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Jane M. Swift, Governor

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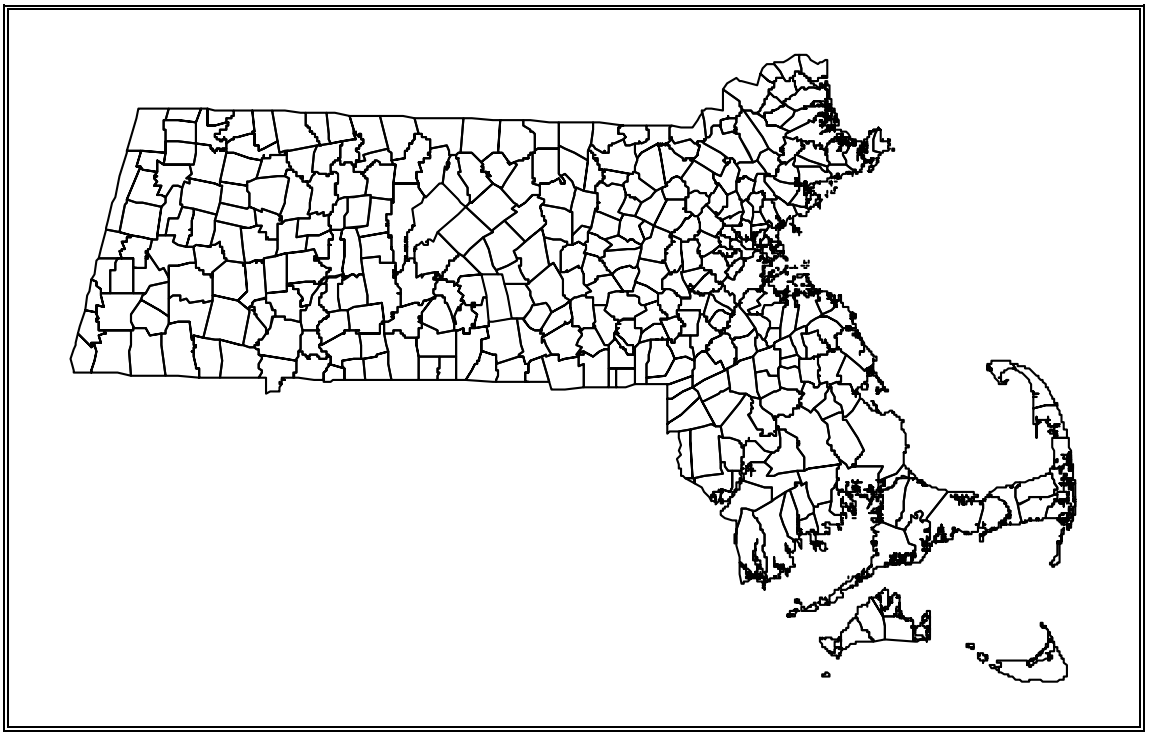
GETTING STARTED WITH GIS

A GUIDE FOR MUNICIPALITIES



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In 1999, the Massachusetts Legislature charged the Massachusetts Office of Geographic and Environmental Information (MassGIS) with "fostering cooperation among local, state, regional and federal government agencies… in order to improve the quality, access, cost-effectiveness and utility of geographical and environmental information as a strategic resource for the state…". In the context of that charge, MassGIS is pleased to provide this third edition of *Getting Started with GIS: A Guide for Municipalities*.

The Massachusetts Department of Housing and Community Development (DHCD) originally published this guide. In 1999, MassGIS collaborated with DHCD on a revised version of the guide. As with previous versions, this version of *Getting Started* is provided free of charge to municipal officials and others who are interested in city and town-level geographic information system (GIS).

This version of the guide is heavily revised and updated throughout. While the focus of *Getting Started* has always been on establishing a community-wide GIS, a project with that scope may not be suitable for your town. Recognizing this circumstance, this document now includes a chapter devoted to establishing a single-department GIS with little or no budget. Note that even if a single department GIS is your objective, there will still be a lot of useful information in the other chapters. Other additions and changes in this edition include revised GIS database cost information, many up-to-date examples of how a GIS can be used, new information on quantifiable GIS benefits experienced in Massachusetts' cities and towns, and a new appendix of internet resources. There is even a discussion of why GIS projects fail!

Regardless of the level of interest in GIS in your town, *Getting Started* is a useful reference. It is a nuts-and-bolts approach to planning for and implementing a GIS. *Getting Started* will take you through a description of GIS, why to use GIS, how to get organized, and how to conduct a needs assessment as the basis for planning your GIS project. The document also includes descriptions of GIS related computer hardware and software, data, staffing, costs, and funding.

We would like to thank the individuals who reviewed this document, either partially or in its entirety. Many thanks also to colleagues who willingly shared their professional experience in response to questions about specific issues covered in this guide. The contributions of reviewers and professional colleagues have improved the quality of this guide; any errors or omissions should only be attributed to those authoring the guide and should be sent to the contact below. We hope you find this guide useful. If you have further questions on municipal GIS, please contact your regional planning agency GIS group or MassGIS at:

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In addition to this guide, the MassGIS web site includes a section on "Municipal GIS Resources". Access these resources through your internet web browser at www.mass.gov/mgis and then click on the link in the middle of the screen labeled "Municipal GIS Resources".

I. INTRODUCTION

Cities and towns in Massachusetts have broad responsibilities for providing a wide range of services to their residents. As part of providing these services, they do some or all of the following:

- Assess property for real estate and personal and business property taxes,
- Review proposed land sub-division or re-development,
- Evaluate proposed land use changes for conformance with zoning ordinances,
- Create and maintain a water delivery, sewage disposal, and storm drain infrastructure,
- Maintain roads (e.g., re-paving, snow removal, catch basin cleaning, etc.)
- Grant or deny permits and licenses for everything from dogs to liquor sales to septic systems,
- Inspect properties for compliance with land development ordinances as well as those for public health and safety,
- Supervise elections,
- Provide police and fire services,
- Provide recreational opportunities and services, and
- Maintain land and buildings.

One characteristic all these services have in common is they are concerned at least in part with geographic location. In other words, staff providing these services need to know where things are, whether property boundaries, crime incidents, proposed developments, pipes in the ground, septic systems, wetlands, precinct boundaries, or snow plow routes. In short, about 70 – 80 percent of all information required for local government operations is or can be depicted on a map. Cities and towns keep this kind of information in different forms: on maps (of varying quality and at different scales), in filing cabinets, on computers using different kinds of software, or in the minds of employees. Whatever the format, this information is found in physically separate locations, whether in different rooms in one building or in multiple buildings.

While these record formats and storage methods have worked well in the past, your reason for reading this guide is likely because you find existing map information resources inadequate for the tasks you face in the 21st century. Maps are the wrong scale or format, contain insufficient information, or the information you need is on multiple maps of different sizes and scales; the information you require is not in map form, but your interest is in seeing the locations associated with that information; the maps or other records are in a building across town, are out of date, are too hard to understand; or they are physically too inconvenient or tattered to use out of the office. You have heard or seen that a geographic information system can help solve these kinds of problems.

Defined broadly, GIS — Geographic Information Systems — is a computer-based system "for capture, storage, retrieval, analysis, and display of spatial (locationally defined) data."[1] The essential elements in this definition for local governments are "spatial" and "analysis": where are features

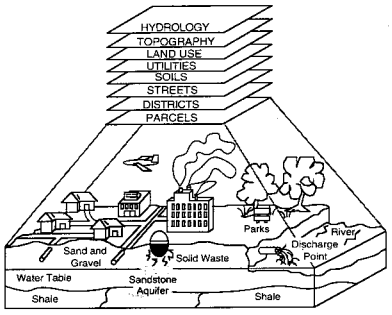
[1] National Center for Geographic Information and Analysis (1988).

such as boundaries, pipes, streets, buildings, crime incidents, and permitted activities; where are these features relative to others, why do we want to know about them, and how can our community use this information to make better decisions? And of course implicit in the above definition are staff that know how to build and use such a system.

GIS software links (1) map features and (2) databases, (called attributes or tabular data). In a GIS, individual map features are stored as separate "layers" of map features (see figure below). The layers selected by the GIS user are drawn on the screen and features in each layer are represented using different point and line symbols.

The Data Layers Concept in GIS

This graphic illustrates the layering concept behind GIS mapping.



Graphic provided courtesy of Environmental Systems Research Institute, Inc and is used herein with permission

Likewise, the database of attributes contains information associated with individual features on the map. Some common examples of attributes associated with map features in local government GIS data layers are:

- Property address, owner, assessed value, and anything else from the assessor's property list,
- Crime incident type (burglary, assault), location, date, etc.,
- Permit or license type, date, etc.,
- Pipe diameter, material, and year of installation,
- Zoning district code,
- Topographic elevation,
- Street name and house number ranges on each block.

These attributes can also be displayed on the screen as text labels for the map features. Standard computer database software capabilities can also be used to find attributes that meet certain criteria. For example:

- What properties larger than one acre sold in the past year and are assessed at over $X?
- Where are car break-ins that occurred between 4:00 and 7:00 pm in the past month occurring?
- What septic system permits have been issued in the past two years?

Once the computer finds records meeting the above characteristics, the corresponding map features can be highlighted on a computer screen or map.

A key difference between viewing map information on paper or mylar versus using a GIS is that each person using the GIS can create their own view of information. Each individual user can choose what to see, why to see it, how to see it, and how to use it.

What information can be used in a GIS database? The content of any paper or mylar map can probably be converted ("digitized") for use in the GIS. Also, just about any database with a reference to a geographic location (house address, zip code, assessor's

property identifier) can become attributes of suitable map features in a GIS. A GIS can make it easier for communities to use each database to its fullest advantage — information developed by one department can be used by all departments — and it can be used repeatedly.

The real key for cities and towns is that a carefully planned and implemented GIS effectively integrates information with location. GIS can provide a better, faster, easier way for municipal employees to see the map information they need, to find answers to questions, and to carry out analyses based on spatial relationships. GIS also allows you to ask questions about spatial relationships you previously could not. By developing a GIS you can centrally store all this map and database information, thus creating an integrated information resource. Think of a GIS as an "information infrastructure" to support decision-making and management.

In developing a GIS, you are not necessarily creating new information, but rather you are using the capabilities of modern computers to store your existing information in a single repository. When this repository is carefully constructed, your existing records can more effectively support town operations such as those listed at the beginning of this Section.

While a GIS created for use by multiple departments has enormous promise, it is important to keep in mind that developing one is a significant multi-year challenge. GIS software companies, consultants and practitioners tend to gloss over three facts: 1) converting existing records for use in a GIS often requires extensive work before the promise of a GIS can be fully realized, 2) GIS databases can be relatively expensive to construct, and 3) learning to use GIS software can be difficult. Exactly how much work, how expensive, and how difficult will depend on the quality of your existing records and the expectations you have for what will be possible with your GIS.

Expectations for a GIS will not be satisfied unless the quality of the information in the GIS database is sufficient to support the capabilities driving those expectations. House addresses are an example. Many, many town records, ranging from dog licenses to building permits, contain an address. You may expect that the GIS software to use those addresses to create points on a map representing their locations. However, this capability presumes that your GIS database includes a comprehensive record of your community's addresses. It also presumes that the addresses in town records are complete (street names complete and spelled correctly) and in a format suitable for the GIS software. So in reality, before GIS software can create points on a map or screen representing individual addresses, a lot of data preparation may be required.

Similarly, another expectation for your GIS will probably be linking properties on the assessor's map and their associated record in the assessor's property list. For this to happen, the GIS data layer containing the property boundaries must have an identifier for each property that exactly matches the corresponding identifier in the assessor's information. If it does not, then the link will fail. This failure means that such basic and important GIS capabilities as determining the addresses for abutting properties will result in incomplete information because the addresses needed come from the assessor's database.

GIS use is expanding at all levels of government. Some state agencies have been using GIS for almost 15 years and the number of agencies using GIS has grown dramatically in the past five years. The

regional planning agencies (RPAs) all use GIS. The community "build-out analyses"[2] recently completed by MassGIS and the RPAs, were only possible because of GIS capabilities and the state's investment in building statewide GIS data. The Executive Office of Environmental Affairs, through MassGIS, has developed a GIS based tool, the "Alternative Futures Tool", that enables communities to see how their build-out would change if they changed their zoning or if they added additional open space.

Ten years ago, only a few municipal governments in Massachusetts were using GIS. Now at least 80 communities have some level of GIS usage, with about 30 of those communities having one or more staff dedicated full-time to their GISs. In some communities, GIS use is limited to one department and a few modest GIS capabilities. In others, the GIS is truly a mult-department resource that enables those communities to exploit a dizzying array of GIS capabilities. The point here is that GIS use is spreading rapidly and, as communities face greater and greater challenges from growth and other concerns, they are turning to tools such as GIS. For most communities, as unlikely as this may seem given your community's current circumstances, it's not a matter of "if" you develop a GIS, but "when". The remainder of this guide provides the information you need for getting started with the process of building that GIS.

[2] Each community's build-out analyses used information about existing zoning, land use, and land development constraints (e.g., wetlands, steep slopes) to vizualize present development and maximum by-right development under current zoning.

II. WHY DEVELOP A GIS?

Local governments have hard choices to make about where to spend their scarce resources — especially limited funds and limited people time (both staff and volunteers). At the same time, the potential capabilities of a GIS may increasingly be needed as the challenge of delivering services and planning for a community's future becomes more complex. Fortunately, GIS has become easier to develop. The convergence between this need and this greater ease of development is evident in how many communities are using or developing a GIS in Massachusetts (see Figure 1).

Like all computer based technologies, GIS has become less expensive, faster, and easier to use. The cost of developing GIS databases has also dropped. In addition, there is a wealth of useful GIS data from the state available through MassGIS including a color photo base map, a road network, zoning, wetlands, topographic contours, floodplains, etc.

So what does GIS have to offer? Why should your community start a GIS project?

A. Examples of GIS Usage

Think about where you are today and why your community is interested in GIS in the first place. You've probably already found situations where:

- In recent year's your town's staff hasn't increased, but their responsibilities have. You know that some of their routine tasks (e.g., determining abutters for notifications, finding information for building permits, reviewing proposed sub-divisions) could be accomplished with less time using a GIS.

- Recently several controversial development proposals were approved based in part on "discretionary judgment" by the reviewer(s). Subsequent review of the decision reveals that if better map records had been available to the reviewer, such judgments would not have been necessary and the proposals would have been rejected or modified.

- An business is interested in moving to your community and wants to know where it can find a tract of land, maybe involving adjacent lots, each with different owners, which meets their criteria for zoning, aggregate acreage, access to roads, and utility services. Similarly, the community may be interested in evaluating potential traffic or environmental impacts of the business' proposed location.

- Fire officials are trying to track fires set by an arsonist and want to see if there is correlation with delinquent taxes or code violations. By using the GIS, locations of fires (from Fire Department), properties with delinquent taxes (from the treasurer), and code violations (from inspectors) can, with perhaps a few day's work, be mapped; this task would take weeks without a GIS.

- Inadequate maps are making it increasingly difficult to communicate about issues (e.g., traffic problems, open space planning, community preservation, zoning appeals, land use) at community meetings. Staff in communities with GISs report that one of the big benefits is that it is easier to communicate about issues at meetings using maps produced with their GIS.

- GIS may make possible a more effective response to emergency situations. This

might be because dispatchers can access more detailed maps from the GIS, thus enabling them to better direct officers performing the search for a lost child. Likewise, a DPW employee can respond to an emergency by reviewing records on a lap top computer at the emergency site instead of first visiting the office to review those records or, more likely, working without them.

- A community needs to see if it can balance student populations at the elementary schools by adjusting each school's boundaries. By doing this, they hope to avoid the costly construction associated with expanding existing schools or building new schools. If the community does need to build a new school, they will need to determine location and size given: 1) where is land remaining for residential development; and 2) expectations of the community's ultimate population when it is fully developed ("built-out"). A similar example could be based on siting a new fire station.

- You become aware that two departments have just made significant investments in new software to support their operations. Both software packages include some sort of GIS capability, but they use different GIS data formats on computers with different operating systems. In either case, the GIS capabilities can only be accessed as part of department specific operations, and not generically for other purposes.

- The Rivers Protection Act restricts development within 200 feet of a river or stream. The city council or board of selectmen wants to know how many properties with commercial or industrial zoning are affected. Answering the question will take many hours your staff doesn't have working with the assessor's maps – which may not have all the perennial streams indicated. Also, the zoning map is out-of-date, and so individual zoning changes will have to be researched to determine their relevance to this issue.

- At a recent meeting, your City Council or Board of Selectmen is embarrassed because they cannot answer a question about where all the criminal incidents of a certain type had occurred in the last three years, following a disturbing repeat of that same kind of incident with tragic consequences.

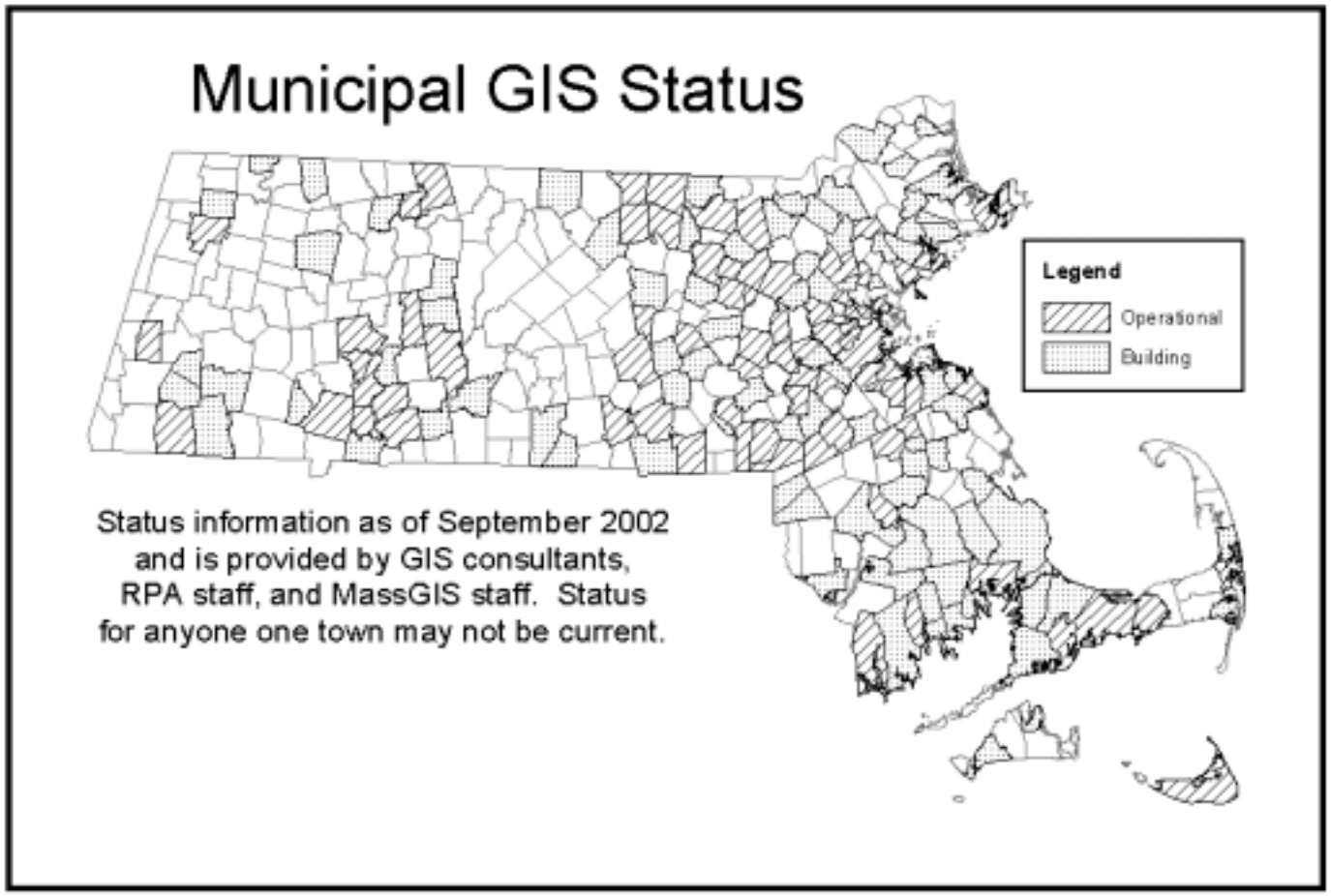
- The Town decides to develop a master plan. However, it is difficult to systematically identify long-term needs for municipal services (e.g., schools, public safety) and infrastructure (e.g., water supply) because existing information is on maps at different scales, in different computer databases and/or paper files, or unavailable.

- Institutions that underwrite bond lending are requiring that you meet the new government accounting standards for financial reporting concerning the age and condition of your community's built infrastructure (buildings, streets, sewer systems, etc.). Without this information, borrowing money will be more expensive. However, preparing the required information is either impossible or hideously time consuming. Developing a GIS with the appropriate data layers and attributes would provide a ready source for this information.

These possible uses of GIS can also provide a broader political constituency for funding the community's investment in GIS. For instance, most local governments have not

thought about applying GIS to issues regarding school construction or managing the capitol costs of their infrastructure. Where each construction decision can have a multi-million dollar price tag, the value of a GIS's contribution may make its cost less of an issue.

Figure 1: Status of Municipal GIS in Massachusetts



B. Quantitative Benefits of GIS

GIS may also positively impact your community's finances through significant dollar savings in staff time or even by increasing revenue. Consider how many requests for information are handled by your assessing office or by your public works office. It is common for municipalities to exhaust their staff time simply answering the public's request for information. Other examples of quantifiable benefits experienced by Massachusetts' municipalities include:

- The City of Cambridge reports that the time required for producing mailing labels for an abutter notification, a capability required by many departments (e.g., Assessing, Public Works, Planning, City Clerk, Licensing, Historical Commission, Traffic), has gone from between two hours and two days to about ten or fifteen minutes. This is a typical time saving for other communities that have developed this GIS capability.

- The City of Fitchburg reports that by comparing the area of a parcel calculated by the GIS with the area listed in the Assessors database, finding errors and making the necessary corrections in lot area, the city gained $225,000 in assessed value for the first ten properties corrected.

- A number of towns/cities report that since they put assessing information with maps on their web site, foot traffic in their assessor's offices has dropped by 25 – 50 percent. This has freed staff for other tasks.

- The Town of Concord reports the following significant benefits from having a GIS. The town Planning staff used the GIS to determine the impacts of an existing zoning bylaw and proposed an expanded overlay district for locating new wireless communication towers. The staff planner used the GIS to create maps showing the effects of 300-foot, 500-foot, 750-foot, and 1000-foot setbacks from existing single-family structures in areas of town desired by wireless communications services. The single-family structures were identified using information from the assessor's database. Based on the analysis, five overlay districts were identified. The work required about a day of staff time. A similar analysis two years earlier, before the GIS was available, required two weeks of staff time.

- Concord also recently amended their Groundwater Conservancy District (GCD) to match the Zone II wellhead protection areas used by the Department of Environmental Protection. The GIS enabled town staff to overlay the Zone II boundary on the parcel boundaries and easily identify properties in the old district, but not the new, properties in the new district, but not in the old, and properties not in the District. The owners of properties identified in each of these categories could then be notified of their status; the mailing labels for the letter were created using a link to assessing information. Without the GIS, a staff person would have had to individually look up each parcel on the new GCD map, identify the property on the proper assessor's map, find the parcel number, look up the owner's name and address in a separate book, and input that information into a database so that mailing labels could be generated. This project was estimated to have saved staff time valued at about $5,000.

Your community may simply see GIS as part of creating an "information infrastructure"

needed for providing effective government services in the 21st century. Just as you may have shifted your payroll, accounting, or other record keeping to computers, it is increasingly the norm to do the same with your map and related records. In this case, you or your elected and appointed officials believe that the time has come to implement GIS even if you haven't analyzed the costs and benefits.

What is clear from the above benefit descriptions, is that the benefits to your community from a GIS can be real and tangible, regardless of the motivation for its development.

III. DEVELOPING A SINGLE DEPARTMENT GIS

This guide's primary focus is establishing a multi-department GIS. This chapter provides some information and recommendations if your objective is a GIS for your department only. You are probably taking this approach because there is little or no money for a project with larger scope, there is no interest in other departments in developing a GIS capability, or because other departments have other priorities.

By developing a GIS capability in your department, you can:

- Support some of the needs of your department or program,
- Learn basic concepts and skills,
- Demonstrate the capabilities of a GIS to others, including those who might be interested in a multi-department GIS project, and
- Better make the case for converting your assessor's maps and other map information to a format useable by GIS software.

Never underestimate the amount of interest in GIS that can be provoked by putting maps made by a GIS on your walls – seeing is believing!

There are two approaches to such a project. One is to create some minimum GIS capability with little or no money. In this "low budget" approach, an existing computer and color printer are used, free GIS software is installed, and GIS data are obtained from publicly available sources. Training consists of what you can figure out on your own, or perhaps a course you pay for somewhere. A second approach, the "modest budget" approach, involves spending some money on GIS software and on developing data; it also presumes that you have an appropriate computer and color printer. In either of these scenarios, the necessary computer and color printer can be purchased for under $1,000 and under $150, respectively. Both these scenarios are discussed in more detail below.

A. Low Budget Scenario

In this scenario, starting your department's GIS project requires a computer, GIS software, some data, and a color printer. Each of these components is discussed here in turn.

1. Computer

The specifications given here are much less than available on today's (or even last year's) typical new computers. This was done intentionally to allow for older computers that may be available and that may still be adequate to run some GIS software. Note that before purchasing any software, you should check the computer requirements of that software versus the specifications of the computer where the software will be installed.

The computer should have at least a Pentium II class of processor, have at least 64Mb of random access memory (RAM), run Windows 95/98/2000 or NT 4.0, and should have a CD reader with 16x speed, or faster. In general, more RAM will make software run faster, so if you can afford to buy more RAM, do so. While a 15-inch monitor is adequate, in general because GIS software emphasizes graphic display, a 17-inch monitor makes using the software easier. The video card should support a resolution of at least 1024 by 764. Similarly, if you can afford a better video card (the card

controls displaying graphics on the screen), you will find the quality and speed of graphics display improves. If you don't have access to a computer with these specifications, you can purchase one that exceeds them for under $1,000. Computers currently on the market typically include a CD-ROM drive; you may want to upgrade to a CD drive that can both read and write CDs as this will provide you with a backup capability as well as the ability to pass large files to and from your computer.

Leasing a computer may be an alternative to buying one, at least for the short term. You can probably also acquire a used computer with suitable capabilities for much less money than a new one. Most computers purchased in the past 3 years will exceed the above specifications and be able to run the available free GIS software as well as the lower and mid-level GIS software packages. While a 17" monitor is not required, the extra cost is modest, and the larger screen makes using GIS software easier.

2. Software

Free GIS software is also available. The easier to use free GIS software has limited capabilities, but can, nonetheless, help you learn basic GIS skills and demonstrate GIS capabilities to others. There is also a free "high end" GIS software package. Three free GIS software packages are described below in order of capability and complexity. Note that at MassGIS we are not aware of any free GIS software that runs on Apple Macintosh computers. None of the major commercial GIS software runs on Macintosh computers either. GRASS (see below) does run on machines using the LINUX operating system. It is possible to purchase software for the Macintosh that enables it to run Windows software; how well this will work with GIS software can only be determined through testing.

Arcexplorer – Arcexplorer can be used to view (pan, zoom, etc) GIS data, click on a map feature to see basic associated database information, find a location based on a street address (presuming suitable address information in your GIS database), and make basic maps. It can also be used to view GIS data available on some web sites with GIS data. This product is available for free on the web site of the Environmental Systems Research Institute (ESRI; the download site is http://www.esri.com/software/arcexplorer). Note that ESRI also sells the widely used ArcInfo and ArcView software. These two products were recently combined into the ArcGIS software. Note that Arcview Version 3.x is still a widely used product and will remain so for the foreseeable future.

MassGIS Runtime Data Viewer - The Runtime Data Viewer is a stand-alone, "light," or slightly scaled-down version of ArcView GIS 3.1.1 that offers much of the map-making and other capabilities of the full ArcView. The Data Viewer lets you display MassGIS data, change symbolization of the data, add symbols and text to maps, create maps with map elements such as a scale bar, north arrow, legend and title, and print your layout. The Runtime Viewer also gives you the ability of saving any finished map layout as a bitmap image, Windows Metafile, or Postscript file, which then may be brought into a variety of other software. In addition, standard GIS capabilities such as finding map features based on a database query are also available.

The Runtime Data Viewer will not allow you to save your current screen view, edit tables, or create new GIS data, so it may not be comprehensive enough for everyone. However, if you are new to GIS or simply want an inexpensive way to get started making your own maps, the Data Viewer is a good place to start. The Data Viewer comes on a CD-ROM with data for a

specific geographic area, such as a town or a watershed. You can learn more about the Data Viewer and order it from the MassGIS web site at Mass.Gov/mgis/viewer.htm (no http://www required). Installation information, some training documents, and other assistance are also available on the MassGIS site.

MassGIS is also in the process of developing (October 2002) a product similar to the data viewer that would enable you to view the entire MassGIS database via the internet. Running this product will involve downloading a free software product from Sun Microsystems. Once this software is installed, you will, through services provided by MassGIS, be able to select the features you want to see from the MassGIS database. In addition, you will be able to select an area of interest from a list of place names or areas (e.g., (city/town name, watershed) and that area will be displayed on your screen. When this new "data viewer" product is available, it will be announced on the MassGIS web site.

GRASS – This software is in the public domain ("open source software") and was originally developed by the U.S. Army Corps of Engineers in the 1980s. The Corps stopped supporting GRASS in the mid 90s, and it has since been supported by an open source software community group coordinated by a group at Baylor University in Texas. GRASS is a comprehensive GIS software package with a diverse array of GIS capabilities. Some people may find GRASS too complex to install and use, although it is not more so in this respect than other "higher end" GIS software; that is the trade-off for the capabilities that it provides. Information about GRASS, and the software, can be found at http://www.baylor.edu/grass/index2.html

3. GIS Data

Your regional planning agency may have GIS data for your town (see Appendix B for RPA contact information). Free GIS data created by MassGIS and other stare or regional organizations are also available through MassGIS. These data can either be downloaded or ordered on CD-ROM from the MassGIS web site at www.Mass.Gov/mgis. Data distributed by MassGIS that are potentially useful to a town include:

- Color digital orthoimages (air photos with distortions removed) with ½ meter pixels
- Road lines
- Wetlands
- Land use
- Zoning
- Town boundaries
- Topographic contours (10' interval)
- Areas with endangered species habitat
- Certified and potential vernal pools
- Public water supply protection areas
- Aquifer locations
- Watershed boundaries

4. Printers

If you have a color printer already, it can probably print your GIS maps. If you don't have a color printer, one capable of printing 8 ½ x 11 inch maps can be purchased for under $150. If you can afford a little more money, a printer capable of printing 11" X 17" maps will be well worth the extra cost because of the larger paper size. Getting larger size maps printed is more difficult, both because you have to find the equipment necessary and because larger maps usually have very large print files. Your regional planning agency (RPA) may be willing to print maps on larger paper sizes for you, particularly if you only have a few maps you

want to print. The RPA may also be willing to provide printing services for a fee. Also, some commercial printing/copying stores have large format printers. Larger format maps often have very large print files. So the problem with them will be getting the print file to the printer's location. If you have a Zip drive (a large capacity floppy disk format) or the ability to write files to a CD, you could transfer the files that way. Be aware that most maps, particularly when you are new to map making using GIS software, will usually require at least one draft before you have a satisfactory result.

B. Modest Budget Scenario

This scenario differs from the one above, in that it presumes you can afford to buy some software and convert some essential map data into GIS format. The computer required is the same, although more RAM, a better video card, and a larger monitor will all make using the GIS software easier. The same free data are still useful, particularly if augmented with some of your town's maps in GIS format. Note also that in spring of 2002, MassGIS initiated a grant program to subsidize creating digital parcel files. There will be additional rounds of funding under this program in future years. Finally, if you have money for a larger printer (those capable of printing a map 3' X 4' cost about $8- $10,000), you will quickly find your map-making capabilities in demand!

1. Software

GIS software for use on a single computer can be purchased for some hundreds of dollars and up. These days, GIS software for personal computers is distributed with small-scale data (e.g., interstate highways, state boundaries, city/town locations, large lakes/rivers, census data, etc.). While these data are generally not suitable for most city and town needs, they are just fine as a basis for learning and following the software tutorials. Information about some of the many GIS software vendors is in Appendix C. Note that none of the major commercial GIS software runs on Macintosh computers.

2. Data

The most important maps to convert for use in your GIS database are your assessor's maps, as they show property boundaries for your community. Properties are often the "unit" by which other information is recorded, both in the assessor's database, but also in other city or town records. Therefore, if these maps are correctly converted to GIS format, they can also be linked to information copied out of your assessor's property valuation database. This link provides a wealth of useful information for a variety of purposes using the capabilities of your GIS software. These include mapping properties color coded as to their assessed value, data of last inspection, whether they filed an abatement, etc., etc.).

Similarly, using information from other records, such as those for the Board of Health, properties can be color-coded based on that information. This enables you to see spatial distribution of conditions that you cannot otherwise see. You can also perform analyses: what properties greater than 6000 square feet, have a single-family land use, but are zoned for multi-family? This question was actually asked in a Massachusets community; the answer was obtained and presented on a map with less than half a days work on the community's GIS. It would have been virtually impossible to answer this question without the GIS. Of course their GIS had been well constructed and included the property boundaries, assessor's information, and zoning boundaries needed to determine the answer.

The MassGIS Standard for Digital Parcel and Related Files (on the MassGIS web site at www.state.ma.us/mgis/muniparc.htm provides useful background on converting parcels to digital form as well as establishing a standard for such projects). This same page of the MassGIS web site contains a template "request for proposals" that you can modify and use for obtaining contracted services for developing a digital parcel file.

C. Conclusion

The cost of GIS and the challenge of learning the vocabulary and the software are all significant. However, if you have access to a suitable computer and printer, the only thing standing between you and those maps on the wall that make people stop and look is desire, perseverance, and some time. As has been documented above, there is free software and suitable data available for the taking. The rest is up to you!

IV. STARTING YOUR MULTI-DEPARTMENT GIS PROJECT

Successful GIS projects have a "GIS champion". This is someone who believes in what can be achieved with a GIS. This belief may stem from their understanding of a GISs capabilities, or from their trust in the advice of someone who has this understanding. This person will work with a GIS project team (see below). If the individuals on a GIS project team share a vision for the possibilities of a GIS and work well together, then the role of the GIS champion may be simply to coordinate and administer. Conversely, the GIS champion may need to be someone with a vision who can not only plan and manage such a project, but also provide the funding, or persuade others to provide the funds, and overcome political and organizational hurdles. Which kind of GIS champion your community needs will depend on factors specific to your community.

Besides having a champion, participation and organization are the keys to success with GIS. Those whose activities will benefit from or be affected by GIS need to participate. And by implication, a formal structure is needed to manage the GIS this participation and guide the GIS project. The best structure is usually to have a GIS project team.

What needs to be done to create the project team? Who should be on the project team?

A. Identify Potential GIS Users

Make a list of all departments who have a stake in work based on maps and related records and decisions. This list will be the basis for many of your decisions regarding GIS. Use the form in Appendix A, GIS USERS, to help you.

Once you have created the list of potential users, the GIS project team can use it later in the process to identify which department or staff are the most appropriate to actually have GIS. Part of deploying your GIS will involve setting priorities for which users will have access, when, and with what capabilities. This is because not all expectations for your GIS can be met simultaneously. Consider the extent to which each department desires to use GIS, which staff have time to use GIS, and how well equipped each department is with computers, among other factors.

B. Identify GIS Project Team Participants

Initially, the GIS champion should manage the GIS project team. At some point, it may be appropriate to turn the project's day-to-day coordination over to someone else who would report on the project to the GIS champion. Every department identified as a potential user of GIS should be involved in the project team with a full, regular member as its representative. This person should be interested in GIS and be familiar with all of their department's operations.

Use the form in Appendix A, GIS PROJECT TEAM PARTICIPANTS, to identify your community's participants. Keep in mind that the offices listed in Appendix A are for illustrative purposes only. Your community will need to revise this list to include all offices it believes ought to be involved.

While it is important to have management staff fully informed and involved in your GIS project, it is also important to include support staff and supervisors. Good ideas on how GIS can benefit your community

come as much from support staff — the ones on the front line every day — as from supervisors and managers. The support staff's full participation is essential.

Citizen volunteers can also make a significant contribution to this effort. They can bring knowledge of GIS itself, technology in general, planning, environmental analysis, and other disciplines which will be important to the community's GIS project.

C. Build Partnerships

Your community can often gain directly in dollar savings and other ways by having public or private organizations participate and contribute financially or otherwise. These participants can include adjacent communities, regional agencies, public or private utilities, colleges or universities, or conservation-oriented organizations (e.g., land trusts and watershed associations), among others.

Before appointing the GIS project team, do some brainstorming. Think expansively and creatively about who may have some interest in this effort, even if they may never have approached the community previously regarding this subject. The last several lines on the GIS PROJECT TEAM PARTICIPANTS form include examples of groups which might be interested in working with your community in its GIS efforts.

D. Create a GIS Project Team

The community's board of selectman or top manager needs to create a GIS project team and publicize the names of those appointed to the project team. It is important for the community's leadership to attach a high level of visibility and provide public information about this effort from the beginning. This will help substantially in developing and maintaining the base of political support needed to obtain funding for the GIS project.

A GIS project team is important because it:

- Provides a forum for coordinating the interests and priorities of the participating departments,
- Educates its members about work in other departments, thus facilitating identifica-tion of common information needs,
- Helps to identify staff expertise, particularly as it relates to technology issues,
- Educates key staff about GIS technology and the process of developing a GIS, and
- Develops a sense of a shared enterprise.

The GIS project team will need to be chaired by someone who can provide effective leadership. They should be interested in and committed to the project and have the support of elected and/or appointed officials.

The GIS project team may wish to form subcommittees to serve as working groups. Sub-groups are usually an effective means to address issues and accomplish tasks identified by the full GIS project team. Sub-committees may be an effective way to involve additional staff. Any sub-committees should complete their tasks and report findings and recommendations to the full project team.

E. Why GIS Projects Fail or Succeed

GIS projects fail or are only partly successful for a variety of reasons. Some of the common reasons are, in no particular order:

- Lack of an administrative champion,
- Lack of funding sufficient for the project scope,
- Unrealistic project scope and expectations, particularly with regards to GIS capabilities versus GIS database content,
- Inadequate commitment of staff resources, both during the planning stages and once the GIS is operational,
- No mechanism for group decision-making and planning,
- Project participants cannot agree on a suitable mapping accuracy for the database or the database is built with data that are inadequate to support the expected uses of the GIS,
- No or inadequate provisions for database maintenance and related changes in procedures.

The reasons for success are easy to summarize; they are the opposites of the reasons for failure listed above.

Other than not having a champion or funding, all of the above reasons for failure can be avoided with systematic planning agreed to by all the participants. From the above reasons for project failures, two warrant further discussion: (1) inadequate planning of the database's content, and (2) lack of dedicated staff time.

Planning the content of your GIS database is particularly important. If the expectation is that your GIS will be able to provide certain capabilities (whether simple maps or sophisticated analyses), then there must be a connection between those expectations and the content and accuracy of your GIS database. As one GIS consultant has observed:

"*No offense meant, but MassGIS stuff [data] has limited applicability in many municipal contexts. The novelty of zooming and panning wears off and communities need their good, detailed stuff [data] in there to derive the maximum value. Some projects get going with mediocre data, and then don't get better stuff [data] in there. These projects look bad when the Selectmen (or Town Manager) try and make a decision and the GIS can't support it due to lack of good data. This is where good planning can help prevent [problems]. What's worse, having no system, or a $50,000 system that doesn't add value?*"

A GIS project will require some dedicated staff time. Throughout the initial planning stages, GIS projects need someone to facilitate and coordinate. Sometimes, if the project participants already work well together, this person's job may be no more demanding than coordinating meetings. Other times, this person will have to navigate significant political and organizational issues and/or build consensus.

The transition from group planning of the project to actually initiating the GIS development is a difficult time; there is more and more work to do and that work requires an increasingly sophisticated understanding of issues specific to a GIS.

As a multi-department project enters the implementation stages, it will need at least one person half-time. As the GIS project continues, it will need a full-time staff

person. Lack of dedicated staff as the project shifts from planning to implementation will cause the project to fail. While it may seem logical to have the person who had been coordinating the project morph into "the GIS person", this is a very challenging assignment. While some may find the challenge exciting and stimulating, others will find their job becoming increasingly frustrating and stressful as they struggle to develop new expertise "on the fly" while managing a complex technical project. Be sure the person making this transition wants to have that responsibility; if your GIS project makes them leave to take another job in their original profession, it will suffer a significant setback. Staffing issues are discussed further in Section X.

V. LEARNING ABOUT GIS

Before undertaking any tasks, the GIS project team and any other future users of the system need to learn about GIS and related technology. This training should address the following kinds of subjects:

- What can be accomplished with a GIS,
- What information is typically found in a GIS and how existing information is converted for use in and used in a GIS,
- How the community can use GIS to its best advantage,
- What is involved in the needs analysis or if the analysis has already been done, what the results are,
- What various GIS development options are and their related costs,
- How the procurement process works,
- What the community needs to do implement GIS successfully, and
- Related technologies (e.g., GPS, document scanning, the internet).

Training in GIS should include several components.

A. Training Workshop

The full GIS project team — and anyone else who's interested — should participate in a training workshop on GIS in local government.

The workshop provides the project team with a common base of information. It is an important first step in the project team's activities, serving as the "kick off" event for the effort.

This session should take a half-day. The workshop should be oriented to the kinds of practical issues that the project team must address throughout the process, from needs analysis to implementation.
The training workshop can be provided by the staff of your regional planning agency, a qualified consultant, staff from other communities, or faculty from colleges or universities. While GIS software vendors can also be very useful sources of training and high quality information, it is important to recognize that such offerings may be thinly disguised marketing or sales pitches.

B. Site Visits

Site visits are intended to provide the project team with additional background on how other municipalities are using GIS and how they went about their needs analysis, decision-making, and implementation.

The GIS project team, or a subcommittee, should undertake two or three site visits to other local governments and to your regional planning agency (RPA). Plan to ask the following kinds of questions:

- Why did the community/RPA choose its GIS software and contractors, if any?
- What has the community/RPA learned from its experience; what would it do differently now if it could?
- What outside sources of data do they recommend; what have they learned from developing their own data, if any?

After the site visit, the GIS project team should have a full discussion of these findings and try to determine how it can

incorporate the experience of the other communities into its own needs analysis.

Choose communities which are similar in size or type to your own in order to get realistic ideas for what you could be doing. You can get valuable information from dissimilar communities if you have specific questions for them.
To learn about existing municipal GIS projects, contact your regional planning agency or MassGIS. MassGIS maintains information on the status of GIS in municipalities and posts a status map on its web site (www.mass.gov/mgis).

The community should inform itself about GIS-related products which other organizations in its vicinity or at the regional and state level are using. Appendix B lists various organizations worth contacting.

The site visits are one important means of learning what GIS products other communities are using. In addition, be sure to meet with the GIS staff of your regional planning agency.

C. The Internet

Internet sites are an excellent resource for learning about all aspects of GIS. A good place to start is the MassGIS web site (www.state.ma.us/mgis) and in particular the choices on the front page of that site labeled "Municipal GIS Resources" and "Other GIS Resources". Documents available through this portion of the MassGIS web site include this one, a "template" request for proposals (RFP) document for services to convert assessor's maps to digital form, and the MassGIS Digital Parcel File Standard. Other useful sites are listed in Appendix C.

D. Videos

Videos and other "live action" depictions of GIS are available from vendors and professional associations, among others. The advantage of videos over printed materials, of course, is that they bring the subject alive. You actually see GIS in action which can dramatically affect your understanding and thinking about GIS.

Videos on GIS and on conducting a needs analysis (see Appendix C) are available from your regional planning agency or from MassGIS. See the contact information in Appendix B.

E. Professional Conferences

Conferences can be an excellent opportunity to immerse yourself in GIS related information. Local and national conferences offered by professional associations typically include many presentations by GIS practitioners. See Appendix B for a list of local, state, and national associations. In recent years, the New England GIS Conference (www.negis.org) has provided excellent opportunities to learn about GIS. This conference always devotes a significant portion of its program to municipal GIS topics.

Conferences and seminars are important opportunities for your community's personnel since presentations at these events are typically by people who can put GIS in a practical context. The community should consider these events and their related costs as useful training.

F. Other Meetings

State and regional agencies, vendors, and others offer GIS presentations on a regular basis. These sessions are good opportunities for your community's personnel to obtain

additional training in GIS and related subjects. They also have the advantage of being low cost or free.

1. Massachusetts Geographic Information Council

The Massachusetts Geographic Information Council (MGIC), for example, is a monthly or every-other-month GIS users meeting with presentations on a variety of GIS topics. Many topics are geared specifically toward municipal GIS, such as: parcel base mapping, public safety, needs assessments, writing technical specifications, working with contractors, starting up a municipal GIS, integrating GPS and GIS, and assessing and GIS. MGIC meetings are usually held every other month, are open to all, and are held at locations around the state.

If you have any questions about MGIC, there is a MGIC page on the MassGIS web site with information about upcoming meetings. Presentations from many previous MGIC sessions are also available through the MGIC portion of the MassGIS web site. If you have further questions, contact Paul Nutting at MassGIS (617-626-1238). To receive MGIC meeting announcements, visit the MassGIS web site and follow links to the MGIC page. On that page there is a link to a page where you can request receipt of MGIC announcements by e-mail.

2. Municipal GIS Managers Group

This informal group, consisting of municipal staff who are dedicated full or part-time to GIS work in their community, meets regularly over lunch in different locations. There are actually separate groups for Eastern and Western Massachusetts that are coordinated through the same web site and occasionally meet together. To learn more about this group, go to http://groups.yahoo.com/group/maGISusers.

Using this site requires you to create a Yahoo! account, but doing so is a formality and is something you can do the first time you visit this site. Also, note that as this guide was being completed, this group was discussing alternative Internet hosts for their communications.

VI. THE NEEDS ANALYSIS

Why do the needs analysis? How is it conducted? Answers to these important questions are below.

The needs assessment serves multiple purposes.

1. It results in an inventory of existing geographic information.

2. It forces the GIS project team to take a global look at geographic information resources and use across all departments.

3. It identifies how geographic information is presently used, thus laying the foundation for reaching agreement on what GIS capabilities you want to develop, with related decisions about the content of and priorities for building the various parts of your GIS database.

4. It helps you identify strengths and weaknesses in your existing map resources; this information will be important to know as you start planning how to build and what to budget for your GIS database.

5. It may help you identify a GIS capability that you can deploy relatively early, thus giving you an early successful result for your GIS project.

6. It will reveal if any individual departments have already embarked on software projects with a GIS component. For example, your public works department may have purchased a pavement management system that displays a pavement status map by color-coding a street network. Likewise, your assessor's property valuation software may enable you to display assessing information as a map. While these two systems serve the specific needs of their departments, the GIS data required could be beneficial to other departments as well. However, that benefit can only be realized if departments collaborate on building a shared GIS resource. This kind of a finding is particularly valuable as it helps make the case for developing a shared GIS database.

7. It provides the raw information you need to develop an implementation plan for your GIS project that includes a project design and scope, schedule, and budget.

A needs analysis accomplishes these results by systematically collecting detailed information about the following:

- Currently used maps;

- Currently used databases and files containing a link to a geographic location (e.g. address, parcel identifier, etc.);

- Existing processes (e.g., plan review) in all departments that use maps and other geographic information) - any processes (e.g., building permits) that involve multiple departments, boards, or committees should be described and diagrammed and the geographic information required at each stage should be identified;

- The responsibilities of existing departments as they pertain to the use and maintenance of maps and any records that could be associated with a geographic location;

- Existing computers and computer networks (if any); and

- Existing software.

Successful multi-department GIS projects rarely succeed without some sort of plan. The needs assessment is the basis for developing an implementation plan that works. The needs assessment should be conducted before buying any equipment or starting to develop the GIS database.

Your needs assessment does not need to result in a fat report. If it did, very few people would read it anyway. However, the information gathered in your needs analysis should be pulled together in one location for reference and then distilled and summarized so that you can tell people about the results and develop the implementation plan you will need to guide your project.

The rest of this chapter provides more detail about the needs assessment process, how its results should be reported, and the implementation plan it should support. The forms referred to in the rest of this section are found in Appendix D.

A. Who Does the Needs Analysis?

Some communities are able to conduct their own assessments. However, the majority of communities retain consultants to do both a needs analysis and an implementation plan. You may find that your regional planning agency staff would conduct or assist with your needs assessment. In addition, some Massachusetts universities and colleges have GIS programs and might be interested in assisting with or conducting your needs assessment. Note that a needs assessment conducted by a regional planning agency or a college or university will also require funding. Another approach might be to do some of the work (particularly the map and data inventory) using in-house staff, with other work completed by an outside organization or individual.

1. Advantages of a consultant

Typically, a private consultant will charge $5,000 to $20,000 or more, depending on the project scope and the community's size. Hiring a consultant is a good method because you do not tie up your own staff time, you probably do not have the expertise to do this task effectively, and consultants are generally familiar with municipal operations and processes already. They will know what findings are most important from the needs analysis, and how to report them. Consultants can be effective in helping you "sell" your GIS project to the finance committee. This is particularly true when barriers exist between departments; conclusions or recommendations from a consultant may be more convincing than when presented by an employee perceived to have a particular bias or with "political baggage" from prior dealings with the selectmen, finance committee, or other decision-makers.

Experienced consultants have also been through the GIS implementation process before and will be able to complete the process more efficiently. Also, on an informal basis, they can provide useful advice beyond the scope of the contracted project. On the other hand, consultants require money you may not have.

However you retain a consultant, you should spell out your interests in a "request for proposal" style document. This document should include, as appropriate, the following sections:

- Background on your community and its use of maps and other geographic information
- A description of the services you seek and what you want delivered (e.g., needs assessment report and implementation

plan); the more detail you provide, not only about your community's objectives, but also about factors such as schedule and cost, the better;

- What information you seek in the prospective consultant's proposal,

- The criteria you will use in evaluating proposals.

Even if you do not go through a competitive procurement process in retaining a consultant, you should evaluate your consultant in the following areas before committing to using their services:

- Company or individual experience with needs assessment and implementation planning,

- Experience of the project manager and the proposed team members,

- Quality and clarity of the bidder's proposed scope of work,

- The quality of the bidder's client references,

- The length of the proposed schedule,

- Price.

You can find qualified vendors through the MassGIS web site on the "Municipal GIS Resources" web page. The Commonwealth of Massachusetts has a "master services agreement" or "blanket contract" that cities and towns can also use. One option is to select several consultants from the blanket contract vendor list (see ftp://ftp.comm-pass.com/Data/00559669.PDF) and ask them to respond to your request for proposals. This is a less time consuming approach than the procurement rules associated with a "Chapter 30B" procurement under state law.

2. Advantages of In-House Assessment

Having town/city staff perform the needs assessment can be beneficial because your staff will become much more knowledgeable about the GIS needs in the municipality as a whole, instead of just one or two departments. Your own staff are also likely to better understand the specifics of your town's operations and processes up front whereas a consultant will need time to develop familiarity with your specific circumstances. It is important to realize, however, that a needs assessment requires much time and effort in order to do things right; so any attempt to do it yourself requires dedicated staff with plenty of time set aside specifically for performing the needs analysis. This will require that the people involved be temporarily relieved of at least half of their regular responsibilities while they are working on this project. Anyone working on a needs analysis must also be interested in the work and committed to completing it expeditiously.

What follows in this report will help both communities who contract for the work and those who do it themselves to understand what goes into a needs analysis and what to expect. The forms in Appendix D will help communities doing it themselves to organize and conduct the analysis in a comprehensive manner. The information collected on these forms will also be useful in preparing a project plan and budget and any scopes of work used in hiring consultants or companies to create your GIS database.

B. The Needs Assessment Inventory

1. Potential Users' Primary Functions

Identifying each department's mission and functions provides the project team with a clear understanding of each department's

roles and responsibilities. This information can be used later to identify what data layers and needs each department will have and how those needs relate to their mission priorities. It will also indicate where and how data may be shared across departments or organizations and whether there may be conflicts with data maintenance and use. One of the primary objectives of and benefits from a GIS is creating a database shared by everybody. This is beneficial because it eliminates issues of different versions of data with differing update schedules. Of course this also means that the update schedule for important map features in the database (e.g., property boundaries) needs to meet multiple needs. Issues around creating and maintaining a shared GIS database can be a source of considerable conflict. A good needs analysis helps identify these issues early, thus making it possible to resolve them as part of the planning process.

Use the PRIMARY FUNCTIONS form in Appendix D, to identify 1) land related and 2) non-land related functions of each future user of the GIS.

2. Currently Used Maps

The first step is inventorying your current use of maps and related data. You will probably be surprised at the number of maps and databases with information about a geographic location documented by a needs analysis. Similarly, the number of processes (e.g., property revaluation, plan review, permit applications) that involve maps and other geographic information should be reported; their number will also probably surprise you. If not, either you have an unusually broad knowledge of your community's operations or your community may have inadequate geographic information resources!

Knowing what maps are out there and how they are being used will help you determine what data you have, what is a priority, what data are missing, and will later help you determine how the data can be converted into GIS.

The MAP USE/MAINTENANCE FORM inventories essential information about each map currently used.

The project team needs to be as thorough and complete in this task as possible. It needs to do some brainstorming to identify all maps the community uses, whether from the community itself (including its school district), outside state or local governmental agencies (especially regional planning, environmental or community development organizations), publicly owned utilities, non-profits (such as conservation organizations), colleges or universities, or private firms.

Be sure to identify all existing maps, and whether they are currently computerized ("digitized") or not. Also identify which maps are frequently used, which are not, and which are shared and by which departments; this will help in determining priorities for adding each map set to your GIS database.

3. Current Databases and Records

As stated earlier, almost any database with a spatial element (e.g., house address, property identifier) can be used in GIS, therefore, it will be useful to know what all your databases are — even if they weren't intended for use with mapping. Use the DATABASE RECORD form to inventory the databases and records which you may use with the GIS even if that use is not a priority. And don't limit yourself to traditional databases during this exercise. Remember, a filing cabinet full of address-referenced permits can converted to computer database format and become a valuable database in a GIS. Similarly, if you

have drawers full of plans and permits, include them in your inventory. You may want to scan these documents because it is possible to view scanned documents in your GIS if they are linked to a map feature using an identifier such as the assessor's property ID or a drawing number.

As with the map information, be sure to identify records and databases that are both computerized or in paper form.

4. Hardware Inventory

The hardware inventories are intended to identify which of your community's current hardware may be compatible with the GIS. Computer compatibility will hinge on things like memory (RAM), hard disk size, processing speed, and graphics display capability.

Two forms entitled PERSONAL COMPUTER INVENTORY and PRINTER INVENTORY apply to hardware. Use these forms to inventory equipment purchased in the last two years. Each of these forms is fairly detailed. The detail is necessary for assessing the suitability of available computers for using GIS software.
Likewise, GIS puts particular demands on printers. It will be useful to know whether your current printers can be used and if they are sufficient for your mapping needs. Even if they are the right size and print in color, you may still need to add memory.

5. Software Inventory

The community needs to have baseline information about its current software.
Different GIS and related products have different requirements for operating system software. Also, the GIS and related products may or may not integrate well — or at all — with various applications software, such as database programs, graphics programs, or certain versions of these applications.

The SOFTWARE INVENTORY form is used to gather the information you will need to have regarding all of your community's current software. Also use this form for software which your community anticipates licensing or developing in the foreseeable future.

6. Data Communications Inventory

Data communications refers to the infrastructure that your computer uses to send information to and receive information from other computers in your organization or from external sources. It involves:

- Internal communications networks ("local area network" or LAN), servers, and other equipment

- External communications lines (i.e., internet access) and other equipment, whether dial-up, leased lines, or a wide area network (WAN). A WAN may be part of your contractual arrangement with a local cable company franchise.

The DATA COMMUNICATIONS INVENTORY form consolidates information on all data communications facilities which are now in use. Use this form for all of the above types of communications.

Once the project team has completed this inventory thoroughly, it will have important information in hand.

Why is this inventory important? GIS use, especially in remote locations, has requirements for higher speed communications capacity than is required for most other applications (e.g., e-mail; office automation) which are common in local government. The inventory will make

it possible to more readily see what, if any, upgrade your communications capabilities might need with your GIS. Whether or not you need this level of sophistication in your GIS will depend on how you want to use, what you can afford, and what you already have.

7. Mapping Needs

a. Context

Your community's mapping needs are a function of the goals and objectives for your GIS project. Mapping needs are shaped by the level, quality, and complexity of services provided by the community. Likewise, current or anticipated issues, particularly those associated with rapid development, such as school construction or economic development, environmental quality, and water or wastewater facilities may drive a community's mapping needs.

If your community has a comprehensive plan, master plan, or a build-out completed under Executive Order 418, use it to help determine what direction the community is taking over the next 10 or so years. Once you have identified this direction, you can identify those goals to which GIS can be applied.

b. Scale

Scale is an essential element of your community's decision-making regarding GIS mapping. Scale is a way of referring to map accuracy. Generally, the larger the scale, the more accurate and more expensive the data. Note that a 1" = 100' scale map is a larger scale and, if developed according to map accuracy standards, is a more accurate scale than a 1" = 200' or a 1" = 400' scale map. For most city and town needs, a map scale of 1" = 100'(one inch = 100 feet; typically this scale has a horizontal accuracy of +/- 2.5 feet) is sufficient. The larger scale and accuracy associated with 1" = 40' scale mapping is usually needed only for engineering design functions. In dealing with this issue, you have to objectively determine whether the greater cost of higher accuracy maps is justified by your community's mapping needs. You must look carefully at what information ALL your map users need to obtain from your maps as part of deciding what accuracy to use in constructing your GIS database. This can often be a "hot button" issue in communities that ends up polarizing potential GIS users.

The following guidelines further address the issue of scale.

1. Follow the standard set by your town engineer or assessor -- usually 1"=100' or 1"=200'. Sometimes, the standard is 1"=40'. However, note again that a GIS database developed at 1" = 40' accuracy will cost approximately four times as much as one developed at 1" = 100' scale accuracy. It will also be more difficult or expensive to maintain.

2. Follow the standard set for your type of community: urban areas typical of all but the more densely settle communities in Massachusetts usually need a scale of 1"=100'; rural areas can effectively use a scale of 1" = 200'. In evaluating this issue, you may want to discuss it with communities that have already developed a GIS database. What scale did they choose? Why? What do they think about the decision in hindsight?

3. Follow the standard set by your preferred outside source of data. MassGIS data were developed primarily at 1"=400' and 1"=2000'; some utilities develop data at 1"=100'.

The GIS project team should make decisions on scale after considering all the community's GIS requirements. It will usually be less expensive to develop your GIS database from existing maps than from new mapping. However, if the existing maps are not suitable for supporting the GIS capabilities you want to develop, you will need to either change your ideas about your GIS capabilities OR create new map information that meets your scale requirements. Be aware that the larger the scale, the more expensive it will be to computerize the data.

Also be aware that just because maps of different scales can be used as source material for your GIS database, using the GIS to display those different maps at larger scales does not make the information any more accurate than it was on the original maps. Map features originally mapped at one scale may have limited usefulness with data layers originally from another scale.

c. Helpful Forms

A two-page form, DESIRED MAPPING, provides a structure for defining the community's mapping needs. It is intended to help the GIS project team:

- Determine the types of maps that the community would like to have — for example, assessor's parcel maps, water/sewer, planning and zoning, storm sewer, structures and facilities, or natural features.
- Determine the features for each type of map. Sample features related to each type are listed on the worksheet.

- Determine the scale for each feature.

The full GIS project team should review all of these features. The collective input is essential here. If you don't see a map feature you need on the forms, simply add it to the list.

C. The Needs Assessment Report

The needs assessment report should summarize the information collected on the forms used in the needs inventory. The plan should, where possible, emphasize brief text descriptions and graphical presentation of the information. For example, consider summarizing information about department specific responsibilities and use of geographic information using "bulleted" lists; likewise, present cross tabulations of maps or map features and the departments that use them. A similar graphic for databases/files or required applications will also be helpful. Consider using diagrams to illustrate processes that use geographic information, particularly if those processes involve more than one department.

This report should also briefly describe what applications your GIS should support, and the priority placed on them by the individual departments. The GIS Committee will use the application priority rankings as it decides overall application and database development priorities. Key considerations in setting those priorities will be map features used by multiple departments and applications that would support multi-department processes.

D. The Implementation Plan

Finally, your needs assessment should lead to an implementation plan. This plan should describe a course of action for developing your GIS:

- What data should be developed and in what order,

- What applications should be developed and when,

- When the hardware and software should be purchased and how it should be deployed (a diagram of the proposed system configuration showing individual components and their physical location will be useful; don't forget to include the communications network in your diagram if you have or will be developing one),

- When staff functions specific to the GIS will need to be supported, and

- When training should occur.

You will need a schedule or timeline in your implementation plan and, at some point, you will need to develop budgetary estimates for your GIS project. An implementation plan that includes these will be a more useful document.

Ideally this plan would also address the issues of how data will be maintained, what GIS application can be developed quickly to provide early evidence of the system's utility, and, very importantly, any schedule or cost dependencies between data and application development. Because, at a minimum schedules and budgets change, you should think of your plan as a "living" document that will change and need editing. So plan on being able to edit your plan and on printing revised versions!

VII. DATABASE DEVELOPMENT

GIS design and development should be driven by what you want to do with your GIS ("applications"). The applications require certain kinds of data. These requirements are the basis for identifying what information needs to be in your GIS database. The GIS database will be a collection of records much like your existing map records. Computers come and go; GIS software changes. The database persists. Think of your GIS database as an infrastructure – an information infrastructure – that needs to be designed, implemented, and maintained just like your physical infrastructure. The cost of developing the GIS database is typically about 70 – 80 percent of the total system cost. Therefore its important to spend time figuring out what the database needs to contain, how you are going to develop it, how much it is going to cost, and, once its built, how it is going to be maintained.

Your community needs to respond to several issues related to data in constructing the GIS needs analysis. These are discussed in more detail in the remainder of this section.

A. What Kind of Information Do You Need?

Earlier, we presented the DATABASE RECORD and DESIRED MAPPING forms. These should be used to identify specific kinds of information which prospective users of the GIS need. Remember the definition of information: *organized data.*

Now that you have read most this far, you may have more ideas about the kinds of GIS information you could use either now or sometime in the future.

Use the AVAILABLE DATA form to consolidate information about the different kinds of data – maps and related records such as card files and computer databases - currently available in your community. It may take several rounds of discussion to be sure that all of the sources of data have been identified and described accurately.

B. Who Has What?

The second column in AVAILABLE DATA, "Department in Charge", records which office has the legal or actual authority for maintaining the information or "data set". This includes adding new records, updating existing records, and deleting records.

Much of the "Department in Charge" information is well known as a matter of statute, regulation, or customary practice. Where there are questions, the community should consult its legal counsel. Unless the current maintainer of the data specifically does not want to continue that responsibility when the data set becomes part of the GIS database, it is best to plan on the same department having maintenance responsibility in the GIS database. This helps ensure that the GIS is not perceived as usurping existing responsibilities. It also may encourage participation in developing the GIS. In particular, those currently maintaining a data set are probably the best qualified to perform quality assurance once as that data set is converted into the GIS database.

C. Sharing Data in the Enterprise

By enterprise, we mean your community's entire organization — all of its departments, offices, boards, committees and commissions. If there should be other participants

outside of your local government, this would include all of these parties as well.

Much of the benefit from a GIS is realized through having the departments and offices in your community share a common GIS database; the GIS should be perceived as a shared resource with different parts maintained by different departments. Imagine that instead of having to visit multiple departments to obtain all the maps you need, you can display all that information on a single computer screen. Further imagine that you no longer have maps at different scales and that your area of interest does not require you to work across map sheet boundaries! This is what a shared GIS resource means. Furthermore, with all the map records and related tabular records in a shared GIS database, redundant record keeping can be eliminated and the analytical power of GIS becomes possible. This is where our discussion of GIS began, and it is the main reason for investing the time, effort, and funds required to implement GIS successfully.

Sharing data requires two elements: 1) a communications network connecting the departments sharing the data resource; and 2) "links" between data sets which enable the GIS to work with the data. Communications simply means connecting each location needing access to the GIS database (creating a network). Although not common, it is possible to have a "multi-department" shared database resource without an electronic network and based on simply installing copies of the GIS database on each GIS users computer. Obviously the success of this approach hinges on the copies being kept synchronized and having them all updated in a timely manner.

The "links" between data sets can best be explained with examples. Your conservation commission maintains a computer database (or files in a drawer) containing a record for each property in town where a site visit has determined there is a wetland. Each property's record includes its address and the property ID from the assessor's maps. If you want to use a GIS to color-code these properties on a map, you need to access the database of site visits from your GIS software and establish a link between it and your property map features. With that link established, you can build a legend for the "thematic map" indicating which properties have wetlands or not. The same kind of thematic mapping can be performed for any other town record containing a property ID. Of course, if the town records are in a paper file rather than a computer database, then the wetlands findings first have to be entered to a computer database. However, it is just this kind of information that will be apparent after you complete the DATABASE/RECORD and DESIRED MAPPING FORMS discussed in Section A of this chapter.

Use the column "Computer or Hard Copy" on AVAILABLE DATA to record format of the data. If the data you have are computerized, put the specific computer in this column. The column headed "Software Program" will also help the Committee to see the amount of work which may need to be done if there should be multiple vendors involved.

D. Data Maintenance

Data maintenance is a very important issue for GIS. Only one individual or office should have the ability to edit and update each set or subset of information. For example, engineering staff may maintain the property boundaries on the assessor's maps now and the planning staff may maintain the zoning map. With a GIS, access to the property boundaries or the zoning districts

should be available to all. However, only the engineering and planning staff should be able to edit the property and zoning district boundaries, respectively.

Conversely, you may decide to have one person develop the expertise needed to do all map maintenance. In this case, only that person would have the access needed to edit these data sets. In some communities, GIS database maintenance may be conducted under a contract with a private firm or the regional planning agency.

However maintenance occurs in your GIS, access to the information is controlled using the capabilities of your computer systems. Whichever way maintenance is handled, you will need to ensure that there is a process being used whereby other town employees can submit recommended or needed data updates or corrections. System security generally needs to be managed by whoever is the community's administrator for its computer systems. If your GIS database exists on only one computer, then the users of that computer are its "system administrators"!

E. Choosing a Base Map

How you want to use the capabilities of a GIS, will determine what type of base map you need (data and map are synonymous in this case). Base map is a catchall term used to describe maps that provide common map features for use by all participants; they serve to orient the map user about the area depicted. Base map features may be used alone or they may be used underneath other map features that are the main focus or "theme" of the map. Orthophoto, planimetric, property maps, or some combination of these types can be used as a base map; they are discussed further below.

You should decide what type of base map you want early in your project. The type of base map you choose will be a function of your goals and of your scale (i.e., accuracy) requirements. Note that you might change this decision later. For example you might start with your assessor's property maps as the base and then, when funding becomes available or as the need arises, acquire an orthoimage or planimetric base map.

1. Planimetric maps

Planimetric base maps display physical and cultural features, such as roads, bridges, building footprints, topographic contours, edge of street pavement, retaining walls, utility poles, and bodies of water (see Figure 2). A familiar example of a planimetric map is the U.S. Geological Survey's topographic maps. These maps are typically created by mapping features from aerial photographs in conjunction with detailed and precise information from engineering surveys to remove distortions in map feature locations due to the aerial photograph (see discussion of orthoimages, below).

2. Property Maps (assessor's maps)

Assessor's maps present information about properties such as their boundaries, identifying numbers (e.g., map, block and lot), and easements. These maps also typically include street names and may include property dimensions. A map of property boundaries can be created on the basis of legal property records (deeds) or, more commonly, by scanning or digitizing the assessor's property maps.

3. Ortho Images

These photo-based "maps" are created from aerial photographs. Aerial photographs cannot be used directly as a map because

they have distortions. Distortions occur because:

- The distance from the end of the camera to the ground at the center of the photo is shorter than the distance at the edge of the photo

- The ground elevation varies across each photo; and

- The orientation of the plane relative to the ground is not perfectly level.

Using accurately surveyed coordinates for a pre-determined set of points (or ground control), a detailed model of surface elevations (a digital terrain model or DTM), information about the internal characteristics of the camera, scanned versions of the photographs, and some complex calculations and manipulations executed by a computer, these distortions can be removed; the photos have been "rectified".

The end result of this rectification process is an air photo map, or "orthophotograph". When photos were first rectified in this manner, they were still printed on paper or mylar and so were referred to as "orthophotos". Nowadays, these ortho rectified photos are used in digital form and so should be referred to as "orthoimages". The key characteristic of both orthophotos and orthoimages, however, is that you can make measurements and correctly determine locations, just as you can with any other map. Of course these measurements and locations can only be as accurate as the specifications for horizontal and vertical accuracy established when the orthoimages were created. Orthoimages are very useful as a base map because other GIS database features (e.g., property boundaries) can be displayed or overlaid on top.

For city and town needs, orthoimages having the horizontal accuracy associated with a 1" = 100' scale map that meets industry standard specifications for accuracy are sufficient. Similarly, orthoimages with a resolution ("pixel size") of one foot or six inches meet or exceed city and town needs.

F. Building Other Parts of the GIS Database

Important parts of the GIS database besides the base map may include a street network, the water and sewer system infrastructure, a variety of political or jurisdictional boundaries, and point features such as locations of school children. Issues to consider in developing these parts of a GIS database are discussed below.

1. The Street Network

A street network is a common feature in a GIS database. At a minimum, if your street network includes an attribute of the street name, it will enable you to put street names on your maps by labeling the street segments. In addition, streets are often used to define, wholly or in part, boundary features (e.g., police beats, planning areas, school feeder areas, wards/precincts). More sophisticated GIS applications such as routing services or depicting features (e.g., pavement conditions) that are represented by a portion of a street also require a street network. Not all municipalities will be interested in using a GIS in these ways however.

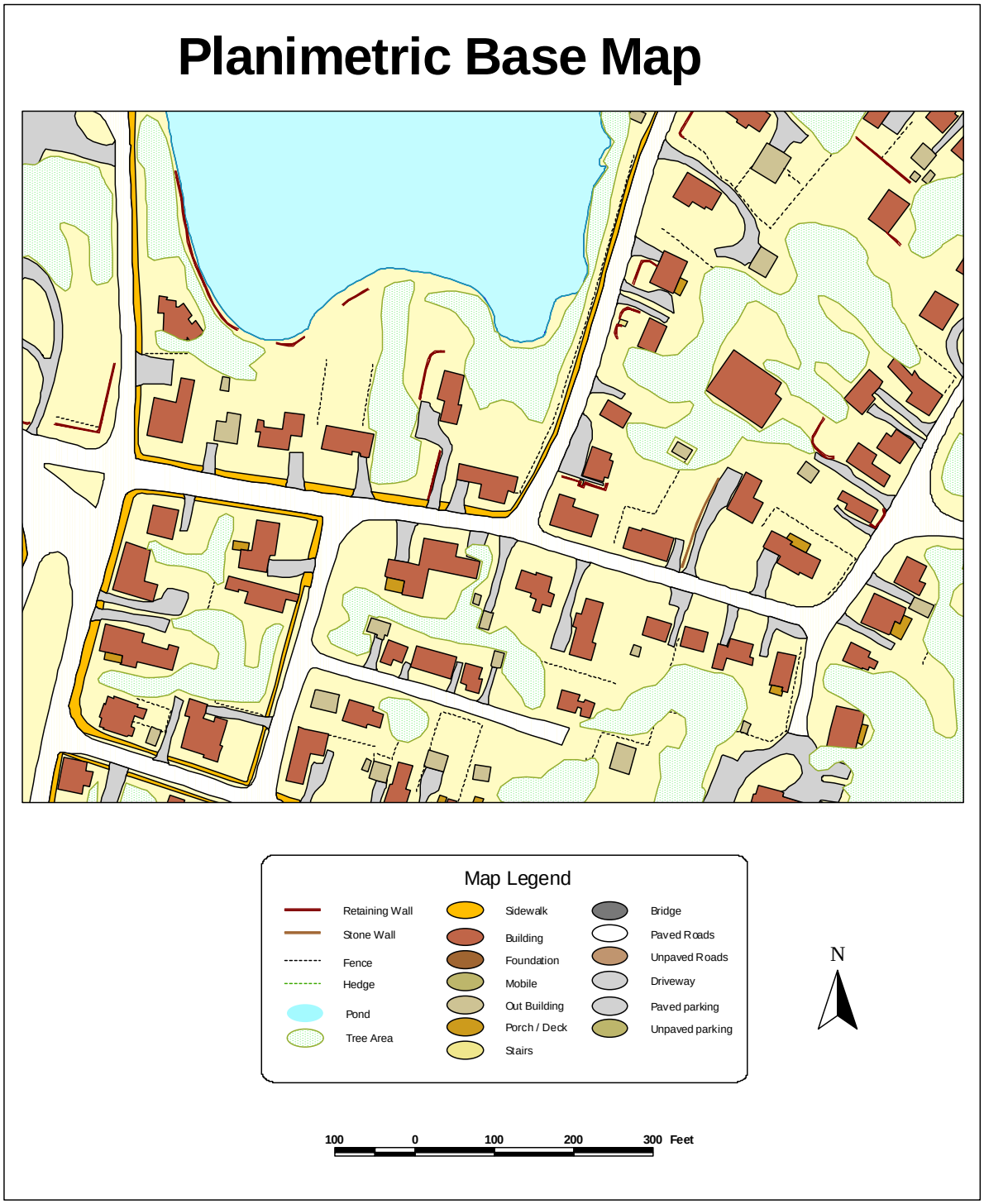
A street network is fairly easy to develop. Presently, MassGIS can provide street lines for your community. They will need updating and some extraneous features will need removing. Also, this street network will need attributes such as street name and address ranges added. A project to incorporate the MassGIS street network into

the MassHighway street network was started in September 2002. By late 2003, the street network distributed by MassGIS for MassHighway will include the data resulting from this project. Thus, by late 2003 or before, the MassHighway street network will be spatially accurate enough for cities and towns to use and it will include street names.

2. Water and Sewer Infrastructure

Not all communities have water or sewer infrastructure. Some only have it for some areas. If map features representing the water and sewer infrastructure are needed in your GIS database, your needs analysis or some other planning process will have identified that need. Realistically, if your community

Figure 2: Planimetric Base Map
(Figure courtesy of the Town of Ipswich)



has maps of these features, the only reason they will not be identified as necessary in your database is if your Department of Public Works is not participating in your GIS project.

How to proceed in converting your existing maps of water and sewer infrastructure will very much be dictated by the type and quality of your existing records. These might range from large-scale maps that are spatially very accurate to much less spatially accurate small-scale maps, to schematic drawings. You may or may not have detailed highly accurate "as-built" engineering drawings to back up these maps.

For creating maps that serve planning and display purposes, water and sewer pipes typically only have to be mapped accurately enough in your GIS database so they appear somewhere in the street right-of-way where they exist. The "as-built" drawing would be consulted when it was necessary to know exactly where in the ground the pipe is located. This accuracy requirement for representing water and sewer pipes in your GIS database also has the advantage of being much less expensive than an approach that maps the pipe locations more accurately.

Besides pipes, water and sewer infrastructure also include features represented as points. In the case of sewer networks, this means primarily features such as manholes. For water networks, these features may include various types of valves, fire hydrants, pipe junctions, and pressure reducers. Usually, the location of the visible, "above ground" (e.g., manholes, valves, and fire hydrants) or visible point features will need to be mapped more accurately.

The visible parts of the water and sewer infrastructure can be mapped from aerial photography if they are first marked with a "target" visible on the photographs. However, recently, it has become more common to map these feature locations using global positioning satellite (GPS) receivers in conjunction with a laser range finder. It is realistic to have this kind of mapping project handled by city or town staff. However, such a project should be undertaken only if there is strong project management, suitable equipment, staff who can be dedicated to the project and who understand the equipment, and a clearly defined and well understood project methodology.

Much of the detail you need to know when you dig up a water or sewer pipe is stored on the "as-built" drawings. These drawings show where the pipe was actually placed in the ground, including deviations from construction plans because of underground conditions. An important adjunct to your GIS database of water and sewer features worth considering is scanned versions of the as-built drawings. Once scanned, these can be linked to the relevant pipe features in your GIS database using a common identifier. This link makes it possible to first display a portion of a particular street and its water or sewer pipes using the GIS, and then call up the "as-built" drawing for display on the screen. Similarly, details of individual residential and commercial service locations are often sketched on "service cards". These are typically indexed by address. It is also possible to scan these cards and link them to appropriate service location.

While not always simple to implement, the kinds of capabilities described above nicely illustrate the possibilities for integrating information through the capabilities of a GIS.

3. Boundary and Point Features

Boundary and point features are often found in GIS databases. Common boundary features are police beats, assessor neighborhoods, school feeder areas, water pressure areas, wards and precincts, and trash pickup day areas. Common point features include crime incident locations, student locations, and permit locations.

Boundary features are often found on existing small-scale maps and often follow streets. They are usually easily recreated using basic map feature editing tools in GIS software.

Creating point features can simply be a matter of having a person place the features at their correct map locations using GIS tools. However, very often information that can be represented as a point feature (e.g., school children, crime incidents) is identified using an address; most GIS software has the capability of mapping an address as a point feature, provided the GIS database includes a comprehensive list of addresses associated with either a street network or with property boundaries.

G. Quality Assurance (QA)

Whenever you have a project to convert existing records for use in your GIS database, you will need to check that you received the results you expected. Exactly how you do this process and what you should check for depends in part on the map features involved.

A complete discussion of QA procedures is beyond the scope of this document. However, generally speaking, what you are attempting to verify is that the version of the information in the GIS database is a correct representation of the original materials. This kind of checking involves some or all of the following:

1. Checking if the map features are accurately represented in your GIS database;
2. Checking that the map features are linked to the correct attribute information;
3. Checking that all map features you expect are in the GIS version of your map; and
4. Checking that attribute values are entered correctly.

Determining whether or not the above characteristics are true can be very tedious and time consuming. Examples of QA tasks include:

- Taking a print of the map information produced by the GIS (a "check plot") and laying it on top of the original on a light table to check for errors. The method used to identify and note errors on the check plots should be established ahead of time; one method that has been used involves drawing a line from a map location out to the map margin, where a standard code should indicate the error or issue. Another, potentially less cumbersome method, involves using your GIS software to create a "point" map feature at the location of the error or issue. These point features with their associated comment can then be e-mailed to the company or person that created the digital data.

- Checking that each parcel on the assessor's map matches to a corresponding record in the assessor's database, or that the drawing ID associated with each sewer pipe or a selection of sewer pipes, is correct.

- Making sure that if certain map features were supposed to be coded in specific ways in the database, that only correct codes were used.

An excellent presentation on parcel mapping QA was given at the Massachusetts Geographic Information Council (MGIC) seminar series in November 2000. That presentation can be found on the MassGIS web site in the Municipal GIS Resources section at: www.state.ma.us/mgis/munimgic.htm. Similarly, MassGIS staff gave a presentation on orthoimage QA at the New England GIS 2002 conference. That presentation is also on the MassGIS web site at: www.state.ma.us/mgis/munigis.htm.

Quality assurance is an essential task. As a municipal GIS coordinator once noted in a presentation on this topic:

"*Nobody [no contractor] is perfect, not at any price...*
…but, there is no such thing as a perfect map. However, inaccurate or incomplete maps are rarely trusted. Once you have given final approval, it is your mess to clean up!…or it can be your new foundation to maintain."

H. GIS Database Costs

Besides your assessment of what capabilities you want your GIS to provide, another factor influencing your decision about the content of your GIS database must be funding. What are you able to spend?

If you are converting existing maps to digital form, then cost is a function of map condition and completeness. Condition includes not only physical condition (maps in poor condition are more expensive to convert or may not be a viable source at all), but whether or not the maps are associated with geographic space (e.g., the maps have map coordinates on them), are at the same scale or different scales, how many map sheets there are, and whether or not features match across map sheet boundaries. Completeness concerns whether or not the maps are up-to-date and include all the features you want.

Cost is also a function of accuracy: the higher the accuracy (larger scale data), the higher the cost. Existing maps will cost more to automate if their scale is larger, because there are more map sheets and because the accuracy requirements for the conversion process will be more stringent. However, developing new maps of similarly large scale from aerial photography or other sources will probably cost even more.

Because different communities have different needs and because existing map resources vary from community-to-community, it is impossible to describe here exactly what your GIS database will cost. However, it is possible to provide some information about cost ranges for commonly needed parts of a GIS Database.

1. Planimetric Base Map Costs

The following table gives approximate costs for developing a planimetric base map from aerial photography.

Typical Planimetric Mapping Costs

	Cost/Sq. Mile
Rural	$900 - $1,000
Medium	$12,150 - $13,150
Urban	$17,500 - $18,500

Estimated costs as of 2002 and courtesy of Chas. H. Sells, Inc., Charlton MA

These costs are suitable for budgetary purposes and presume that the map features below will be created. Density and terrain will greatly affect these costs, as will the features chosen for mapping. Typical map features on a planimetric base map include:

- Building outlines,
- Topographic contours (2 ft. interval),
- Walls,
- Fences,
- Paved Roads (mapping curb cuts for driveways would add to the cost),
- Unpaved roads,
- Parking areas (paved and unpaved),
- Wooded areas,
- Street tree locations,
- Ponds and lakes, and
- Streams and rivers

Changes to the above list of planimetric features would change the cost. Also, mapping costs for more developed areas will be higher than in more rural areas and higher when terrain is more variable. Finally, the cost for larger areas will be somewhat less than for smaller areas, all other things being equal.

2. Parcel Map Conversion Costs

Converting your assessor's property maps for use in a GIS will be relatively inexpensive provided the existing maps:

- Were created and maintained at a known scale,
- Use a numbered sheet layout where property boundaries match across adjacent sheets, and
- Are in good condition (not torn, crisp lines and text, features not obscured by stains)

Property maps that meet these requirements can typically be converted for use in a GIS database for between $4 and $6 per parcel, and sometimes less.

Assessor's maps that do not meet the conditions above may need to be recreated based on researching property deeds and other records. Mapping from deeds is very expensive, with costs ranging from $15 - $25 per parcel. Sometimes a combination of automating existing maps and mapping from deeds may be most appropriate.

3. Orthoimage Costs

Orthoimage costs include those for surveying ground control, developing the terrain model, taking the aerial photography, and processing the photography to remove distortions, as discussed above. In addition, you have to decide what accuracy and resolution you want in your images. The costs below are producing GIS data with an accuracy typical of 1" = 100' scale mapping.

Typical Orthoimage Costs

	Cost Per SQ/Mile Color	Black & White
1	$7,100 - $8000	$6,850 - $7,700
2	$7,700 - $8,700	$7,300 - $7,800
3	$850 - $1,800	$600 - 1,400
4	$1,150 - $2,150	$900 - $1,700

Estimated costs as of 2002 and courtesy of Chas. H. Sells, Inc., Charlton MA

1 = With Photos/Control/AT/ DEM, 1' Pixels
2 = With Photos/Control/AT/ DEM, 0.5' Pixels
3 = Existing Photos/Control/AT/ DEM, 1' Pixels
4 = Existing Photos/Control/AT/ DEM, 0.5' Pixels

These costs are suitable for budgetary purposes.

Obviously, not all communities will be able to afford their own orthoimages. Under these circumstances, and option worth considering, are color orthoimages available from the state. These images are based on aerial photography taken in 2001 (the islands were photographed in 2003) and are available through MassGIS at no cost to cities and towns. While the pixel size of the state orthoimages is a half meter (about two feet), and thus the images will not allow you to zoom in as far as images with smaller pixel sizes, they are still a very good base map option for a community's GIS base map.

VIII. SOFTWARE

A full discussion of the myriad GIS software packages is beyond the scope of this document. GIS software is abundant, varies greatly, and is becoming increasingly affordable and more powerful. Programs vary in terms of sophistication, user friendliness, and inclusion of "extensions" or "modules" for special capabilities such as modeling networks or three-dimensional surfaces, reading data from computer assisted drafting (CAD) systems, among others.

Software also varies considerably in price, from a few hundred dollars per license to well over a thousand. When making your decision about GIS software, consider:

- Your needs and goals. Will you require customized applications or will you be using only the capabilities provided by the GIS software?

- Will the software be installed on computers connected to a computer network and sharing files and software from a central "server" computer?

- What type of existing digital data, if any, you have. If you are getting existing data from a utility or other outside organization, for example, you may prefer to use software compatible with that of the utility. Most GIS software can import files from most other GIS software. However, sometimes these translations require additional work or don't work completely. So this process may not be something you want to deal with.

- The sophistication of the users. Are they proficient on computers? Do they know cartography?

- The amount of time dedicated to GIS for each user. For example, a desktop, menu-based program will likely be more useful to staff with only a few hours a week to make maps.

- The power of hardware. This may be a consideration if you will be installing GIS on existing hardware rather than purchasing new computers.

If you are working with a consultant, they can provide information about GIS software. The internet is also a valuable resource for learning about GIS software products (see Appendix C). If you know of specific vendors, you can also contact them directly. Please note that MassGIS and the RPAs will not recommend a specific vendor's product. They can however provide an introduction to various products, tell you about their experience with some or all of them, and provide contact information for GIS software vendors, if needed.

IX. HARDWARE

Hardware provides the vehicle for GIS. These days, GIS software will run effectively on a PC with pretty ordinary specifications. In other words, the same PC you might purchase for standard office software will probably work fine for your GIS software. If there are any differences, it will be a need for additional random access memory (RAM) and a better video card. Although not essential, a monitor that is at least 17" will make your GIS data easier to work with. Note that a more detailed discussion of computer specifications is in Section IV of this document. If you include orthoimages in your GIS database, you may need to increase the amount of disk storage space.

Keep in mind that your community can phase its implementation of GIS on different hardware platforms. It is not unusual for local governments to begin with a single-user PC and then advance to a networked or server-based system in order to provide access for multiple users in multiple departments.

Be sure to check the hardware and software vendors' product literature before configuring or ordering any hardware for GIS. Generalizations about hardware requirements for GIS are extremely dangerous. Your community's best option in procuring GIS software is to leave the characteristics of hardware for the GIS as the vendor's responsibility with specific performance-based warranties for payment and long-term support. It is generally a good idea to delay as long as possible purchasing the computer equipment, because the capabilities and pricing of computer equipment change frequently, with money required for the same capabilities dropping or the capabilities available for the same money increasing.

Municipal GIS projects will include some or all of the following hardware types:

A. The GIS Server

Not all communities will implement a GIS that involves a central server. For some communities a server's cost and administrative overhead is not appropriate. In this case as the database is updated, each user's copy of the data on their computer would be refreshed.

If a server is purchased, it will enable the GIS database to exist on a single central computer. GIS users would access the GIS database from their desktop PCs via a network. This means that different people in different offices, whether in the City or Town Hall or at other locations in your community, can all access the same copy of the GIS database at the same time.

Your server needs to have the following essential characteristics:

- Ample memory and disk space. GIS is a very resource-intensive application. Memory and disk overhead for GIS and related products are substantial. For example, a GIS server for a small- to medium-sized community should be configured with at least 80 gigabytes (GB) of disk storage and 512 megabytes (MB) of memory.

- A network interface card (NIC) so the server can connect to the network. While the most common NIC capacity is still 10 megabytes (10Mb) per second, you should probably install a 10/100Mb card as this kind of card can handle both 10Mb per second and the increasingly common 100 Mb per second data transmission rate needed as computer file sizes grow (e.g., orthoimages).

- A high capacity, high-speed backup device. This will make it possible to create backup copies of the database, including off-site copies to protect against catastrophic events like fires and floods. This backup unit might be a CD-WORM (CD that you can **WR**ite **O**nce **R**ead **M**any times) device, tape drive, a Zip or Jaz drive, or a data DVD disk.

B. The GIS Workstation

The GIS workstation is the personal computer on your desk that you use to work with the GIS. These days, this workstation can be used for general office software uses as well as running the GIS. As discussed earlier, a PC used for GIS may need additional RAM, a larger hard drive, a better video card, and a larger screen. Most PCs you can buy today are sufficient to run most GIS software adequately without adding memory or storage space. Note that lower level users of your GIS are more likely to need a workstation with conventional specifications. The GIS "power users" or those performing the role of a GIS technician or GIS manager may need a workstation with more advanced capabilities: more RAM, more disk space, a better video card, and a larger screen.

To be safe, check the literature from your GIS vendor and the vendors of the other software you are using to determine how the PC ought to be configured. When you're done checking, add another 25 to 50% to the recommended (not minimum) specifications to be safe — GIS software and operating systems upgrades often require more power. This will also make it more likely that your workstation will meet system requirements for future versions of your GIS software.

C. Printers/Plotters

Color printers are the essential output devices for GIS. As with all of your community's needs, the type and quantity of printers or plotters you need depends on: 1) what your goals and objectives are; and 2) how much money your community is willing or able to spend.

Be sure to review the information from the vendors of your GIS and related software and also the computer configuration to see which printers they support and in which operating environments.

Printers and plotters fall into two categories, general purpose and large format.

1. General Purpose Color Printers

Many GIS software products are compatible with leading brands of general purpose business printers, such as inkjet desktop models which your community can purchase for less than $150. These allow you to produce output on 8 1/2" by 11" paper. These typically print using color from a black ink cartridge and a single color cartridge. These cartridges have to be replaced periodically at a cost typically between $25 and $35 each. It is also possible to save money by purchasing ink-refill kits for these cartridges.

2. Large Format Color Plotters

Plotters are available that can produce prints up to 60" wide, although 36" or 42" is more typical. These printers typically print from a roll of paper, so the length limitation is that of the roll, which is typically 100 or 150 feet. Additional rolls of paper cost around $40. As with the general-purpose printers described above, these printers use multiple cartridges, typically one each for black, cyan, yellow, and magenta. Replacement costs are again $25 to $35 each, with the color cartridges being the more expensive.

One problem with the standard inks from large format color printers is that they fade quickly, especially when exposed to sunlight. This fading can be avoided by purchasing special inks that resist the ultra-violet radiation responsible for the fading; these inks are more expensive and are not available for all kinds of printers.

The commonly used device in this category is again based on inkjet technology. Variables that affect the costs of these devices are primarily the size of your print files, the file format you will be sending to the printer, and how fast you want the printer to complete a print. For most communities, a satisfactory printer in this category can be purchased for under $10,000. You may also be able to arrange for printing services through your regional planning agency or even a commercial copy shop.

D. Scanners

Scanners are devices used to take a "picture" of a document. Scanners for mapping projects are different from those used on home computers in that they can scan large documents like maps and they do so at a much higher resolution (e.g., 1300 "dots per inch"). Scanners work by measuring the intensity with which light is reflected from different parts of a document; the intensity varies depending on how dark (e.g., a line or some text) or light (e.g., white space) the document is at any location. Note that while most maps being scanned for a GIS database will be in black and white, it is possible to scan multi-colored maps. Scanners with this capability are <u>much</u> more expensive, however.

Once a map is scanned, locations on the map need to be associated with their actual locations on the surface of the earth. This makes it possible to display the scanned map on a computer screen in the correct location relative to other map features. Scanned maps can be used in a GIS with no further processing. However, scanning maps is usually just the first step in a process that uses the scanned map as a guide for creating map features (points, lines, and polygons) directly on the computer screen in a GIS database.

It is feasible to purchase a scanner and related software and computer storage, develop proficiency in using the scanner and GIS software, and to then create your own GIS data. However, purchasing a scanner is only cost effective (and large scanners cost tens of thousands of dollars) if there are large numbers (tens or dozens) of maps to be scanned. Scanning projects with this number of maps can be complicated and time consuming to manage. Therefore, such projects will only be effective if someone can be dedicated to working on them for a set amount of time every week. Also, to avoid having the project drag on too long, the dedicated time must be sufficient to finish the project quickly enough to satisfy the needs of the GIS project. In addition, creating GIS data is not only about creating the visible map features (points, boundaries, etc.), but also about designing the database information (the "attributes") associated with the map features. In general, unless you happen to have the right staff expertise, it is probably better to have a contractor at least start this project for you by developing a work flow and database design that can then be continued by a city or town employee. Contractors will have the experience needed to perform the work more quickly and with better quality control, and will also be able to most effectively work with city or town staff in designing the database of map feature attributes.

E. Digitizer Tablet/Table

These tables have a closely spaced grid of fine wires embedded in their surface. The table is connected to the back of a personal computer. Then a map is taped to the table and locations on the map are associated with ("geo-referenced to") the coordinates of the geographic area depicted on the map. At this point, features on the map can be traced with a special puck containing a fine cross-hair. A computer tracks the pucks movements relative to the embedded wires and records coordinate values for the map features.

This device should include a translucent top that allows backlighting of the surface for better interpretation of dark imagery (orthophotos, old sepias, etc.). The active surface of the tablet should be at least 36" by 48".

Whether a digitizer tablet or table is required to digitally input information from existing hard copy source documents into the GIS will depend on how you decide to build your GIS database. If you are going to have a private contractor or a regional planning agency develop data for you, you will not need a digitizing table.

A digitizer table is only necessary if you plan to do in-house data development from paper, mylar, linen, or other source documents. The primary reason for in-house digitizing is if you have a large number of source documents where correctly capturing the information requires the knowledge and expertise of your community's staff.

X. STAFFING

Staffing is an essential element in the success of your GIS project. Initially, as discussed elsewhere in this document, you will need to have staff participating in the planning stages of the project. As your project shifts from the planning to the implementation stage, more dedicated time will be required for the project. Ideally, at about this stage, you would hire a half or full-time GIS staff person. At least 30 Massachusetts communities have hired one or more full time GIS staff; these communities include ALL those with the most successful GIS projects.

In the beginning stages of GIS implementation, project tasks will include:

- Developing, maintaining, and managing an implementation plan,
- Developing scopes of work for, selecting, and managing consultants and other contractors (note that this process is required in some form for any sort of outside assistance),
- Procuring database development services (e.g., parcel map conversion or orthoimage base map development),
- Performing and/or managing the process of systematically checking ("quality assurance") data being developed for the GIS.

These kinds of tasks require an understanding of GIS database design and construction as well as good project management skills. A consultant can handle some of this work, although contracting for and managing consulting projects will require a significant amount of time. Most successful multi-department GIS projects in Massachusetts cities and towns have included some level of planning and facilitation from an outside source, typically a consultant. Existing staff with project management capabilities, perhaps assisted by staff familiar with specific city or town records, may initially adequately handle these project tasks. However, it will sometimes be a full-time task.

Once the process of constructing the GIS database has started and, subsequently, once the GIS is operational, someone will be needed full-time to make the most of your GIS investment and to keep the GIS project running smoothly.

Dedicated staff time is needed for a multitude of tasks as a GIS becomes operational. Someone has to (in no particular order):

- Organize the GIS data on the computer (whether a central server or multiple stand-alone machines), make decisions about related matters of storage size as the database is started and grows, determine and establish file security, and project specific storage areas;
- Determine how individuals will access the GIS;
- Develop custom capabilities needed for your community or needed to make GIS easier to use;
- Produce maps, develop reports, and perform analyses;
- Determine how often updates need to occur, how the work processes that generate the updates will mesh with the update process, and how those updates will be accomplished;
- Resolve issues with network speed as GIS data files are often large, so even if

you have a network administrator, the GIS staff will have to be involved;

- Determine how best to back the data up and how often;
- Order printer/plotter supplies;
- Procure and manage hardware/software maintenance contracts;
- Resolve software glitches
- Coordinate between the GIS software and software being used by or proposed for other projects;
- Establish file-naming conventions and database documentation standards.

A. Making the Right Decisions About Staffing

What does your community need to evaluate to make good decisions about GIS-related staffing?

1. Your Goals for GIS

- How far does your community want to go with GIS?
- How substantial a commitment is your community ready to make financially and otherwise to support GIS?
- How critical does your community believe GIS is to its future?

2. Characteristics of Your Community

Size, both population and land area, matters. Population alone can affect the nature and type of staffing your community requires. While unlikely, a small community may be able to manage GIS with existing staff within its Assessing, Planning, Public Works, Health, or other departments, a medium to large community will probably require staff dedicated to GIS.

Land area may also affect the level and type of staffing required. A town of 30 square miles may need to use and manage GIS very differently from a town of four square miles.

Finally, staffing needs for GIS may also be affected by such factors as:

- How urbanized your community is,
- What your rate of development is,
- What the community's major development-related issues are — for example, industrial development or downtown commercial redevelopment,
- The difficulty with justifying and funding new staff positions.

3. GIS Consultants

Whether or not you choose to use GIS consultants and service providers will depend on your expectations for your GIS project, the capabilities of your existing staff, and your finances. Depending on how you will use your consultant, you may not need to hire technical staff. For instance, some communities in the state have contracted for data maintenance with the same consultant who provided their GIS data development. There are also some instances where communities contract out the entire GIS operation to a consultant. However, in the long run, this will probably not be particularly cost effective or operationally satisfactory.

B. Staffing Functions

GIS project staffing can be thought of as consisting of the following staffing functions: program manager, system administrator, database manager or technician, and user. These are described in more detail below.

Many communities have decided that their need for GIS capabilities justifies one or more full-time staff dedicated to GIS. Regardless of whether or not creating a dedicated GIS staff position is feasible in your community, the "staffing functions" below will still need to be accounted for as part of implementing your GIS project. Some elements of all these "staffing functions" will be needed for any GIS project.

There may already be someone in your city or town performing some of these job functions for other computer related projects. As you start your GIS project you should determine what staffing functions you need to fill. Then decide which of these functions can be supported by existing staff, by volunteers, by a contractual arrangement with your regional planning agency, or with a private company. You may start with existing staff, volunteers, or a contractual arrangement, and then decide to try and make the case for new part or full-time staff specifically for your GIS project. Remember, as discussed in Section V, inadequate arrangements for staffing are a key reason for GIS project failure.

Some communities have used a GIS project as a justification for introducing computers for a variety of other town functions. This approach to GIS projects typically also involves installing computers and a network connecting them. It will likely also involve undertaking a variety of significant other projects (e.g., acquiring and deploying software for payroll, purchasing, finance, etc.). Often these kind of "GIS projects" result in someone being hired to support all the software being used on the PCs, the network connecting them, AND the GIS project. A community following this model must recognize that the GIS portion of the project will probably proceed very slowly and often not at all.

1. Program Manager Function

Someone on the community's full-time staff needs to serve as Program Manager for GIS.

This person needs to have both the authority and responsibility, acting with the GIS project team, to serve as the community's key person in coordinating all efforts related to GIS. Once the GIS project is actually underway, this person could spend between 20% and 100% of their time managing the project in any given week. The time required will be particularly heavy when there are contracts for data conversion to manage.

2. System Administrator Function

If communities have a system administrator for its general computing resources, the same person can manage those requirements for a GIS; they are very similar. Note that in some communities, this job function is provided through a contract with a third party. Taking this path helps to assure that close coordination among all of the community's computing resources, including GIS, is established and maintained for the long term.

If a community has no central computer systems "department", or dedicated (either town employee or contractor) "computer person", it will not have a "system administrator". In this situation the community will probably not be developing a GIS based on a central shared GIS

database. Instead, one person will be overseeing the GIS effort using a single PC, and any additional users will have copies of the GIS database and software on separate PCs.

3. Database Manager/Technician Function

Someone needs to do the hands-on work associated with data development, map conversion and/or quality assurance of contract data development, and data maintenance. If city or town employees currently do map maintenance strong consideration should be given to continuing that role when the GIS is implemented. In this case, the GIS technician role is being filled at least in part by one or more existing staff.

Contracting for data conversion and maintenance services is a viable and commonly used option. This option is not unlike arrangements that towns have used for maintaining their assessor's maps. The request for proposals for contracted services will need to identify very specifically the scope of services the contractor is to provide, the basis for their payment, the timeliness of their work, the standards of the work, and any other considerations involved in contracting for technology-based services.

Regional planning agencies as well as colleges and universities with established programs in GIS, may also be able to provide data development at very reasonable cost. Be sure that your procurement of conversion services from the college or university complies fully with state law. Also, make sure that the individuals involved have experience with the kind of work you want them to do. Regardless of what arrangements you make for contracted GIS services, it is important that your arrangement include a written detailed scope of work, a schedule by which the work will be completed, and a budget.

4. End-User Function

The end-user is the person who makes the maps and tabular reports and conducts analysis and queries. This person may be the same as the technician (where GIS is centralized and all requests for maps go to this person) or may be someone who is not involved at all in the data management. Typically, end-users are the regular existing staff of departments in your city or town.

As people start to use your GIS, you will find that the level of use follows a "pyramid model". At the base of the pyramid are the majority of the users; they will use the GIS occasionally and typically for a specific task or purpose. In the middle of the pyramid are a smaller number of users who will use the GIS to support more than one task. For example, they might produce abutter mailing labels and also a variety of map products. At the top of the pyramid are a limited number of users, perhaps one to three, who are the most proficient users of the software; this group includes the GIS technician or manager. They are capable of using most of its capabilities and of training others.

C. Training

Training for GIS has several aspects, related to the roles and responsibilities of the various staff that are participating in GIS.
The key at the beginning is that the community must be prepared to make a serious commitment to fund training. Under-investing in training will damage your efforts in GIS. There is no alternative to ample, appropriate training as each staff member requires. ALSO, training is useless if not immediately followed by regular job

related needs to use the GIS software and applications.

1. Technical Staff

The technical staff includes those with the roles of System Administrator and of GIS Technician. As previously discussed, in many communities, these jobs are performed by the same person.

The technical staff will need to obtain training in several different areas:

- GIS software
- database management software, if separate from the GIS application
- hardware, including the workstation, tape drives or other data storage devices, digitizer, and plotter
- related products, such as design software (like CAD), query tools (like SQL), or report generators and text editors
- Programming languages used by the GIS software. This kind of training will not be necessary for all communities and it may be more effective for this kind of work to contracted.

Training can be done by your software vendor, GIS consultant, by a college, or sometimes by a regional planning agency, or other qualified individual.

2. End-Users

Training for end-users needs to focus on non-technical subjects which will help these personnel carry out the basic GIS operations (viewing data, navigating the GIS software), map making, and basic analyses and other tasks which are most central to their respective responsibilities in the community.

This training needs to focus on:

- GIS software and applications,
- Making and printing maps, and
- Query tools and report generators.

3. Cost of Training

The cost of training does not have to be prohibitive. As mentioned above, there are numerous sources for training so take advantage of the more affordable options. Cost will be determined by the source, the level of knowledge of your staff, the sophistication of the GIS, and the location of the training. Having a vendor come to your community is generally more expensive than going to a central location, because off-site training means travel costs. Whether or not it is more cost effective to have a vendor do on-site training versus sending people off to training, depends on how many people are going to be trained. Generally, if you are going to train more than three or four people, it becomes more cost effective to bring the trainer to your site. Of course, this presumes you have a suitable facility available. Note that you may be able to make arrangements to use a computer facility at a local college or university.

Your annual training budget should include funding as follows:

- $1,500 - 3,000 per person for initial training of technical staff
- $500 - 1,000 per person annually for continuing training of technical staff

This assumes that the technical staff will be able to train end-users, both as they initially

learn how to use the GIS, and as new software releases add features and functions to the GIS products. If the technical staff will not do training, then budget between $500 - $1,000 every other year per person for training.

4. Training and the GIS Software Purchase

Your community's purchase agreement for GIS software should commit the vendor to a specific amount (“five days training each for up to three people”) and type (“Introduction to WhizBang GIS”, “Intermediate WhizBang GIS”, “Advanced WhizBang GIS”, etc.) of training for both technical staff and end-users. You should also agree ahead of time what location will be used for the training. This is your community's best opportunity for obtaining the best possible "deal" on training.

XI. FUNDING FOR GIS

However the funding is achieved, a multi-department GIS project is a long-term capital investment. Any formal initiation of a GIS project should make this clear from the beginning. In this way, elected or appointed officials cannot say they have been caught unaware when the time comes to authorize or appropriate the money.

A. Sources of Funding

Your community should explore various approaches to funding its efforts in mapping. These approaches might include seeking general funds through the annual budget process, multi-year capitol funds, pursuing grants from state and federal sources, and sharing costs with other organizations. Massachusetts communities have used all of these strategies for their GIS projects, sometimes in combination.

One note on borrowed (capitol) funding: Massachusetts communities can use bond money over a period of up to ten years to cover the cost of aerial photographs being used for preparing assessors maps (see MGL Ch 44, sect 7(18)). This source of funding could be used, at least in part, to cover the costs of developing an orthoimage basemap for a geographic information system.

1. State Funding Sources

Described below are state grant or revolving loan funding sources that have been used by Massachusetts communities for covering some of the costs of developing their geographic information system. They are presented here in no particular order.

- The Massachusetts Department of Environmental Protection has a loan and grant program to assist communities with water pollution control projects. For information on the 604(b) Water Quality Management Grant Program and the Clean Water State Revolving Loan Fund (no interest loans) go to http://www.state.ma.us/dep/brp/mf/mfpubs.htm. (Then click on link titled "Grant Programs and Additional Information." On the page that appears, scroll down to the downloadable document: "Grant and Loan Programs: Opportunities for Watershed Protection, Planning and Implementation"). Some Massachusetts communities have used these funds for GIS projects because water quality regulatory requirements could not be met without better map information.

- In 2002, MassGIS inaugurated a grant program to subsidize the cost of converting assessor's maps to GIS format. In the first round of funding under this program, 34 communities received between $2,000 and $25,000. Some of these communities requested that their regional planning agency apply for the grant and do the work on their behalf. MassGIS expects to fund additional rounds of these grants in coming years. More information about this program can be found on the MassGIS web site.

2. Other Funding Sources

- Public and Private Sector Public Safety Technology Grants – See Appendix E.

- ESRI State and Local Government Grants Program. – "ESRI believes that building better communities requires public private partnership opportunities. The pursuit of this goal results in a growing number of Livable Communities. These opportunities can help lessen the burden of governments by sharing expertise and resources, and often reduce the initial investment

capital. The results of these partnerships are programs and returns on the investments that both parties can benefit and learn from." For more information go to: http://www.esri.com/industries/localgov/grants/esri_grants.html

- Mapinfo Coporation's Homeland Security Grants – "MapInfo's grant program assists small to medium-sized municipalities (counties, cities, towns, villages, etc) in the United States to develop and deploy Homeland Security/Continuity of Government Plans and Initiatives." For more information go to: http://www.mapinfo.com/industry/government/homeland_security_grant.cfm

3. Cost Sharing Strategies

- *Partnerships* – Building partnerships can be one of the most effective ways to make your dollars go further; they can also bring additional expertise into your GIS project.

- *Neighboring communities.* Regional mapping may provide some economies of scale. A joint bid or RFR which provides a larger piece of work, generating more total revenue for the vendor, may produce savings for the participating communities over what they would have spent, had they proceeded individually.

- *Private firms.* Private utility companies, major realtors, or developers and others may be willing to contribute funds to this effort. The level of funds will depend on each party's perception of their own benefit. But, from the community's point of view, every dollar helps.

Additionally, private firms may provide gifts as corporate contributions. The advantage for the corporation is that these gifts will likely be tax deductible. Such gifts may take the form of a general grant of funds, funding for a specific purpose (such as conversion of maps) or the actual donation of hardware (such as workstations or printers) or software.

- *Non-profits or educational organizations*. Conservation organizations, community-based organizations, and colleges or universities, among others, may see value in the GIS. These organizations may also have endowments or major donors who would be interested in specific applications of GIS.

B. Who Pays and How Much

Where there are several funding sources and participants in the GIS, the parties need to find an equitable solution to cost sharing. This applies both to a) the one-time costs, such as database development (e.g., digital orthoimages or conversion of maps), as well as b) ongoing costs for maintenance.

In a fairly simple example, two communities may use relative population as a ready measure. Where there are disparate participants, measures of equitable sharing may be more difficult. An easier example may be assessing each participant the marginal cost of all layers for which it has control or which it has authority to use. Or, one may wish to look at the relative number of total authorized users or devices. None of these measures is perfect. The parties must be willing and able to come to an initial agreement and to re-negotiate periodically if patterns of use should change.

C. Funding and Marketing

At some point, the GIS project team will present a specific request for authorization and appropriation of funds to finance its recommendations.

As we emphasized earlier, there are several keys to success in funding. The Committee needs to:

- Present a plan that makes good sense to the community's leadership and the general public.

- Make the community's leadership aware from the start that there will be a request for funding.

- Plan and execute a carefully thought out program of public relations. This includes such steps as publicizing the GIS effort and its benefits at meetings of leaders in the community. You should have interested organizations in the community make their support known to the public and key officials.

D. Continuing Costs

Your community needs to budget very carefully for all of the costs that will be involved in supporting GIS from year to year. These include, among other things:

- *Software support.* Budget according to your vendor's specifications. This fee will vary from vendor to vendor. *Maintaining the annual support agreement for your software is absolutely essential.*

- *Hardware maintenance.* The trick with hardware is not so much what happens when the machine breaks, but what happens when the machine is obsolete. As with software, follow your vendor's specifications. Mail order houses offer good multi-year warranties.

- *Communications.* Meet with your provider of data communications tools in order to determine what the monthly cost will be for each communications-related service.

- *Printer.* This may be the piece of equipment that requires the most maintenance. Budget according to your vendor's maintenance agreement.

- *Staffing.* Budget as required for your staff's wages, benefits, and training.

- *Operating Expenses.* Budget for plotter paper, ink, specialized materials, computer and printer supplies, training, and other items which the GIS operation will require.

List of Appendices

APPENDIX A: GIS PROJECT ORGANIZING FORMS

GIS Users

	Name	Address	Phone
Administrator			
Assessor			
Board of Health			
Building Inspector			
City/Town Clerk			
Community Development			
Conservation Commission			
Engineering			
Finance			
Fire			
Housing			
MIS			
Planning			
Police			
Preservation			
Public Works			
School			
Tree Warden			
Water and Sewer			

GIS Project Team Participants

	Name	Address	Phone
Administrator			
Assessor			
Board of Health			
Building Inspector			
City/Town Clerk			
Community Development			
Conservation Commission			
Engineering			
Finance			
Fire			
Housing			
MIS			
Planning			
Police			
Preservation			
Public Works			
School			
Tree Warden			
Water and Sewer			
College or University			
Utility Company #1			
Utility Company #2			
Chamber of Commerce			
Realtor			
Regional Planning			
Conservation Trust			
Volunteer			
Public Library			
Historic Commission			
Regionall Planning Agency			

Appendix B: Organizational Resources

A. Commonwealth of Massachusetts

Below is contact information for state and regional with GIS programs as well as state universities and colleges with GIS programs.

Government and Quasi-Public

These agencies are available online at www.state.ma.us/massgov.htm

Coastal Zone Management – Dianne Carle, Data Manager, (617) 626-1222
Department of Environmental Management – Nathanael Lloyd, GIS Manager, (617) 626-1381
Department of Environmental Protection – Brian Brodeur, GIS Manager, (617) 574-6802
Department of Fisheries, Wildlife and Environmental Law Enforcement – Steve McRae, GIS Team Leader, (617) 626-1592
Department of Food and Agriculture – Barbara Hopson, GIS Manager, (508) 792-7712
Executive Office of Transportation and Construction (MasHighway), Bureau of Transportation Planning and Development, - Mark Berger - (617) 973-7340
MassGIS - (617) 626-1000
Massachusetts Geographic Information Committee (MGIC) - Paul Nutting, MassGIS, 617-626-1238
Massachusetts Historical Commission – Michael Steinitz, (617) 727-8470
Massachusetts Water Resources Authority – Glenn Hazelton, GIS Manager, (617) 305-5526
Metropolitan District Commission
Division of Watershed Management – Paul Penner, GIS Coordinator, (617) 727-5274 x 288

Regional Planning Agencies

Most of the regional planning agencies (RPAs) have one or more full-time GIS staff. The RPA GIS staff often work with communities on GIS related projects. The services and products they can provide vary; contact the individual RPAs or visit their web sites to learn more about their GIS services for towns and cities.

Berkshire Regional Planning Commission - (413) 442-1521 *web: www.berkshireplanning.org*
Cape Cod Commission - (508) 362-3828 *web: www.capecodcommission.org*
Central Massachusetts Regional Planning Commission - (508) 756-7717 w*eb: www.cmrpc.org*
Central Transportation Planning Staff - (617) 973-7077 *web: www.ctps.org*
Franklin Regional Council of Governments - (413) 774-1199 *web: www.frcog.org*
Martha's Vineyard Commission - (508) 693-3453
Merrimac Valley Planning Commission - (508) 374-0519 *web: http://www.mvpc.org/services_sec/gis1.htm*
Metropolitan Area Planning Council - (617) 451-2770 *web: www.mapc.org*
Montachusett Regional Planning Commission - (978) 345-7376 *web: www.mrpc.org*
Nantucket Planning and Economic Development Commission - (508) 228-7237
Northern Middlesex Area Council of Governments - (508) 454-8021 *web: www.nmcog.org*
Old Colony Planning Council - (508) 583-1833 *www.ocpcrpa.org*

Pioneer Valley Planning Commission - (413) 781-6045 *web: www.pvpc.org/gis/html/gis_services.html*
Southeastern Regional Planning and Economic Development District - (508) 824-1367
web: www.srpedd.org

Colleges and Universities

Boston University, Environmental Remote Sensing and Geographic Information Systems Program,
http://www.bu.edu/cees/academics_gra.html
Holyoke Community College, Associates Degree in GIS Technology,
http://www.hcc.mass.edu/CATALOG/geographic_info_systems.html
Salem State College
Department of Geography – (978) 542-4228, web: www.dgl.salem.mass.edu/ms
Resource Mapping (Formerly the MacConnell Land Use Mapping Project) - (413) 545-3589
Office of Geographic Information, The Environmental Institute - (413) 545-2842
University of Massachusetts at Amherst, www.umass.edu
Earth Science Information Office - (413) 545-0359
University of Massachusetts at Boston
Department of Geography - (617) 287-5280 *web:* www.umb.edu
Westfield State College, Department of Geography, Certificate in GIS
http://www1.wsc.ma.edu/garp/HANDBOOK/handbook.pdf (scroll down to information on certificate program)

Note that there may be GIS courses and degree programs available in adjacent New England states that are more convenient for you to reach.

B. Selected National, Regional, and State Professional Associations

American Congress on Surveying and Mapping (ACSM)
6 Montgomery Village Avenue, Suite 403
Gaithersburg, MD 20879
(240) 632-9716 *web:* www.ascm.net

American Society of Photogrammetry and Remote Sensing (ASPRS)
5410 Grosvenor Lane, Suite 210, Bethesda, MD 20814-2160
(301) 493-0290 *web:* www.asprs.org

Geospatial Information and Technology Association (GITA)
14456 E. Evans Ave., Aurora, CO 80014-1409
(303) 337-0513 *web:* www.gita.org

Massachusetts Association of Assessing Officers, GIS Committee
Contact Dave Beck, Assessor, Town of Hull, 781-925-2205, maaogis@yahoo.com

Urban and Regional Information Systems Association (URISA)
1460 Renaissance Drive, Number 305, Park Ridge, IL 60068
(847) 824-6300 *web:* www.urisa.org

New England Chapter , Geospatial Information Technology Association
C/o Dennis Brown, Principal Engineer, Duke Energy
dhbrown@duke-energy.com, 617 560 1374

New England Chapter of URISA (NEURISA)
Web. www.neurisa.org

Appendix C: Internet Resources

The internet has huge and diverse array of resources for GIS. These range from introductory explanations, to sample request for proposal (RFP) documents, to free data and software. Below is a list of resources known to be useful. There are many, many others and the number of useful sites will continue to grow. The web sites listed here all existed as of August 2002.

A. Massachusetts Sites

MassGIS
Also known as the Massachusetts Office of Geographic and Environmental Information
www.mass.gov/mgis

The Commonwealth of Massachusetts
This Commonwealth's "internet portal" is where you can find a listing of and links to other state agencies – www.mass.gov

B. A Selection of General GIS and Geography Resource Sites

http://www.mayko.com/hugo/ - The web site of the "Free GIS Project".
http://faculty.washington.edu/chrisman/explor/glossary.html - an excellent glossary of GIS related words.
www.gis.com – Great introduction to GIS
http://info.er.usgs.gov/research/gis/title.html - USGS site introducing GIS.
www.geo.ed.ac.uk/home/giswww.html - an index of GIS sites world wide
www.geographynetwork.com - A global network of GIS users and providers
www3.sympatico.ca/mkostiuk/gispage.html - MANY links to GIS web sites
http://www.geoplan.ufl.edu/software.html - GIS Software and resources.
http://www.gislinx.com - Categorized List of GIS Sites
http://www-sul.stanford.edu/depts/gis/web.html - Standford University Web Sites for Digital GIS Data
http://www.geojobsource.com/homepage.htm - Geo Job Source - GIS Jobs Around the World
http://lcweb2.loc.gov/ammem/gmdhtml/gmdhome.html - Library of Congress Map Collections
http://www.topozone.com/ - On-line USGS quad maps.
http://www.gisdatadepot.com - GIS Data Depot, Free, worldwide GIS data
http://mapping.usgs.gov - USGS National Mapping Information
http://www.gisportal.com/ - Self proclaimed "GIS Portal" site.
http://www.census.gov/geo/www/faq-index.html - This is the US Census Bureaus list of "frequently asked questions" (with answers): a useful site.

C. On-Line GIS Publications

Note that most of these sites also enable you to sign up to receive email newsletters.

Directions Magazine - http://news.directionsmag.com/
GIS Café - http://www.giscafe.com/
GIS Monitor - http://www.gismonitor.com/
GIS.About - http://gis.about.com/
GeoCommunity - http://www.geocomm.com/
SpatialNews - http://www.spatialnews.com/
GeoPlace.Com - http://www.geoplace.com/gw/

D. Massachusetts City and Town Sites with GIS or Mapping Pages

Many towns and cities have maps on their web sites. These maps range from static "pictures", to interactive mapping capabilities where you can choose to display the map features you want for the area you want. Some of the many cities and towns with maps on their web sites include:

City of Cambridge - http://gis.ci.cambridge.ma.us/
City of Boston - http://www.cityofboston.gov/bra/maps.asp
City of Fitchburg - http://www.ci.fitchburg.ma.us/
City of Newton: http://www.ci.newton.ma.us/
City of West Springfield - http://www.west-springfield.ma.us/gis/default.htm
Town of Concord – See "Concord WebGIS" at http://www.concordnet.org/
Town of Weymouth -http://weymouth.appgeo.com/PropertySearch.asp

E. Professional Organizations

See Appendix B

F. Partial List of GIS Software Vendors

(List does not include software for which the primary focus is "business geographics"

AutoDesk – Autodesk Map, Autodesk MapGuide: www.autodesk.com
Caliper Corporation – Maptitude, Maptitude for the Web, TransCAD: www.caliper.com
ESRI – ArcGIS (formerly ArcInfo), ArcView, ArcIMS, Atlas GIS, others: www.esri.com
Intergraph – GeoMedia (a suite of products): http://www.intergraph.com/gis/
GE Network Solutions – Smallworld GIS:
http://www.gepower.com/dhtml/network_solutions/en_us/gis_solutions/index.jsp
Mapinfo Corporation – MapInfo, MapInfo MapXtreme: www.mapinfo.com

G. Free GIS Software and Resources

There is a "Free GIS" web site - http://www.mapcruzin.com/free_gis.htm

For a discussion of these free GIS software packages, see Section IV of this document.

Arcexplorer – This product is available for free on the web site of the Environmental Systems Research Institute (ESRI; the download site is http://www.esri.com/software/arcexplorer).
MassGIS Runtime Data Viewer - You can learn more about the Data Viewer and order it from the MassGIS web site at Mass.Gov/mgis/viewer.htm (no http://www required). Installation information, some training documents, and other assistance are also available on the MassGIS site.
GRASS – Information about GRASS, and the software, can be found at http://www.baylor.edu/grass/index2.html

H. Videos

Although they were created in 1996, these videos are still a useful resource.

1996 New England Geographic Information (GIS) Technology Conference, *An Introduction to Geographic Information Systems for Municipal Officials.* Department of Housing and Community Development, Boston, MA. (617) 727-7001 x 443.

1996 New England Geographic Information (GIS) Technology Conference, *Conducting a GIS Needs Assessment: a Hands on Approach.* Department of Housing and Community Development, Boston, MA. (617) 727-7001 x 443.

Appendix D: Needs Analysis Forms

A. Primary Functions

Office/Department/Organization _____

Contact _____ Phone _____

Please describe the primary functions, or mission, of your Department or Office. This information may be derived from your annual budget justification documents. (Please use additional paper as needed.)

Land Related (Functions involving maps and other records about land/facilities (e.g., property, pipes, precincts) or at locations (e.g, permits, students)

_____

_____

_____

_____

_____

_____

_____

_____

_____

Other Functions

_____

_____

_____

_____

_____

_____

_____

B. Map Use/Maintenance

Office/Department/Organization _____

Contact _____ Phone _____

Please indicate characteristics and features of each map that your office uses, maintains, or updates. Complete a form for each map or map set. Identify and attach a sample map copy, index map, and map legend.

Official Map/Map Set Name _____

Common Map Name _____

Scale _____ Sheet Size _____ # Sheets in Set _____

Source _____ Accuracy (+/- ft., if known) _____

Area of Coverage _____

Features Shown _____

Media: Paper _____ Mylar _____ Linen _____ Sepia _____ Other _____

Are the map features computerized? ____ If yes, Using what software (GIS, CAD, consultants)?

_____

What do you use this map for? _____

_____

How often do you use this map? _____

Who updates this map? _____

Briefly explain procedures for updating _____

_____

Source of updates _____

How often is it updated? _____

List any inaccuracies or inadequacies in the mapping _____

_____

C. Database/Record

Office/Department/Organization _____

Contact _____ Phone _____

Please indicate the characteristics and features of each database or record (including card files) in a file cabinet that your office utilizes, maintains, or updates. Complete a form for each database set. If a blank copy is available, please attach a copy to this form.

Database/Record Name _____

Do you maintain this database/record? _____ Yes _____ No

If no, who maintains it? _____

Computerized (Yes/No)? ____ Do you Share this database with another dept.? ____

If database shared, are there any Problems with Sharing the Data? What? _____

_____

Reference to location is: ____Property ID ____Address ____Other

If computerized:

Software type? _____

Database on what kind of computer: _____

Approximate # of current records _____

Approximate number of new records added annually: _____

# of people needing access to this information _____

Any problems/issues with the current system? _____

_____

If not computerized:

Approximate # of paper files _____

Approximate number of new records added annually: _____

Frequency that files are updated _____

# of people needing access to files _____

Location of files _____

Would you like to have these files computerized? _____ Yes _____ No

D. Personal Computer Inventory

(Complete what you can)

Department: _____

Location: _____

Main User(s): _____

Manufacturer: _____

Model: _____

Processor (Pentium II or III, etc.): _____

RAM (amount in megabytes): _____

Operating System: ___ Windows 95 ___ Windows98 ___Windows 2000 ___Windows XP ____ Mac

Monitor (size, max screen resolution): _____

Graphics card type: _____

Hard Drive Size (MB of storage): _____

CD-ROM drive?: _____ Zip drive? _____

Linked to a Network (Yes/No): _____

Other Information: _____

E. Printer Inventory

(Complete what you can)

Unit Number: _____

Department: _____

Location: _____

Main User(s): _____

Manufacturer: _____

Model: _____

Type (inkjet, laser, etc.): _____

Speed (pages/min): _____

Carriage Width (paper size): _____

Memory in MB: _____

Color (Yes/No): _____

Sheet Feed or Roll Feed: _____

Paper Trays: _____ Letter _____ Legal
_____ Single Tray _____ Dual Tray

Linked to a network (Yes/No): _____

Other Information: _____

_____

F. Software Inventory

Your Name: _____
Department Being Inventoried: _____

Product Name	Manufacturer	Release/ Version		Number of Licensed Users	Comments

G. Data Communications Inventory Form

Use this form for communications-related equipment such as: modems, multiplexors, communications servers, communications lines (dial-up or leased), communications software, and building cabling.

Item	Manufacturer or Supplier	Model	Speed	Date Installed	Comments

H. Desired Mapping

Please indicate each feature that you desire to have included for each mapping application. Classify each feature as **E** (essential map feature, used often) or **L** (limited interest, occasionally used). Indicate the desired scale for each feature. All scales are measured as inches to feet (1" = XX'.)

Natural Features	**Scale**
_____ Rivers and Streams	1:____
_____ Lakes and Ponds	1:____
_____ Spot Elevations	1:____
_____ Contours	1:____
_____ Vegetation	1:____
_____ Soils	1:____
_____ Floodways	1:____
_____ Floodplains	1:____
_____ Slope	1:____
_____ Trails	1:____
_____ Wetlands	1:____

Streets/Transportation	**Scale**
_____ Street Pavement Edges	1:____
_____ Street Rights-of-Way	1:____
_____ Street Center Lines	1:____
_____ Street Names	1:____
_____ Railroads	1:____
_____ Highways	1:____
_____ Bridges	1:____
_____ Traffic Signs/Signals	1:____
_____ Parking Lots	1:____
_____ Driveways	1:____
_____ Sidewalks	1:____
_____ Curbs	1:____
_____ Gutters	1:____
_____ Bikelanes	1:____
_____ Bike Paths	1:____
_____ Traffic Zones	1:____
_____ Airports	1:____
_____ Rights-of-Way	1:____
_____ Easements	1:____

Structures/Facilities	**Scale**
_____ Flood Control Devices	1:____
_____ Drainage Structures	1:____
_____ Storage Tanks	1:____
_____ Dams	1:____
_____ Schools	1:____
_____ Parks	1:____
_____ Recreation Fields	1:____
_____ Fire Stations	1:____
_____ Police Stations	1:____
_____ Religious Buildings	1:____
_____ Hospitals	1:____
_____ Cemeteries	1:____
_____ Surveys/Monuments	1:____
_____ Hydrants	1:____
_____ Utility Poles	1:____
_____ Municipal Buildings	1:____

Planning and Zoning	**Scale**
_____ Land Use	1:____
_____ Zoning	1:____
_____ Blocks	1:____
_____ Census Tracts	1:____
_____ Fire Districts	1:____
_____ Neighborhoods	1:____
_____ City Boundaries	1:____
_____ Police Districts	1:____
_____ School Districts	1:____
_____ Special Taxing Districts	1:____
_____ Permit Sites	1:____
_____ Historic Sites	1:____
_____ County Boundaries	1:____
_____ Regional Boundaries	1:____
_____ Overlay Districts	1:____
_____ Conservation Restrictions	1:____
_____ Agricultural Pres. Restrict.	1:____

Water	**Scale**
_____ Water Mains	1:____
_____ Feeder Lines	1:____
_____ Service Lines	1:____
_____ Valves	1:____
_____ Pump Stations	1:____
_____ Treatment Plants	1:____
_____ Man Holes	1:____
_____ Easements	1:____
_____ As-Builts	1:____
_____ Sprinklers	1:____
_____ Meters	1:____
_____ Taps	1:____
_____ District Lines	1:____
_____ Hydrants	1:____
_____ Wells-Public	1:____
_____ Wells-Private	1:____
_____ Tanks	1:____

Storm Sewer	**Scale**
_____ Underground Lines	1:____
_____ Open Ditches	1:____
_____ Culverts	1:____
_____ Pump Stations	1:____
_____ Catch Basins	1:____
_____ District Lines	1:____
_____ Man Holes	1:____

Sewer	
_____ Man Holes	1:____
_____ Force Mains	1:____
_____ Treatment Plants	1:____
_____ Public Connections	1:____
_____ Private Connections	1:____
_____ Risers	1:____
_____ District Lines	1:____
_____ Sewer Mains	1:____
_____ Sewer Lines	1:____
_____ Pump Stations	1:____

Political Districts	**Scale**
_____ Local Election Districts	1:____
_____ State Election Districts	1:____
_____ Federal Election Districts	1:____
_____ Precincts	1:____

Other	**Scale**
_____	1:____
_____	1:____
_____	1:____
_____	1:____
_____	1:____
_____	1:____
_____	1:____
_____	1:____
_____	1:____
_____	1:____
_____	1:____

I. Available Digital Data

File Name	Department in Charge		Software Program	Number of Records	MB of Disk Space Used	Comments

Appendix E: Example Departmental GIS Needs Analysis

Town of Northborough
Engineering Department

Contact
Jack Perreault, Town Engineer

Mission/Responsibilities

The Engineering Department deals with all aspects of development from beginning to finish; therefore, the functions of this department are multi-disciplined. An ever increasing strong growth in Northborough; the ever increasing mandates of federal, state, and regional government; and the necessity to interact with numerous town departments increases the need for this department to have state-of-the-art capabilities.

The department works with the Town Planner and Planning Board with subdivision activity from preliminary design, to installation of infrastructure, to acceptance as public streets, as well as assisting with the calculation of bonds. Another responsibility of this department is to assist the Conservation Commission. These functions are processing construction filings; developing and adopting local wetlands regulations to supplement the existing state regulations; and developing landscaping plans for parks, cemeteries, etc. The department assists Water and Sewer Departments with well, sewer and watermain design. Also, Engineering reviews calculations and plans for projects within the Groundwater Protection Overlay Districts and designs roadway improvements and drainage projects.

Geographic Processes

- Subdivision locations
- Parcel location
- Construction sites
- Wetland sites
- Groundwater districts
- Flood control zones

Maps Used and/or Generated

Assessors' Maps - The Assessors' maps are used daily for identifying and locating real estate. There are currently 149 Assessors' maps at scales of 1" = 100 and 1" = 200. These maps are 24" x 36" and are mylar-based.

The updating process is completed in and by the Engineering Department. The information for updating is obtained from subdivision plans, plats, and new surveys.

Town Street/Base Map - Town street map was prepared by American Air Surveys (1965), using photogrammetric processes, at a scale of 1" = 1000'. The Engineering Department manually updates this map using information from subdivision plans, plats, and new surveys.

Zoning Map - Zoning information originating from Planning Board activities is used to develop an overlay to the official Town Street Base Map. This zoning map is mylar based, at a scale of 1" = 1000'. The size of the map is 32" x 36".

Ground Water Map - The ground water map is produced using aquifer information from geological surveys and other sources. This information is plotted as an overlay to the Town street map. A scale of 1” = 1000' is used for this mylar-based map. The sheet size is 36” x 42".

FEMA Maps - The U. S. Government produces the FEMA maps at a scale of 1" = 400'. There are seven (7) sheets in the set of maps covering the Town of Northborough. These maps are used by the Engineering Department to determine the location of flood zones.

USGS Quad Sheets - The maps are produced by USGS Geological Survey. The sheets are formatted in 7.5 x 15.5 minutes of longitude and latitude. The sheet size is 24" x 38". These sheets are used to reference topographic information for determination of elevations. The contour interval is three (3) meters. One sheet encompasses the Town of Northborough and surrounding areas.

Maps Used/GIS Suitability

Name	*Scale*	*GIS Suitability*	*Comments*
Assessors' Maps 1" = (149 Sheets) orthophoto) map	1" = 100' 1" = 200'	Fair	An accurate base (l" = 100' or 200' planimetric or is required to properly reference these maps to real-world locations.
Town Street and more accurate scale. (1 Sheet)	1" = 1000"	Poor Base Map	This map should be updated prepared at a
Zoning Map and used street/base map.	1" = 1000'	Fair	This data could be digitized as an overlay to the
Ground Water Map and used street/base map.	1" = 1000'	Fair	This data could be digitized as an overlay to the
FEMA Maps (7 Sheets)	1" = 400'	Poor	These maps should be digitized and adjusted to a more accurate base.
USGS Quad Sheet digital the Regional Planning	1" = 2000'	Good	These maps are available in format from Agency.

Desired Mapping

Street Map - An accurate, up-to-date, digital street map is desired to be the base to which many databases could be linked. This street map should contain the correct address linkages to allow all departments to use the information in spatial analysis. This map should be developed at a scale of 1" = 100' or 1" = 200' if it is to be used for accurately referencing utilities or property line information.

Assessors' Mapping - The Assessors' maps should be referenced to an accurate base map and should be automated. The maps could be automated at existing scales or the scales could be enlarged where necessary. The ability to update the maps digitally would reduce the amount of time currently required to manually draft updates onto the mylar master prints.

Wetlands Maps - The wetlands information should be mapped onto an accurate base and should be automated to allow ready reference to the location of delineated wetland areas. This mapping information would be one of several layers of mapping. This combining of layers would greatly reduce the amount of time required to verify information required for various permitting processes.

Topographic Mapping - Topographic mapping with contour intervals of 2' or 4' is desired. This particular mapping would provide vital information on storm water runoff, drainage basins, retention areas, preliminary design of sewer outfalls, etc. Topography would also be valuable in the review and approval of subdivision plans.

Utility Mapping - The process of locating of utility information onto an accurate base would allow the department to more efficiently facilitate the management and maintenance of utility lines. The ability to overlay this information with other mapping information would reduce the amount of time required to verify information for permitting and inspection processes.

Potential GIS Applications

There are several primary uses for GIS in the Engineering Department

1. The ability to readily review and analyze several sources of information at one time would greatly reduce the effort required to prepare for hearings and enforcement activities.

2. The digital updating of mapping information would reduce the work demands on the assistant engineer and allow other departments to have updated maps on a **more** timely schedule.

3. Response time to citizens' requests for information would be reduced significantly by having access to multiple maps and databases at one time.

4. The ability to connect data (common drives, one-way designations, speed limits, etc.) to street and parcel databases would provide ease of identification and management of these important files.

5. The ability to exchange digital data with the Regional Planning Agency would further enhance and improve the effectiveness of this office.

APPENDIX F: Public Safety Technology Grant Programs

A. Massachusetts Executive Office of Public Safety Grant Programs

http://www.state.ma.us/eops/program_list.htm

The Edward Byrne Memorial Grant in particular mentions technology funding.

B. United States Department of Justice, Office of Justice Programs

http://www.ojp.usdoj.gov/fundopps.htm

Two programs in particular that have been mentioned in the context of technology funding are:

1) Community Oriented Policing Service (COPS) Grant Program

http://www.usdoj.gov/cops/gpa/default.htm
US Department of Justice 1-800-421-6770

COPS MORE (Making Officer Redeployment Effective). This program is designed to get officers out from behind a desk and into their neighborhoods practicing community policing, COPS MORE makes that possible through the funding of technology, equipment, and support personnel. Since COPS MORE grants were first awarded (they were awarded in '95, '96 and '98) over 4,500 agencies have received grants, totaling almost $900 million. Examples of items funded through these grants include mobile data terminals that allow officers to access information from the field, central processing units that allow officers to expedite the booking of arrests, mapping software, and the hiring of booking clerks, dispatchers and other support personnel.

2) Making Officer Redeployment More Effective (MORE) Grant Program

http://www.cops.usdoj.gov/gen/resources/appkit.htm

Grant funding is available to U.S. law enforcement agencies for the purchase of information technology systems.. COPS MORE is intended to support an increase in the amount of time that an agency's officers are deployed in a community policing capacity due to technological enhancements, and subsequent gains in efficiency. The MORE grant program will only provide funding for the following general categories of technology:

- Mobile computing systems
- Personal computer systems
- Computer aided dispatch systems
- Record management systems
- Crime analysis hardware/software
- Automated booking systems
- Automated fingerprint identification systems
- Video arraignment systems

C. U.S. Department of Commerce, Office of Telecommunications and Information Applications

The Technology Opportunities Program (TOP) is a highly-competitive, merit-based grant program that brings the benefits of digital network technologies to communities throughout the United States. TOP grants have played an important role in realizing the vision of an information society by demonstrating practical applications of new telecommunications and information technologies to serve the public interest. For more information go to:

http://www.ntia.doc.gov/otiahome/top/whoweare/whoweare.htm

Technology Opportunities Program
Office of Telecommunications and Information Applications
National Telecommunications and Information Administration
U.S. Department of Commerce
1401 Constitution Avenue, NW
Room 4092
Washington, DC 20230
Email: top@ntia.doc.gov
Phone: (202) 482-2048

D. Whitehouse Office of National Drug Control Policy

Web site page on grant sources

http://www.whitehousedrugpolicy.gov/policy/grants/contents.html

Responding to Drug Use and Violence:
A Directory and Resource Guide of Public- and
Private-Sector Drug Control Grants

(scroll down page to heading for Department of Justice)
Sixteen grant programs listed, including some that fund technology.

E. National Criminal Justice Reference Service

Grants and Funding Information: http://www.ncjrs.org/fedgrant.html