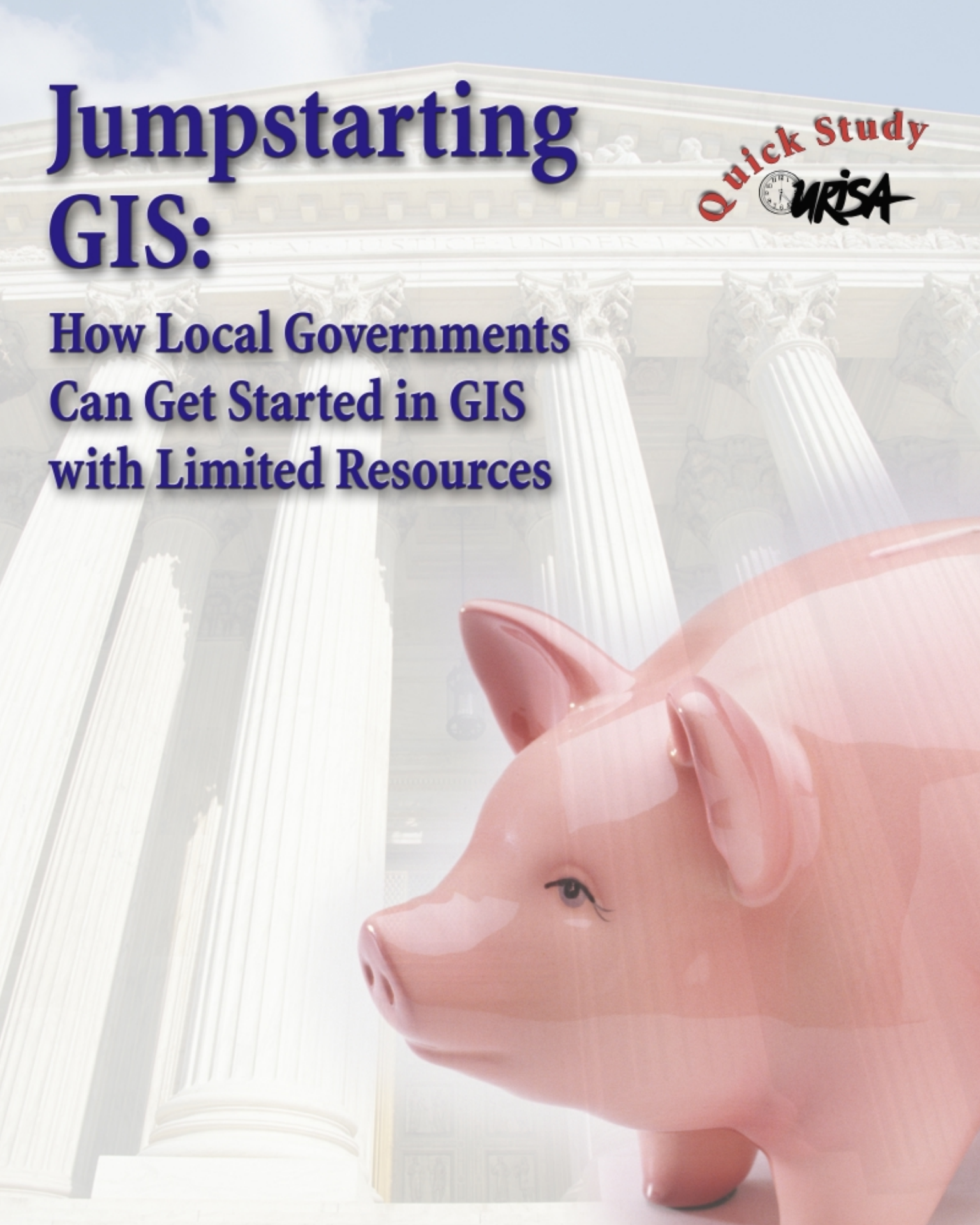
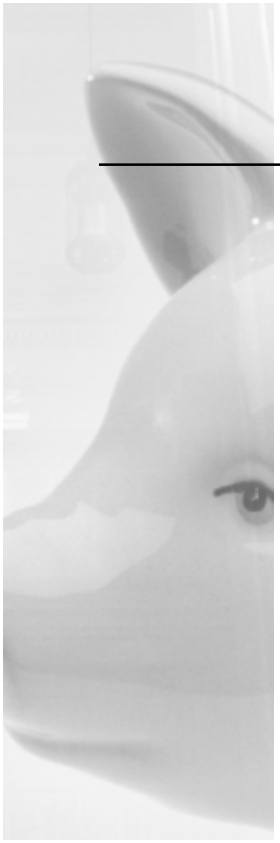
Jumpstarting GIS:

How Local Governments Can Get Started in GIS with Limited Resources

Quick Study

URISA





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HOW LOCAL GOVERNMENTS CAN GET STARTED IN GIS WITH LIMITED RESOURCES

Quick Study URISA

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INTRODUCTION

The purpose of this quick study is to provide small local governments that have limited funds and time with information resources to start a geographic information system (GIS) program. The objective of the publication is to provide a resource guide for GIS system and data components that can be acquired and put into use quickly and inexpensively. (For small local governments, this quick study is a companion book to the Quick Guide to GIS Implementation and Management Guide).

Recent trends such as the need for improved productivity and service to the public, increasing demands for geographic information and analysis, and a desire to minimize redundancy and cost have led small local governments to consider using GIS to provide a centralized service tool for application support and data sharing. Now more than ever, GIS uses cover a wide range of municipal services. For instance, GIS is used for parcel map production, voter and precinct management, school attendance and transportation plans, hazardous waste management, groundwater analysis, and pavement management.

GIS helps focus users' data acquisition activities, provides a framework for improving data storage, and supplies tools that can facilitate data management. Small local municipalities get started in GIS to meet these and other growing geographic information visualization and analysis requirements. Organizational and budgetary conditions, however, often dictate the level of investment that can be dedicated to implementing a GIS. Fortunately, several alternative GIS funding and development approaches are now available to help small local governments build a GIS. This study discusses the short-term aspects of starting a GIS and includes information on expanding the system in the future. The quick study covers planning the GIS, alternatives for getting started, funding opportunities, vendor programs, hardware and software acquisition approaches, partnerships and alliances, and future GIS expansion.

This quick study also focuses on the funding alternatives and information available to assist a local government with limited resources in getting started with GIS. These alternatives are useful for all local governments but are particularly important for small local governments that have limited funds, time, and personnel to devote to GIS efforts.

CHAPTER 1

PLANNING THE GIS

Planning is important to the success of any GIS project or program. Many local governments do not have adequate resources for planning due to the increased need for immediate results and information available in a readily available, easily understood format and limited resources, expertise, and experience in GIS planning. Resource and budget constraints often limit the depth and length of the planning process an organization can undertake. Yet, as noted by Somers (1994), many of the problems that arise at various stages in the GIS development and operation can be linked back to inadequacies in the planning process. Some of these problems may surface as omissions, lack of agreement on technological and strategic issues, or failure to operationally address the needs of user departments.

Fortunately, in recent years, the GIS community has established and provided several programs and tools that have enabled modifications to the traditional GIS development model. Previously, most GIS development processes were lengthy, expensive, and complex; now, in some cases, GISs can be built relatively quickly with smaller budgets. Even with the new methodologies, data resources, and technology tools that are now available, it is still essential that the GIS planning process be addressed at a fundamental level, where at a minimum the core characteristics of the GIS and the future users are defined. It is not required that the entire system development plan be completed, but an accurate pictures of what the intent of the GIS will be as well as who it will serve should be included.

Figure 1 displays a traditional GIS development approach. (This process is discussed in more detail in the Quick Guide to GIS Implementation and Management.) The steps of planning, analyzing, designing, and implementing the GIS should be performed with regard to each dataset and application; however, this does not necessarily have to occur in detail at the same time.

In order to build a successful GIS, some level of initial planning is essential. The next section discusses the minimum and optional components that should be included in the planning process.

GIS Plan - Minimum and Optional Components

At a minimum, before proceeding into design, development, and implementation, a GIS plan should be developed that contains goals, critical factors, objectives, and actions. There are several additional steps in the planning process, which may be

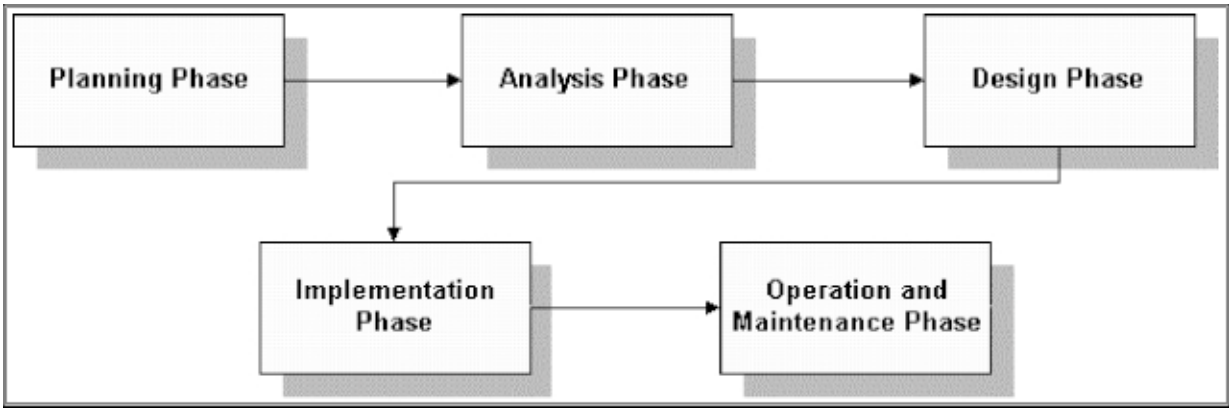


Figure 1

considered options, for the purpose of gaining short-term wins by showing quick results.

Here are some examples:

- **Goals:** Cost effectively acquire, maintain, and use geographic and comprehensive planning information in order to enable departments and the public to make better decisions.
- **Critical Factors:** 1) close cooperation and coordination among departments with regard to developing GIS data; 2) correctness, completeness, and integrity of all data that is collected, maintained, and shared with other entities; and 3) funding support for goals and objectives.
- **Objectives:** 1) identify and prioritize the spatial and attribute data areas of greatest value; 2) establish responsibility for developing and maintaining GIS datasets; and 3) inventory state and local resources.
- **Actions:** 1) prioritize datasets; 2) establish responsibility for data areas from the priority lists; and 3) develop consistent data formats between state and local agencies to facilitate cooperative activities.

These goals, critical factors, objectives, and actions are presented to illustrate the types of activities to consider in a GIS plan. These items may or may not be applicable to a particular local government.

Other components of a GIS plan that would be useful to develop if time and resources permit include: 1) policy statement; 2) formalization of the data acquisition and maintenance process; 3) documentation of standard methodologies for GIS operational procedures; and 4) promotion of the interaction between internal and external agencies. These items, however, are often more time consuming and should be completed as part of a long-term planning exercise.

In sum, as stated by Somers (1994), the importance of at least developing a minimal GIS plan is that "it addresses important topics such as developing policies and practices, balancing long-term goals and short-term tactics, leveraging available resources, establishing effective cooperative relationships, responding quickly to a changing environment, and translating plans into actions."

CHAPTER 2

ALTERNATIVES

The purpose of this section is to provide an overview of potential alternative approaches to developing a GIS. When reviewing and selecting an alternative, it is important to keep in mind the importance of a quick start and early deliverables. A quick start can help gain support from important political allies and potentially produce funding support. Early deliverables enable the quick measurement of the GIS program, allowing for review and change management to easily and cost effectively modify the GIS plan or development process as necessary early in the process.

A variety of opportunities have emerged recently that have made alternative approaches to GIS development processes easier. These opportunities have appeared in the following areas: funding opportunities, vendor starter support, hardware and software, data, and partnerships and alliances. These are discussed briefly here and in more detail in the following sections.

Overview of Alternatives

GIS Funding Opportunities

GIS funding opportunities have become more prevalent in recent years as federal, state, and local agencies have witnessed the important analysis and visualization capabilities associated with GIS views and output. These funding opportunities tend to fall into two categories: general funding and project specific funding. General funding refers to GIS development start-up; whereas project specific funding refers to environmental, transportation, public works, criminal justice, or other applications of GIS.

GIS Vendor Starter Kits

Currently, two GIS vendor starter kits are available to help local governments develop a GIS. These grant programs have been developed by ESRI and Intergraph. Table 1 highlights the major components included in each grant.

Hardware and Software Alternatives

Hardware platforms are becoming cheaper as GISs have been converted and ported from traditional UNIX platforms to the Windows operating system. Personal computers running Windows have decreased dramatically in price. Additionally, GIS servers have become cheaper, as much of the GIS software is now being built on Windows NT technology. For smaller local governments, the NT environment has proven reliable and successful for GIS implementation. Many large GISs still utilize UNIX hardware and software that has proven more reliable when there are more users and applications.

ESRI - Solutions Grants for Livable Communities	Intergraph and NACo (National Association of Counties) GIS Starter Kits
includes: ■ applications ■ software ■ data ■ training	includes: ■ software ■ data ■ workflow ■ training ■ user support

Table 1.

GIS software has become application specific, simplified, and available on multiple hardware platforms, making it easier to use and cheaper than in previous years. Simplified, web-enabled software tools are allowing users to view, query, report, and map georeferenced data, where before these tasks would have been completed by systems personnel. In addition, simplified GIS software has helped reduce the cost of training, as personnel in many cases have become users with only a few days of instruction.

Data Alternatives

In terms of data sources and creation, there are now a variety of less costly alternatives. For instance, commercial and public digital orthophotography, GPS data, population and housing information, transportation networks, and satellite imagery are available in many vendor kits bundled with their software or for little to no cost from several federal agencies. Further, there are several Internet resources now available from local, state, and federal government or other sites that share GIS data. Examples include the National Spatial Data Clearinghouse, USGS, and the GIS Data Depot.

Partnerships and Alliances

Another alternative that may be available to aid small local governments in jumpstarting their GIS program is to develop partnerships and alliances. Partnering with a larger unit of government, regional agency, or utility presents opportunities for GIS and data development. Working through interlocal agreements and local GIS consortia could also provide alternatives for the establishment of a GIS.

GCHAPTER 3

GIS FUNDING OPPORTUNITIES

This section describes some of representative funding opportunities that are currently available for starting a GIS. This is not meant to be a complete list of funding opportunities that are available. The purpose of this listing is to facilitate local governments' review and search for alternative funding opportunities that best fit their particular GIS plans.

As mentioned previously, there are two main types of GIS funding opportunities: general funding and project specific funding. Table 2 describes some of the general funding opportunities.

Table 3 highlights and describes the second type of GIS funding opportunities that are subject matter or project-oriented. These types of opportunities are more abundant than those for general GIS development. Project specific funding is another mechanism for local governments to get jumpstarted in GIS, by beginning with a specific application area and continuing to build the GIS from there. Grants and funds are provided for various subject matter areas that GIS could be applied to including, but not limited to:

- economic development;
- environmental planning and resource conservation;
- transportation;
- housing and urban development;
- information technology;
- criminal justice;
- health care;
- business planning;
- public safety; and
- community development.

Tables 2 and 3 are examples to facilitate thinking and highlight some of the well-known funding programs. There are hundreds of other funding opportunities available throughout the United States at the state and local government levels that should be investigated based upon your agency's geographic location.

Agency	Program Description	Internet Address
Federal Geographic Data Committee (FGDC)/ National Spatial Data Infrastructure (NSDI)	FGDC/NSDI Cooperative Agreements Program (CAP) - The purpose of the FGDC NSDI Cooperative Agreements Program is to facilitate partnerships and alliances among various public and private entities to assist in building the National Spatial Data Infrastructure. The Cooperative Agreements Program funds projects focused on promoting metadata collection and creating clearinghouses of geographic data linked to the Internet, and advancing the NSDI through education. The objective of the program is to help local governments find and access geospatial data, build relationships with organizations to support digital geographic data coordination, develop standards and metadata, and implement education programs related to geographic information.	http://www.fgdc.gov/funding/
FGDC/NSDI	NSDI Community/Federal Information Program (C/FIP) - This FGDC program is an initiative designed to provide incentives for communities to create and make geographic data available for use by citizens, government officials, businesses, and academic institutions. It is presented as a competitive matching grant program to promote availability and use of geospatial data and to support the efforts of the National Spatial Data Infrastructure. The C/FIP has been developed by 17 federal agencies that make up the FGDC. The initiative has two integrated components: 1) a competitive matching grant program to help promote the wide spread availability and use of geographic data for community problem solving, which will increase the capacity of communities to create and use geographic data in decision-making; and 2) support for local agencies to make their geographic data more readily available to communities. The long-term goals of this initiative include: a) more informed decision-making at the community level; b) improved land and resource use; c) a more informed public; d) a greater opportunity for public participation in decision-making; e) ready transfer of data between the federal government and communities, and f) community contributions to datasets of national and global interest.	http://www.fgdc.gov/funding/

Table 2

Agency	Program Description	Internet Address
Several Counties throughout the United States	County General Funds - Several counties throughout the United States have dedicated General Funds to aid in the development of GISs at the small local government level. In most counties, the general fund is the one major funding source at the county that supports the daily operations and functions of nearly all county activities. Responsibilities and operations that are in the best interest of the county are funded through this source. Most GIS programs have a direct or indirect impact on the general fund. In Ohio, for example, the general fund is directly impacted because it is the major contributor to the GIS program. The general fund is indirectly impacted even if special funds are used. For example, the County Engineer's Office is the maintainer of maps as directed by the Board of County Commissioners and is normally funded out of the general fund.	http://www.state.oh.us/ogrip (Example for the State of Ohio)
U.S. Department of Commerce	Telecommunications and Information Infrastructure Assistance Program (TIIAP) - State and local governments have used this program to help build the networks, databases, and infrastructure associated with GIS development. The program is primarily for information technology development that can be then applied to GIS. Grants have been used to: 1) purchase equipment for connection to networks, including computers, video conferencing systems, network routers, and telephones; 2) buy software for organizing and processing all kinds of information, including computer graphics and databases; 3) train staff in the use of equipment and software; and 4) purchase communications services such as Internet access.	http://www.ntia.doc.gov/otiahome/tiiap/
State Level Programs	Several state departments fund general GIS development projects. Several states have started GIS boards that fund GIS development projects. New York, Florida, California, Georgia, and several other states have developed similar types of funding mechanisms. For instance, the State of New York's State Archives and Records Administration (SARA) - Provides support for projects that improve the creation of records and the design and implementation of records systems. Funding has been provided for GIS needs assessments and implementation plans, as well as some limited initial GIS implementation.	http://www.sara.nysed.gov (State of New York example)

Table 2 ***(continued)***

Agency	Program Description	Internet Address
Department of Natural Resources	The Department of Natural Resources funds GIS activities related to the preservation of ecosystems and the environment at all levels of government. A good example of the results of such funding comes from the State of Michigan, where the Michigan State University developed the Partnership for Ecosystem Research and Management (PERM) initiative.	http://www.dnr.state.mi.us/ (State of Michigan example)
Environmental Protection Agency	The Environmental Protection Agency provides grant funding on a project basis to governments and organizations that want to utilize GIS for water resources, environmental information and education programs.	http://www.epa.gov/
National Science Foundation	The National Science Foundation has provided funding and supported several GIS initiatives for university, local government, and corporate consortia in diverse areas such as climatology, satellite imagery, digital terrain databases, and laser technology for GIS uses.	http://www.nsf.gov/
National Institutes of Health	In recent years, the National Institutes of Health have become heavily involved in the development of funding opportunities for health-based GIS analysis. This includes such areas of study as spatial patterns of genetic variability, low birth weights, and incidences of lead poisoning.	http://www.nih.gov/
U.S. Department of Agriculture - Forest Service	The USDA Forest Service provides GIS funding opportunities related to forestry, parks, recreation, and general natural resources applications. A good example of the results from this type of funding is the North Central Research Station. The North Central Research Station has been the leading Federal agency for natural resource research and development in the Midwest. They provide the scientific basis for decisions and policies that affect the management and use of forests in the region. Their research and development advances the understanding of ecosystems, interactions between people and those ecosystems, and ways to provide benefits for people within the capabilities of the land. Their research ranges from molecular to landscape and from local to global.	http://www.ncrs.fs.fed.us/

Table 3

Agency	Program Description	Internet Address
NASA	NASA has funded several GIS initiatives of university, state, and local government agencies that focus on GIS education, development, and utilization relative to space and global technology implementation.	http://www.nasa.gov/
Several Counties Throughout the U.S.	County Special Revenue Funds - These are funds dedicated to specifically mandated duties. There are several special revenue funds at the county level that are used to fund specific, defined activities. Several states have developed specific special revenue funding opportunities that support geographically related functions and activities. In the State of Ohio, for example, county special revenue funds are being used to support GIS development, implementation, and operations in the following area: Real Estate Assessment Fund (REAF or J-Fund) - This special fund is for county auditors in support of assessment activities and the appraisal process. The REAF has been a major contributor to GIS activity in Ohio due to GIS technology's mapping and analytical functionality and the advantages GIS provides to the appraisal process.	http://www.state.oh.us/ogrip (State of Ohio example)
Federal and State Departments of Transportation	For over fifteen years, Departments of Transportation have been applying GIS to transportation related issues. GIS-T funding opportunities exist through state and district level research and development programs. Specific grant funding availability typically varies from program to program.	

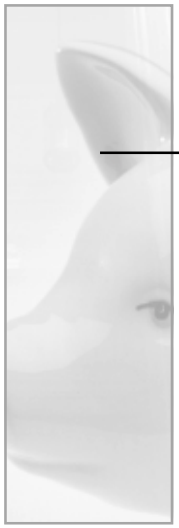
Table 3 ***(continued)***

Agency	Program Description	Internet Address
Department of Commerce	Technology Opportunity Program (TOP) - The TOP program promotes the widespread availability and use of advanced telecommunications and information technologies in the public and non-profit sectors. As part of the Department's National Telecommunications and Information Administration (NTIA), TOP gives grants for model projects demonstrating innovative uses of network and information technology. TOP evaluates and actively shares the lessons learned from these projects to ensure the benefits are broadly distributed across the country, especially in rural and underserved communities. Although not explicitly stated, TOP can and has been utilized as part of projects that include GIS implementation. Since 1994, TOP has made matching grants to state, local, and tribal governments, health care providers, schools, libraries, police departments, and community-based non-profit agencies.	http://www.ntia.doc.gov/otiahome/top/index.html
National Institute of Justice	The National Institute of Justice has provided funding to local law enforcement agencies and governments for the development of crime mapping applications such as incident management, police beat analysis and redistricting, crime typology, and routing scenarios.	http://www.ojp.usdoj.gov/
U.S. Geological Survey	The USGS contracts and grants information Internet site provides information about all of the agency's contracts and grants programs, many of which are directly related to GIS. The USGS provides grant funding in several GIS-related subject matter categories such as: transportation, hydrography, geodetic control, elevation, digital imagery, and cadastral information.	http://www.usgs.gov/contracts/index.html

Table 3 ***(continued)***

Agency	Program Description	Internet Address
Department of Housing and Urban Development (HUD)	HUD provides support for GIS projects if they are related to housing and community development, economic empowerment, and targeted housing and homeless assistance. HUD's grant support is known as the Super Notice of Funding Availability (SuperNOFA).	http://www.hud.gov/cio/grants/fundsavail.html
Federal Environmental Management Agency and ESRI	The Federal Emergency Management Agency's and ESRI's Project Impact: Building Disaster Resistant Communities initiative provides GIS grant opportunities. The purpose of the grant is to foster and support the use of Geographic Information System (GIS) technology by communities as a tool for implementing disaster resistance, particularly as it pertains to developing or implementing strategies for reducing damage from natural hazards.	www.esri.com
Department of Community Affairs (DCA)	DCA has provided grants related to economic business assistance and GIS development pilot and full projects related to economic development. For example, the State of Georgia's REBA (Regional Economic Business Assistance Grant Program) has provided millions of dollars for GIS related projects to local governments and communities throughout the state, through regional commission funding support.	

Table 3 ***(continued)***



CHAPTER 4

GETTING STARTED VENDOR PROGRAM KITS

Two well-known GIS software vendors have established programs to help local governments with little or no funds dedicated to GIS get jump-started. The vendors are ESRI and Intergraph. Their programs are described briefly below.

Environmental Systems Research Institute (ESRI) Livable Communities Grant Series

ESRI has developed the Solutions Grants for Livable Communities. These grants are focused on helping communities enhance their GIS capabilities by providing:

- GIS software
- hardware
- spatial and attribute data
- training

ESRI has developed the program with business partners in order to bundle software tools for customized grants. There are customized grants for:

- livable communities: law enforcement
- livable communities: public safety
- livable communities: cadastral
- livable communities: community development/ public works
- livable communities: public access (internet)
- livable communities: schools
- livable communities: public utilities
- livable communities: health and human services
- livable communities: library services

These grants are available to all forms of local and regional government including regional planning agencies, councils of government, metropolitan planning organizations, cities, townships, and counties. Priority, however, is given to agencies that demonstrate a GIS plan for collaborative efforts between multiple departments, promote public access, and show innovative government solutions.

An example of what is included in a Livable Communities grant is provided below. This example is for the Livable Communities: Public Access (Internet) grant.

Public Access (Internet) Program

The ESRI Public Access Grant Program was established to assist local governments in improving citizen access to government GIS information. It is also the intent of the grant to foster distribution of GIS information throughout the organization via Intranet applications. The grant program is a GIS

investment program that provides software and hardware to one hundred local government agencies meeting the eligibility requirements. Grant recipients will receive one each of the following:

- One IBM IntelliStation Computer Workstation
- One copy MapObjects Internet Map Server
- MapObjects Internet Starter Application
  a. general map utility
  b. property information utility
  c. event notification utility
  d. site selection utility
  e. demographic utility
- ArcExplorer
- Links to ArcData Online Program
- Maps on the Internet by ESRI Press

In return for receiving this hardware and software, the local government agency is required to use the IBM computer as the GIS server, share project successes with other public agencies, and become a reference site for IBM and ESRI.

Additional information on this program is available at http://www.esri.com/.

National Association of Counties (NACo) GIS Starter Kit

The GIS Starter Kit is a partnership between the National Association of Counties (NACo) and Intergraph to enable county governments to begin taking advantage of GIS technology. The GIS Starter Kit is available to all NACo member counties in the United States at no cost. It consists of:

- GIS software (Intergraph's GeoMedia desktop software)
- county government datasets (road, boundary, and demographics from Census Bureau)
- county applications (four GIS solutions specific to local government)
- user training (GeoMedia training, GIS solutions, and familiarity with datasets)
- GIS Starter Kit Support

The following section details NACo's description of each of the program areas.

GeoMedia software

Each starter kit includes a free copy of Intergraph's GeoMedia software, desktop GIS software that enables users to query, analyze, and present GIS data. GeoMedia also gives users the ability to transform data and create a host of other applications to support daily tasks.

County Government datasets

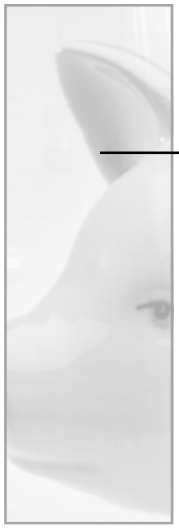
Datasets for each participating NACo county, including roads, boundary files, and demographics from the U.S. Census Bureau are provided as part of the starter kit. The county dataset includes all United States streets and highways, airports, railroads, rivers, water features, and other landmarks. The set includes demographic, administrative, cartographic, environmental, political, transportation, and utility layer data. The U.S. Census boundaries are delivered with the dataset and include states, counties, places, townships minor/major civil divisions/metropolitan statistical area (MCD/MSA), census tracts, block groups, congressional districts, reserves, and ZIP Codes. Supplemental geographic features and database extracts from other sources, along with a data dictionary, are supplied for each of the participating counties.

County Workflows

Three county workflows are included to help users solve recurring local government problems and help produce measurable productivity gains for daily operations. The primary workflow areas are economic development involving facility siting and planning, redistricting and reapportionment for county management, and emergency response for operations planning and incident analysis.

User Training
Training is offered on a regional basis, conducted by universities and local education centers participating in the NACo County GIS Program.

Additional information regarding this program is available at http://www.naco.org/programs



CHAPTER 5

HARDWARE AND SOFTWARE ACQUISITION APPROACHES

Hardware and software costs have dropped dramatically, making it easier for under funded local governments to get involved in GIS development and implementation. Desktop GIS has become common and is now used in many local government GISs. The hardware and software acquisition approaches applicable to these local governments rely heavily on the technical strategies required for implementation; including the difference between centralized and decentralized approaches, user needs, and functional capabilities.

Hardware and Software Components

The general hardware components of a GIS include a computer or central processing unit (CPU) that is linked to mass storage units such as hard disk drives and tape drives, peripherals such as digitizer or scanner, and output units such as printers and plotters. In addition, communication devices such as modem and network interfaces are becoming more important for today's GIS development.

The software package for a GIS consists of four basic technical modules. These basic modules are sub-systems for:

1. Data input and verification.
2. Data storage and database management.
3. Data transformation and manipulation.
4. Data output and presentation.

Hardware and Software Considerations

A review of technical strategies requires consideration of a range of concerns related to hardware and software acquisition. Perhaps the most important task is the assessment of related software to meet GIS, relational databases, Internet, and computer aided design and drafting (CADD) needs. Often the success of a GIS installation is dependent upon the matching of technical requirements and software functionality. The software chosen should provide the needed performance for the minimum investment. GIS implementation success is dependent upon the right hardware and software choices.

An assessment of GIS software requires consideration of several factors. The most important factor is functional capability. This will depend greatly upon the departments in the local government agency expected to participate in the GIS program. A review of all typical GIS subsystem functions weighted by importance as defined by user requirements should be undertaken if time allows. GIS software, however, should not be evaluated by specific functions alone.

Consideration of subjective technical factors such as user interface, help utilities, documentation, training and support, company risk assessment, technical excellence, and operational issues (performance, space, and speed) are also important.

Consideration of general systems characteristics is necessary as well, especially when considering the changing hardware platforms that are available. These characteristics include supported hardware platforms, operating systems, database interfaces, adherence to computing standards, application programming interfaces (API), and spatial data structures.

Hardware and Software Decision Factors

There are three main components to consider in determining appropriate hardware and software:

- **GIS applications** - The GIS applications that are required help define the software, hardware, database management, and data analysis approaches that would be most effective. For example, public works and civil engineering types of applications may prefer software vendors with specialized GIS tools for this industry such as those offered by Bentley, GE-SmallWorld, ESRI, Autodesk, and Integraph.
- **GIS software** - In local government, certain software tools may be appropriate when close partnerships exist or specific analysis tools are required. In some instances, close coordination of data and methods is required between partners. The exchange of data and/or software can be maximized if the parties involved are all using the same hardware/software platform.
- **System configurations** - The type and size of desired databases and analyses required can help determine appropriate system configurations. These configurations are the specific hardware and software required to support the applications. UNIX computers predominate in some regions, while Windows-based hardware predominate in others. In recent years, migration to the NT platform has become more common and may give more consistency across agencies but should only occur as appropriate (within time and budget constraints) for each department using the GIS.

Other Hardware and Software Acquisition Issues

Hardware

Hardware must be able to support a variety of GIS activities, including map production, database development, spatial and attribute data editing, and complex analysis. In addition, at least one GIS workstation or server will be needed to store spatial and attribute data and to provide easy and timely access to information.

The following are some general guidelines for a minimal GIS program hardware configuration. This configuration will vary based upon the amount of information and applications required by a given local government agency.

- One 19-inch color monitor for data maintenance and updating.
- Network-ready workstations supporting a minimum transmission speed of 10 megabits per second.
- Hard-drive capacity of approximately 20 GB for storage of spatial and attribute data on a workstation or server.
- Minimum 32-bit, 200 MHz processor.
- 256 MB RAM (memory), readily expandable.
- 1.44 MB floppy drive.
- CD-ROM DRIVE.

Software

Table 4 displays a list of functions that local governments may wish to evaluate when acquiring GIS and related software. Depending on the GIS plan established by the local government agency, GIS software components may be required for data editing, query and analysis, data production and data visualization.

GIS Functions	Description
Data Editing	
Graphic editing	The process of updating points, lines, and polygons in a GIS
Attribute editing	The process of updating tabular data associated with a particular map feature; the GIS stores the attribute information in a database that is linked to the map feature
File conversion	The process of converting from the native GIS data format to other formats
Merging	The process of combining the spatial and attribute information associated with one GIS layer with another
Edit controls	Allow for the splitting of lines and polygons, merging of map features, combining, subtracting, and creating unions and intersections of spatial and attribute data
Rubber sheeting	The possibility of continuous distortion without tearing or shape breaks when overlaying map features
Data Query and Analysis	
Graphic data query	The ability to query map features, typically through selection functions
Attribute data query	The ability to query the databases associated with GIS map features
Area and distance calculations	Area and distance calculations for point, line, and polygon layers
Buffering	The ability to select any given spatial map feature and make a buffer or a zone of a specified distance around spatial features
Geocoding	The process of identifying a location by one or more x,y coordinates from another location description such as an address
Spatial analysis	The process of modeling, examining, and interpreting model results; the process of extracting or creating new information about a set of geographic features.
Polygon overlay	Merges spatially coincident polygons and their attributes from two layers to create a third layer that contains new polygons and describes new relationships
Network analysis	Analysis related to linear map features such as roads or railroads; types of network analyses include shortest path algorithms or routing and scheduling procedures

Table 4

GIS Functions	Description
Data Display and Output	
Graphic display	A visual depiction of spatial map features
Tabular display	A visual depiction of the database associated with map features
Map and report production	The ability to print and plot graphic and tabular information associated with a map
Chart production	The ability to produce charts from the tabular data associated with spatial map features
Interactive map composition	The ability to perform cartographic development of a map within an automated map layout interface

Table 4 ***(continued)***

CHAPTER 6

DATA ACQUISITION APPROACHES

Once the local government agency has purchased hardware and software, data acquisition issues will emerge. Depending upon the level of accuracy required, GIS data could be relatively easy to acquire either directly from federal government resources or through vendor programs. Many GIS software packages come with built-in datasets, but these are often of limited use due to their lack of local accuracy. Whatever the acquisition method, it is important to ensure that GIS data is georeferenced so that it may be related to points, lines, or areas on the Earth's surface and used in combination with other attribute information.

Most challenging is acquiring local and regional data as cheaply as possible. Typically, local datasets are expensive to create, and their creators are unlikely to share them without in-kind reciprocation. Becoming involved in local GIS user groups, attending meetings, and developing partnerships are a few ways to overcome this problem.

Available data is often limited, and it may be generalized or not sharply focused. The form of the data is critical to the overall database design and the success of the analyses performed with the GIS. The quality of the results produced from GIS analyses and applications ultimately resides in the quality of the data used. GIS data can be obtained in various formats from many different sources. Requirements based upon quality, scale, structure, accuracy, and level of completeness will depend upon the needs of the functions listed in the agency's GIS plan.

Data Types

Several data types can be utilized by a GIS system. Each data type has its own unique properties and potential for contributing to the overall quality and functionality of the GIS. The following is a list of data types as well as visual examples.

- Vector data: Includes point, lines, and polygons, and based on elemental points.

- Raster data: Data normally associated with remotely sensed imagery and aerial photography in a cell-based data storage system. These are datasets developed from satellites and aircraft.

- Attribute data: Tabular information related to map features such as zoning classifications, future land use patterns, and property information.

- Combination of all three data types.

Data Sources

Several data sources are available from federal, state, regional, and local government agencies. Additionally, several vendors package GIS data with their products. Internet sources have become popular in recent years as well.

Government Sources

Government is the largest single source of geographic data. Data for almost any GIS application can be obtained through federal, state, regional, or local governments. Various data formats can be obtained through government resources. The following sections describe datasets that are available through some federal, state, and regional/local government agencies. These are given as representative examples of the types of data sources available. The agency searching for such data should research individually the data opportunities in its region.

Federal Data Sources

The federal government is an abundant source of geographic data. The following table highlights several of these data sources.

Agency	Data Description
U.S. Census Bureau	TIGER (Topologically Integrated Geographic Encoding and Referencing) - Includes national coverage of roadways, address, census designations for population and housing data, economic censuses, and related information.
U.S. Geological Survey	Digital Line Graphs (DLG) - Includes information such as political boundaries and administrative boundaries. Hydrography data includes data in three separate subcategories: streams, water bodies, and hypsography. The transportation category of data includes major transportation systems collected in three separate subcategories: roads and trails, railroads and cultural features (airports, Alaska pipeline).
Department of Agriculture	Data related to hydrologic, boundary, remotely sensed, topographic, and surface features related to forestry, soils, and agriculture.
Department of Commerce	Atmospheric, hydrological, geophysical, geodetic, boundary, and surface geographic features associated with census information, economic analyses, environmental, and weather data.
Department of Defense	Boundary, hydrologic, topologic, and surface spatial features associated with GIS data for defense purposes.
Department of Health and Human Services	Boundary and socioeconomic data.
Department of the Interior	Boundary, hydrologic, land ownership, topographic, and surface features associated with land management, mines, reclamation, minerals management, national parks, geological, and fish and wildlife data.
Department of Transportation	Surface transportation related data.
FEMA	Hydrological data.
NASA	Remotely sensed, hydrological, surface, and subsurface data.
U.S. Environmental Protection Agency	Environmental data.

Table 5

State, Regional, and Local Governments

Many state, regional and local government agencies and organizations maintain GIS databases. These agencies may have data sharing arrangements with local government agencies and other municipalities. Information identifying which government agencies have available GIS data layers is often given through the Internet in the form of GIS data dictionaries or links. The following table highlights some representative example sites for state, regional, and local government GIS data on the Internet.

Private Data Sources

Several software vendors' packages contain GIS datasets for boundary, roadway, census information, hydrological features, and environmental data bundled with their GIS software. These data packages are usually available at no additional cost to the software purchase. Examples companies offering free GIS data include:

- ESRI - packaged with ArcInfo/ArcView;
- Intergraph - packaged with GeoMedia;
- Caliper - packaged with Maptitude; and
- MapInfo.

Other vendors make GIS data available but have costs associated with purchase. For example:

- ETAK - offers highly accurate road network and address GIS databases; and
- Geographic Data Technology Inc. (GDT) - offers street, address, postal, and census GIS databases

Costs depend on the amount and extent of data purchased.

Internet Resources

Most of the resources mentioned above have Internet sites that, at a minimum, explain how to acquire their GIS datasets. In addition, several other online data resources provide GIS data for download and purchase. A couple of the most commonly utilized sites are the GeoCommunity Data Store (http://www.gisdatadepot.com/catalog/index.html) and TerraServer (http://www.terraserver.com) for satellite imagery.

For example, the GeoCommunity Data Store contains the following GIS data for download and purchase:

- State Digital Raster Graphics from USGS.
- Geographic Names Gazetteer (contains millions of features such as locality and vegetation).
- Digital Orthophoto Quarter Quads for several states.
- U.S. State Data Bundles (contains several datasets from Federal data sources bundled into one package).

Agency	Program Description	Internet Address
Center for Advanced Spatial Technologies - University of Arkansas, Fayetteville	Catalog of Arkansas Digital Spatial Data	http://www.cast.uark.edu/local/catalog/arkansas/
Arizona Land Resource Information System	Maintains a statewide multi-purpose digital spatial database for use by as many agencies as possible. The database contains spatial data for land, natural resources, and socioeconomic data.	http://www.land.state.az.us/alris/alrishome.html
State of California, Teale Data Center	The GIS Technology Center maintains a data library of over 35 types of geography. Library coverages are in ArcInfo format and are convertible to other file formats as required.	http://www.gislab.teale.ca.gov/
San Diego Association of Governments (SANDAG)	Provides selected digital thematic geographic data layers in ArcInfo export format.	http://www.sandag.cog.ca.us/
Map and Geographic Information Center (MAGIC) - University of Connecticut	Downloadable GIS data for a wide variety of themes in statewide, county, quadrangle, and city/town datasets.	http://magic.lib.uconn.edu/
Martin County, Florida	Several GIS layers available in ArcInfo export format.	http://www.martin.fl.us/GOVT/depts/isd/gis/
Georgia GIS Data Clearinghouse	The Georgia GIS Data Clearinghouse provides access to GIS resources of Georgia for use by government, academia, and the private sector. GIS data, maps, information, and much more to help build effective GIS applications are available.	http://gis.state.ga.us/
Maine Office of GIS Data Library	Includes listings of statewide data coverage availability and order procedures.	http://apollo.ogis.state.me.us/
Massachusetts Geographic Information System (MassGIS)	MassGIS manages the state's environmental database and produces maps and related materials.	http://www.state.ma.us/mgis/massgis.htm
Oklahoma Spatial and Environmental Information Clearinghouse (SEIC)	Provides access to a file transfer protocol (FTP) site with TIGER data, DLGs, digital elevation models (DEMs), land unit/land cover (LU/LC) data, wetlands inventory data, and census data.	http://www.seic.okstate.edu/

Table 6

Agency	Program Description	Internet Address
Oregon's Service Center for GIS	Access to statewide datasets for various themes at various scales. Datasets also available by county.	http://www.sscgis.state.or.us/
South Carolina Department of Natural Resources	Hydrological data, stream stage reports, and oceanographic data.	http://water.dnr.state.sc.us/gisdata/index.html
Wyoming Spatial Data and Visualization Cluster	Clearinghouse with downloadable data.	http://www.sdvc.uwyo.edu/

Table 6 ***(continued)***

CHAPTER 7

PARTNERSHIPS AND ALLIANCES

Partnerships with federal, state, local, private sector, and university entities has become more common in recent years to expand the potential for future cost sharing, increase the number of data development initiatives and add to expertise and services among local government agencies. These partnerships, facilitated through public outreach, enable the realization of projects and initiatives which otherwise could suffer for lack of adequate support. These entities can provide human resources and expertise as well as financial partnerships on projects. Internship programs, data exchange agreements, and joint development initiatives all may be possible with these external entities. Purchasing data from agencies in a partnership or consortium arrangement is another potential way to jumpstart GIS.

Federal programs such as FGDC's National Spatial Data Infrastructure (NSDI) provide funding programs with the objective of facilitating partnerships and alliances among various public and private entities to assist in building the NSDI. The NSDI consists of policies, standards, agreements, and partnerships among a variety of sectors and disciplines that promote more cost-effective production, ready availability, and greater use of high-quality geospatial data. FGDC's partnership funding programs are as follows:

- **The Cooperative Agreements Program** funds projects focused on promoting metadata collection and creating clearinghouses of geographic data linked to the Internet, developing NSDI standards, and organizing and strengthening programs for geographic data sharing.
- **The Benefits Program** funds projects that assess the qualitative or quantitative benefits of using a shared data resource to solve particular problems over a specific geographic area.
- **The Framework Demonstration Projects Program** funds projects that demonstrate technical, operational, and business capabilities to collaboratively create and maintain certain categories of commonly needed 'Framework' data. Activities initiated under each of the three mentioned programs will promote development of, maintenance of, and access to datasets that are needed for national, regional, state, and local analyses.

Proposals must involve partnering between two or more organizations.

GIS-based services should be developed in partnerships among local, regional, state, and federal agencies. Partnerships and alliances can directly benefit the organizations involved because they can share data, technology, expertise, facilities, and costs associated with GIS data development and implementation programs. These types of partnerships are particularly productive since each agency is part of the process, sharing in responsibility, commitment, benefits, and control.

An effective method of establishing local partnerships and alliances has been the Interlocal Agreement. The following section briefly describes this type of agreement.

Interlocal Agreements

The objective of a sample type of GIS interlocal agreement is to establish policies and procedures for the exchange and sharing of spatial and attribute geographic data, services, facilities, and costs. These types of agreements are commonly undertaken with the understanding that technology transfer, data sharing, and cooperative data development are to be promoted to the greatest extent possible. Important elements to cover include:

- parties to the agreement
- purpose
- description of data to be shared
- responsibilities
- procedures for requests and written communication
- terms of the agreement

CHAPTER 8

EXPANDING A GIS

After the initial short-term GIS development and implementation has been completed, it is important to evaluate the current situation and develop a longer-term plan to meet future organizational and public GIS needs. Once again, alternatives should be evaluated to include benefit and cost considerations. Strategic planning and flexibility are essential to long-term GIS success, not the traditional fixed condition of leaving the current status of the GIS program as is and planning in the short-term. Rather, the GIS plan should be reevaluated annually, if possible, to account for user requirements and functionality as well as provide for GIS expansion.

Often building upon a quick start GIS platform can be difficult. Pre-planning was sacrificed for short-term wins and to gain support from representative constituents. After the initial implementation, however, expectations have been increased and more is expected from the GIS program. Therefore, adequate program expansion methods must be put in place.

Several areas of the GIS program should be addressed as part of the expansion methodology. These areas should include questions regarding:

- Is the program efficient?
- Is the data timely?
- Is access immediate?
- Is the system sustainable?

Efficiency

Because many small local government agencies have limited time and resources but still have high demand for services, efficiency in development and implementation of GIS processes is critical to success. Many of the required services involved in generating products for internal and external customers are repetitive in nature. For instance, zoning maps, tax assessment maps, and future land use maps are frequently updated products. A clear objective of future GIS expansion should be to invest additional resources creating automated procedures that make these tasks as simple and inexpensive as possible. In so doing, the local agency will open additional resources for specialized, resource demanding, and time intensive projects.

Timeliness

The uses of GIS data range from long-term projects and strategic planning initiatives that may cover several years to program planning and management

that are much shorter in term. Requirements for GIS spatial and attribute data should be documented during the GIS expansion phase to ensure the GIS program is convenient and responsive to user needs. If the information can be counted on for production, the likelihood of data utilization will increase.

Access

In an ideal situation, access to GIS data would be immediate; however, typically several processes including data acquisition, assimilation, development, production, and quality control are required. If critical spatial and attribute information can be made available during the decision-making processes as they occur, it is more likely that additional funding opportunities will become evident for future GIS expansion. The increase of web-based GIS tools makes it easy to use, visualize, map, and report geographic information as it becomes available. Therefore, improving GIS data access should be a strong objective in long-term GIS planning and expansion.

Sustainability

Often in local government, GIS programs are shortchanged by the assumption that funding and resource requirements are short-term issues. This limits the ability to plan for future design and development for additional capacity of the system for long term goals. Additionally, programs that are funded only through grants lead to dramatic fluctuations in resources, resulting in frequent displacement of staff.

Local governments should focus their plans for future GIS expansion on local funding bases under the incentive that GIS plans will accommodate delivering basic services at reduced costs to the greatest extent possible. Consequently, short-term grant funding should be utilized to develop procedures and processes that automate long-term delivery of service. A sustainable GIS program is one that is enhanced by the capability to expand and contract resources as required by service demand.

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