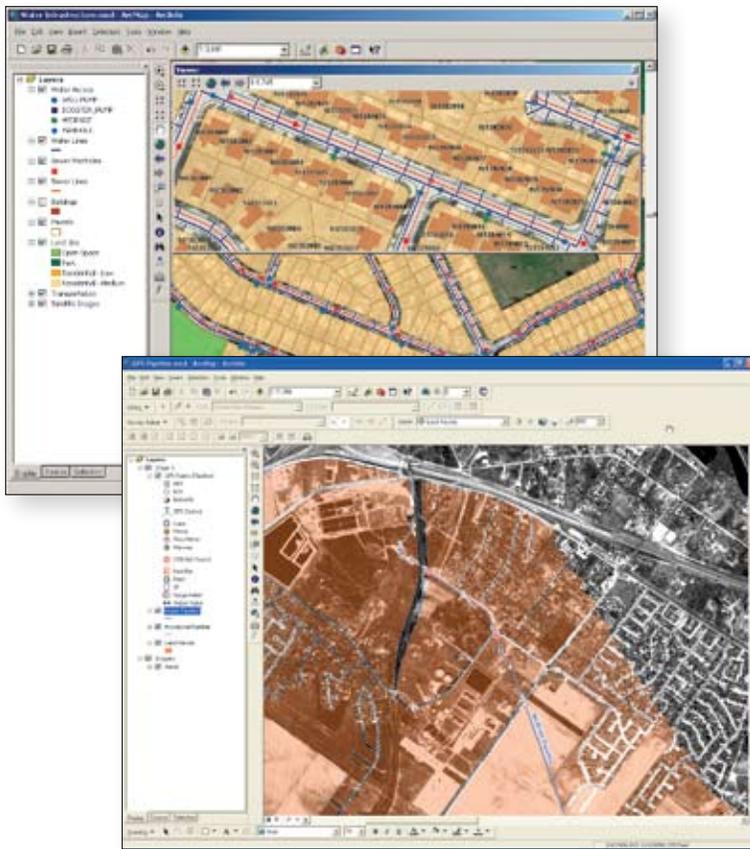
Melbourne, Australia's EastLink tollway was designed and constructed by a joint venture between engineering firms Thiess Pty Ltd. and John Holland Pty Ltd. With a continual stream of incoming data relating to design, survey, the environment, construction, community feedback, and planning, the communication, retention, and distribution of information between the two firms were crucial. As a solution, an enterprise GIS was implemented, which provided high cartographic capabilities, supplied timely and accurate data to stakeholders, integrated with other corporate systems, and was simple to use by existing staff. The GIS gave EastLink staff easy access to accurate and current data, allowing them to conduct data queries and analysis, produce maps and reports, and utilize enhanced field mapping capabilities. With GIS, the ease of map production resulted in significant productivity and efficiency improvements, making map production 50 percent faster than the previous method. By operating its own GIS, the three-year EastLink project was completed ahead of schedule, saving tens of thousands of dollars per year by avoiding the need to outsource GIS services and through the supply of products and services provided by the GIS solution.



Quickly produce maps and reports that can be printed or shared online within your organization or with the public.



# Critical Infrastructure Protection



*GIS promotes strategic and tactical emergency management planning by pinpointing hazards and evaluating consequences of potential problems.*

Engineers responsible for the safety and security of buildings, bridges, utilities, and other critical infrastructure need a comprehensive decision-making tool for emergency assessment, preparation response, and recovery activities.

GIS technology provides a situational awareness tool for fusing information, from flood elevation and evacuation routes to a bridge's structural specifications and inspection results. With critical infrastructure information stored in a geodatabase, you can display that information in real time on a Web-based map.

Use GIS tools to combine and analyze specific data needed to meet a required task. Add current traffic and weather data, draw buffer protection zones, and share new changes in real time.

Emergency managers use the enterprise GIS database to

- Identify critical infrastructure and hazards within affected areas.
- Identify medical resources and route patients to nearest facilities.
- Prepare evacuation routes for at-risk populations.
- Provide accurate damage estimates.
- Identify priorities for short-term recovery needs.
- Assess long-term recovery needs.

[www.esri.com/engineering](http://www.esri.com/engineering)

## Minneapolis Quickly Solves Bridge Routing Problem with GIS Web Mapping Technology

Following the disastrous Minneapolis, Minnesota, Interstate 35W bridge collapse in August 2007, the city was ensnared as travelers attempted to reroute to get to their destinations across the Mississippi River. Traffic barriers set up to accommodate rescue operations blocked passage, and major streets were closed. The city's managers needed an immediate solution and called for an online application with which citizens could see where the current city-defined barriers were located and create a personal route map to get them where they needed to go.

In response, the city quickly implemented a two-tiered, GIS-based Web application that consisted of a public-facing Web page and an administrative Web page. The administrative Web page allowed the city administrators to define barrier locations. These barriers changed from day to day because of disaster command post needs and continued to change in response to cleanup efforts. For example, a street that was closed in the morning could be reopened in the afternoon, so a commuter's route could vary from hour to hour. The city posted this dynamic data immediately on its Web site, where commuters could see the most recent barrier updates and create personalized routes by either entering an address or clicking start and endpoints. A route was instantly calculated and drawn so the user could print out the route and take it on the road.



*Emergency route planner applications provide personal routes and help navigate traffic around disaster areas.*

# CAD Integration

CAD interoperability is an important part of ESRI's software solutions. Existing datasets on state GIS Web sites and flat CAD files are integrated and managed from a central location, eliminating duplicate datasets and providing the platform for all spatial data distribution and functionality.

ESRI provides two solutions for CAD interoperability. CAD direct read involves using CAD data without any conversion. This workflow is similar to directly accessing a geodatabase. Bidirectional translation involves the conversion of CAD data to a GIS data format and vice versa. This enables organizations to incorporate CAD data into an existing GIS and deliver spatial information in a CAD format. Both of these CAD interoperability solutions are available through ArcGIS.

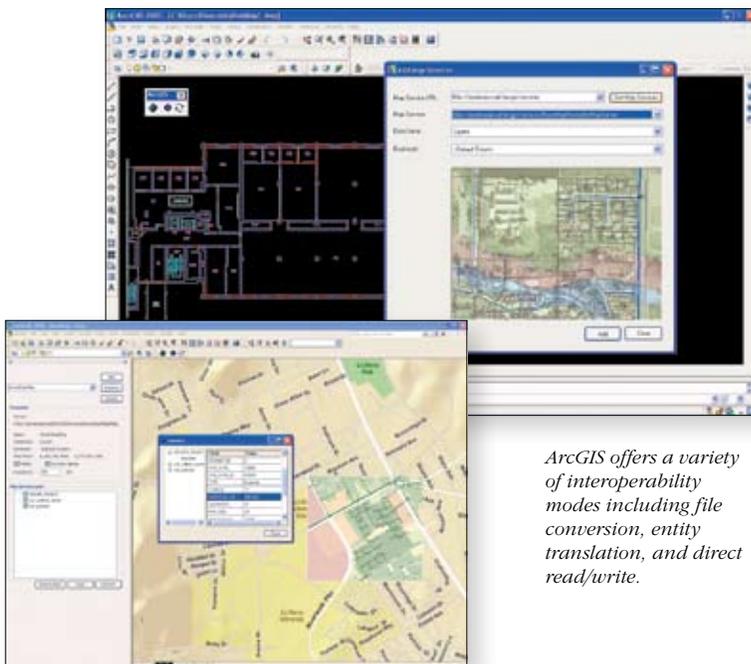
## ArcGIS for AutoCAD

ArcGIS for AutoCAD allows you to visualize and query GIS data in AutoCAD without conversion. As a CAD user, you can work directly with ArcGIS map services to add full GIS context to your AutoCAD session.

ArcGIS for AutoCAD leverages the cartographic and computing power of ArcGIS without the need for special data connections.

With ArcGIS for AutoCAD, you can

- View live GIS maps and display GIS symbology of all underlying GIS data structures in CAD.
- Include GIS analysis results in your CAD designs.
- Include GIS basemaps in your CAD products.
- Define the coordinate system within AutoCAD to automatically project maps on the fly without transforming CAD drawings or converting GIS data.



*ArcGIS offers a variety of interoperability modes including file conversion, entity translation, and direct read/write.*

## City of Roseville Case Study

The City of Roseville, California, maintains more than 130 layers in an enterprise geodatabase and manages the data in ArcGIS. City staff developed and implemented a custom ArcGIS application that combines CAD integration, data maintenance, and validation and imports GIS data into the enterprise database. The application simplifies the processes for parcel and street data conversion and maintenance, enables better data workflow management, and improves CAD-GIS interoperability. The results are immediate, and long-term benefits include staff time and cost savings, streamlined workflow, improved data quality, and quicker data availability for the city's public safety departments.



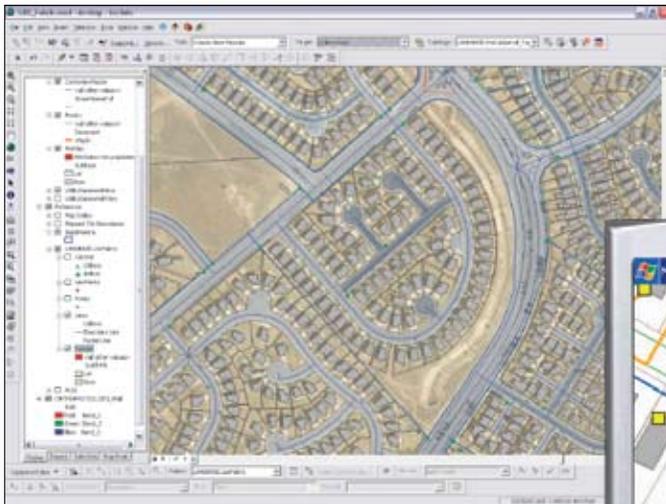
*A suite of tools in ArcGIS reads and translates CAD files into the geodatabase.*

# ArcGIS: The Complete Enterprise GIS

A complete GIS, ESRI's ArcGIS enables you to easily author data, maps, analyses, reports, and models on the desktop; serve them to a GIS server; and use them through Web, desktop, and mobile clients. The ArcGIS family of products includes desktop GIS, server GIS, mobile GIS, and online GIS—the most comprehensive strategy for civil engineers.

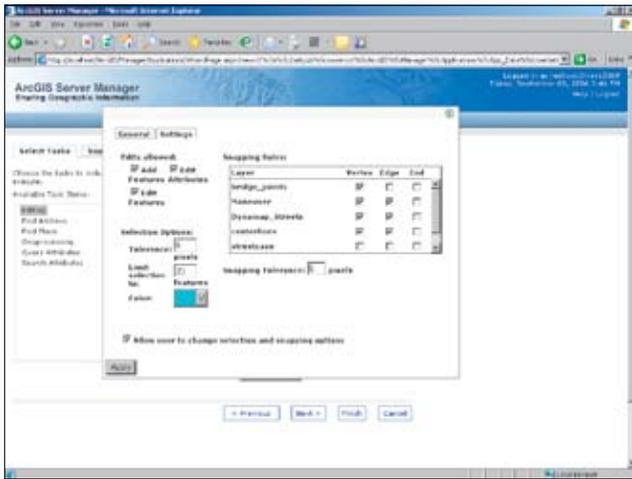
## Desktop GIS

Desktop GIS allows you to see your data on a map and analyze it to reveal patterns, relationships, and trends that are not readily apparent in tabular data, which improves decision making. With desktop GIS, you can create and edit data and work with ready-to-use tools to build and process models, scripts, and complete workflows, enabling you to test predictions and examine relationships in the data. Maintaining customer information and network activity becomes seamless, workflows are streamlined, and data quality improves.



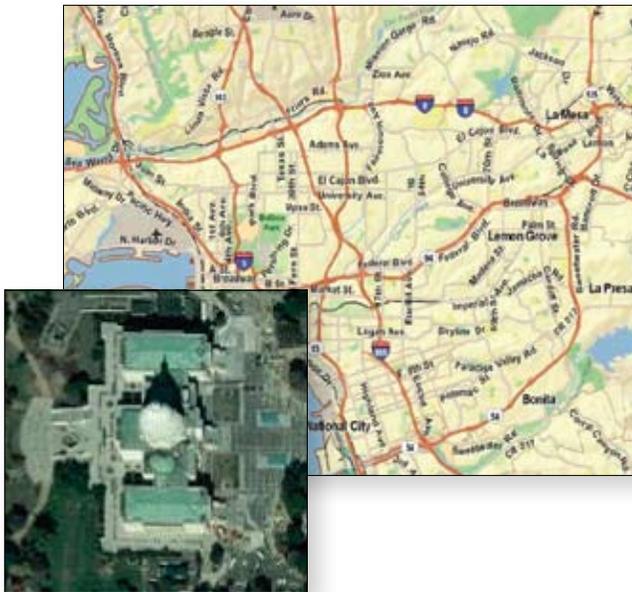
## Mobile GIS

Mobile GIS is the expansion of GIS from the office into the field. Wireless connectivity, geoservices, and Web mapping applications enable communication with and coordination of service technicians and contractors in the field. This increases efficiency and provides access to previously unavailable data for users who may have limited GIS experience.



## Server GIS

Server GIS enables you to share and maintain the data you create on desktop GIS with any number of users across the enterprise, working with focused, easy-to-use applications. Many operational groups within your enterprise can integrate data from various sources, ensuring that everyone is working from the most up-to-date data. Server GIS enables you to distribute your maps, models, and tools to others in the organization in a way that fits their workflows. By accessing accurate data, staff in all departments and in the field will significantly increase their productivity.



## Data

ESRI provides a full spectrum of ready-to-use, high-quality geospatial data products. ArcGIS Online Services deliver 2D and 3D content as a Web Service via the Internet. StreetMap Premium consists of enhanced street data from NAVTEQ® or Tele Atlas®, delivered on DVD, and is perfect for geocoding, routing, and cartographic display. ESRI also offers business, consumer spending, and demographic data so you can analyze your customers' or constituents' lifestyle behavior. ESRI Data & Maps is a set of annual map data that is included at no additional cost with ArcGIS products.

Learn more about ArcGIS at  
[www.esri.com/arcgis](http://www.esri.com/arcgis).



## ESRI

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*For more than 35 years, ESRI has been helping people make better decisions through management and analysis of geographic information. A full-service GIS company, ESRI offers a framework for implementing GIS technology and business logic in any organization from personal GIS on the desktop to enterprise-wide GIS servers (including the Web) and mobile devices. ESRI GIS solutions are flexible and can be customized to meet the needs of our users.*

## For More Information

**1-800-GIS-XPRT** (1-800-447-9778)

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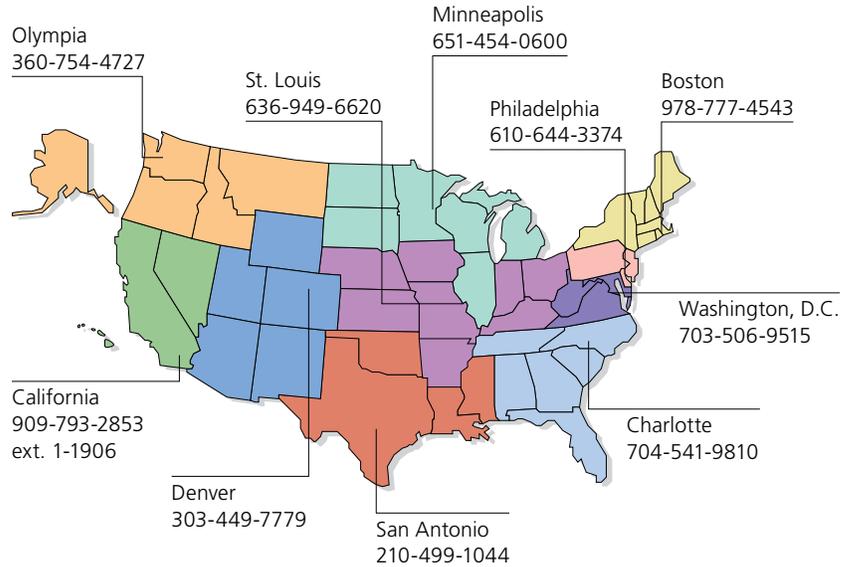
Locate an ESRI value-added reseller near you at

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Outside the United States, contact your local ESRI distributor. For the number of your distributor, call ESRI at 909-793-2853, ext. 1-1235, or visit our Web site at

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## ESRI International Offices

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Belgium/Luxembourg <a href="http://www.esribelux.com">www.esribelux.com</a>	India <a href="http://www.esriindia.com">www.esriindia.com</a>	Portugal <a href="http://www.esri-portugal.pt">www.esri-portugal.pt</a>
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Canada <a href="http://www.esricanada.com">www.esricanada.com</a>	Italy <a href="http://www.esriitalia.it">www.esriitalia.it</a>	Singapore <a href="http://www.esrisa.com">www.esrisa.com</a>
Chile <a href="http://www.esri-chile.com">www.esri-chile.com</a>	Japan <a href="http://www.esrij.com">www.esrij.com</a>	Spain <a href="http://www.esri-es.com">www.esri-es.com</a>
China (Beijing) <a href="http://www.esrichina-bj.cn">www.esrichina-bj.cn</a>	Korea <a href="http://www.esrikr.com">www.esrikr.com</a>	Sweden <a href="http://www.esri-sgroup.se">www.esri-sgroup.se</a>
China (Hong Kong) <a href="http://www.esrichina-hk.com">www.esrichina-hk.com</a>	Lebanon <a href="http://www.esrilebanon.com">www.esrilebanon.com</a>	Thailand <a href="http://www.esrith.com">www.esrith.com</a>
Eastern Africa <a href="http://www.esri-aea.co.ke">www.esri-aea.co.ke</a>	Malaysia <a href="http://www.esrisa.com.my">www.esrisa.com.my</a>	Turkey <a href="http://www.esriturkey.com.tr">www.esriturkey.com.tr</a>
Finland <a href="http://www.esri-finland.com">www.esri-finland.com</a>	Muscat <a href="http://www.esrimuscat.com">www.esrimuscat.com</a>	United Kingdom <a href="http://www.esriuk.com">www.esriuk.com</a>
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Germany/Switzerland <a href="http://www.esri-germany.de">www.esri-germany.de</a> <a href="http://www.esri-suisse.ch">www.esri-suisse.ch</a>	Northeast Africa <a href="http://www.esrinea.com">www.esrinea.com</a>	



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