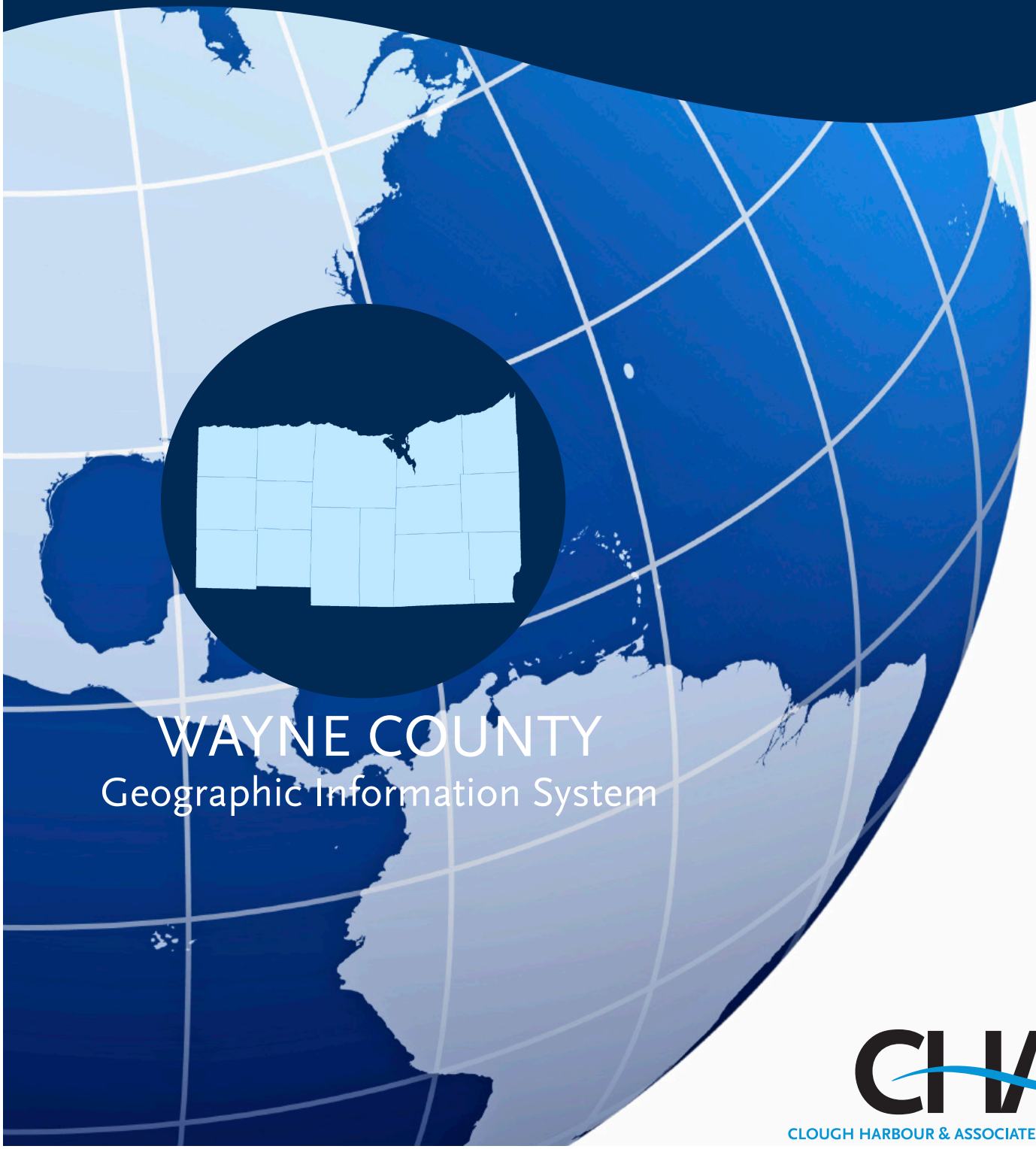
Conceptual System Design Report



WAYNE COUNTY
Geographic Information System

CLOUGH HARBOUR & ASSOCIATES LLP

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Introduction

Wayne County has contracted Clough Harbour & Associates LLP (CHA) to prepare a Geographic Information Systems (GIS) Needs Assessment and Implementation Plan. The primary objective of this initiative is to identify and document opportunities for using GIS technologies to better access, share, preserve, and protect the County's spatially oriented records and information.

This Conceptual System Design Report is the second in a series of three reports summarizing the findings and recommendations generated during the Needs Assessment process. The purpose of this document is to provide a high level overview of the system architecture and components required to support the applications identified in the Needs Assessment Report. The report will explore various alternatives for implementing these components, including the types of hardware, software and data that may be needed. The conceptual specifications presented in this document will then be refined in greater detail in the final Implementation Plan Report.

Summary of Implementation Goals and Objectives

In order to better evaluate the suitability of various alternative GIS architecture and application deployment options it is critical to first clarify the ultimate objectives of the intended system. These objectives may then be used as a benchmark against which to measure the relative value and feasibility of the available design options. During the Needs Assessment process, County representatives established a set of primary goals they hope to achieve by implementing a new GIS system. CHA then categorized these objectives based on the four primary components of a GIS, which include data, software, hardware and personnel.

Data

- Improve the accuracy of core base mapping layers, such as tax parcel boundaries and street centerlines
- Improve the availability, timeliness and accuracy of records and geographic information
- Establish standardized data maintenance, storage, and backup procedures to ensure data is kept current
- Provide the public with access to commonly requested records and information
- Leverage existing, freely available GIS datasets from the State, County and other sources
- Develop metadata and standards for formatting newly developed GIS layers
- Maintain the confidentiality and security of sensitive data layers
- Provide municipalities and the public with access to most commonly requested data sets

Software

- Provide simple, user-friendly tools to help staff and the public access GIS data
- Use web-based applications where possible to make data accessible to a wider audience
- Minimize long term software maintenance and licensing costs

Hardware

- Minimize long term hardware maintenance needs and costs
- Supplement the County's existing computer network and equipment as needed to support the proposed GIS applications

Personnel

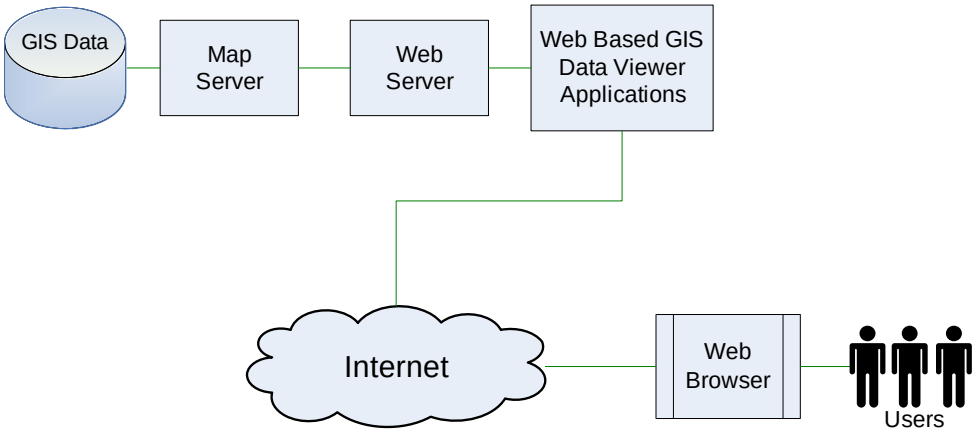
- Establish a dedicated GIS Administrator position to coordinate countywide GIS activities
- Provide adequate training to all staff as needed
- Develop clearly defined system maintenance roles and responsibilities
- Establish a standing GIS Steering Committee

Overview of GIS Deployment Options

In today's GIS market there is a wide range of software programs, hardware devices and data formats available in a seemingly unlimited array of potential configurations. Each of these options comes with its own set of associated benefits, limitations and costs. Although it is impossible to provide a comprehensive and detailed description of all of the potential architecture configurations and components available, the following section has been included to offer an overview of some of the most common deployment strategies in use today.

Web-Based GIS

Web-based GIS applications make it possible to deliver GIS maps and data to individuals using only a web browser. Users may access these applications over the Internet or via a local Intranet connection. The maps may either be static graphics (such as .pdf or .jpg files), or interactive applications that allow users to zoom in and out, turn layers on and off and perform basic inquiries. Interactive web-based GIS applications utilize central map and web server technologies to manage information requests and deliver maps and data to remote users. The following diagram shows a typical configuration for a web-based GIS:



A web-based architecture offers many **advantages** including:

- Applications are accessible at any time from any location with Internet connectivity
- Users do not require high-end PCs or specialized software
- An unlimited number of users can access web-based applications without incurring additional software or licensing charges
- Application updates are made on a centralized server and can be rolled out to all users simultaneously with minimal effort
- Most applications are compatible with multiple data formats
- Web-based applications tend to be more user friendly than standard commercial desktop products, and do not require users to have advanced GIS training

Web-based applications also have some key **disadvantages** including:

- Web GIS applications typically offer limited functionality, and functions such as editing data and conducting complex spatial analysis are not well suited for this environment
- Printed map quality may be limited
- Performance may be diminished if bandwidth is limited
- Server hardware and software can be complex, and costly to maintain

In recent years the proliferation of on-line mapping applications such as Google Earth and Microsoft Virtual Earth has helped bring GIS technology to the mainstream population. These types of applications include many of the basic features found in traditional GIS software programs, and allow users to view maps and aerial imagery, zoom, pan, search for features and addresses, overlay data, and in some cases create or import custom data layers. Often these applications can be customized using Application Programming Interfaces (APIs) provided by the software vendors that supply these applications.

These types of applications are easy to access and use, and provide much of the functionality required for basic GIS users. However, the ability to integrate custom data layers and provide more advanced GIS capabilities is limited. As these applications continue to develop, these types of features may become more readily available. Due to licensing restrictions, users accessing Google Earth for business purposes must use the software's Pro version, which costs $400 per user, per year.

For users wishing to develop more complex custom web-based mapping applications, a number of web GIS application development tools are available. These include commercial programs such as ESRI ArcGIS Server and ArcIMS, MapInfo MapXtreme, and AutoDesk MapGuide, as well as non-proprietary open source technologies such as MapServer. Typical proprietary commercial web map server products cost between $10,000 - $15,000 with annual maintenance fees ranging from $4,000 - $8,000. A web server program such as Microsoft IIS is also required and may cost an additional $5,000 - $8,000.

Desktop GIS

Desktop GIS software programs are available in a variety of formats including traditional multi-functional mapping applications, lightweight read-only data viewers, and customized component-based solutions. These applications run on desktop PCs and allow users to access data on a local hard drive or shared server.

Versatile commercial software packages such as ESRI ArcView and MapInfo Professional offer robust GIS capabilities. These programs enable users to view and edit geographic data, produce high quality cartographic maps, and perform advanced spatial analysis. They also accept a fairly diverse set of data formats. Desktop packages of this caliber typically cost in the $1,500 - $2,000 range with annual maintenance fees of $400 - $500. The power of desktop applications may be extended by utilizing vertical add-ons and extensions that provide supplementary tools for specific applications. Many of these tools are free or low-cost utilities which provide simple productivity enhancements for GIS users. Specialized, commercially available extensions and desktop software programs are also available for selected applications such as asset management, routing, build-out analysis, and water/sewer system modeling. Pricing for these applications varies based on application type and system size.

Desktop products offer many **advantages** including:

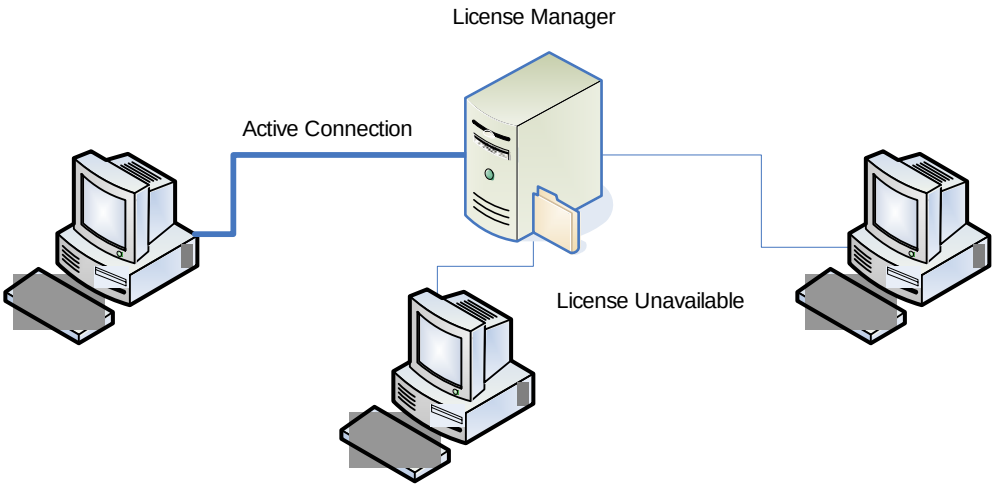
- Advanced capabilities and powerful functionality “out of the box"
- Internet connectivity is not required
- Performance is not dependent on bandwidth

The **disadvantages** of traditional desktop applications include:

- Licensing costs are high on a per user basis compared to web-based GIS
- PCs with higher specifications are required
- More advanced user training is required

<u>Concurrent vs. Stand Alone Licensing</u>
Some desktop software vendors offer concurrent or “floating” licensing options for added flexibility. This allows multiple desktop users to share a single software license. Under this configuration a license manager program and hardware key device are loaded on a central server. Users connect to the license server when opening their GIS software to determine if any open licenses are available. If all licenses are in use, the user is denied access until another user closes out of the program. This configuration works best in a scenario where there are 2-4 users who require access to the software on a limited basis. Floating licenses typically range between $3,500 and $4,500 per seat, but the application may be loaded on as many PCs as desired. Annual maintenance fees may cost $500 - $600.

The following diagram illustrates a concurrent-use licensing model:



The **advantages** of concurrent licensing include:

- Allows multiple users to share access to a single software license
- Per user costs can be lower than stand-alone deployments because software and maintenance costs are spread out across multiple users

The **disadvantages** of concurrent licensing include:

- Managing the license server requires some additional administrative effort
- Usage and available licenses must be balanced to prevent users from being denied access

Free Data Viewers

Free read-only desktop applications such as ArcReader and ArcExplorer are also available. These programs provide basic map viewing, inquiry and printing capabilities, but restrict users from performing editing and advanced analysis. They offer many of the same features and limitations as web-based systems, but are deployed for local use rather than accessing data from a web server.

Customized Component Based Solutions

As an alternative to off-the-shelf products, customized component-based applications may also be developed. These applications require programming efforts to customize existing commercial products or to develop new applications from scratch. Custom applications are developed using programming languages such as ESRI ArcObjects or MapInfo MapBasic.

The **advantages** of custom built desktop applications include:

- Applications may be tailored to very specific needs and uses

- Applications may be integrated with other non-GIS municipal systems (e.g., accounting, work order management, etc.)
- Licensing costs may be lower on a per user basis than deploying traditional desktop programs
- Simplified applications may be created that limit the need for advanced training

The **disadvantages** of custom built desktop applications include:

- Development and programming costs may be expensive for complex solutions
- Maintenance costs are typically higher

Conceptual System Design Recommendations

Through the Needs Assessment process, the County has identified a number of core GIS applications that will undoubtedly help staff and the public access information more quickly and efficiently. These applications were selected for inclusion in the Conceptual System Design because they offer the greatest potential benefit to the largest number of users, and because they address critical priority needs identified by County staff. The selected applications include:

- Web-based GIS Data Viewer (for the Public)
- Web-based GIS Data Viewer (for Staff Only)
- Routing Application
- Publisher/ArcReader
- Mailing List Application
- Highway Culvert Map
- Crime/Accident Analysis Application
- Emergency Management Planning Application
- CommunityViz

Before these items are implemented, the County must ensure that the underlying data, hardware, software and personnel are in place to support these applications. The following sections include a summary of the requirements that the County will need in each of these areas.

Data

Assembling a core set of accurate and complete base mapping layers is currently the most urgent requirement for Wayne County. The County Planning Department has already begun the process of assembling a library of available GIS data, and many of the required data sets are already available from the State, local governments or other sources. The County also has access to recent aerial photography through Pictometry and the NY State Digital Orthoimagery Program (NYSDOP). However, the County's existing GIS based tax map layer will require a significant effort to correct the alignment problems found within this dataset. These alignment problems date back to the original Mylar source maps that were created in the 1960s, and were passed on during the conversion of the maps to digital format in 2001. As a result, parcel boundaries are off

by as much as 150 feet in some areas, and buildings and structures visible on aerial imagery appear well outside of the correct property boundaries in many cases.

Correcting these problems may be accomplished through a variety of methods. Because the direction and distance of the alignment errors are inconsistent throughout the County, global solutions such as re-projecting the data layer or applying a universal coordinate shift are not feasible. Instead, areas must be addressed on a case-by-case basis. The County has indicated that survey level accuracy is not required for the tax parcel boundaries, as they will be used primarily for general information and planning purposes. The County may therefore be able to realize significant cost savings by using aerial imagery to "best fit" the parcels to visible, known landmarks such as fence lines, stone walls or pavement edges. This methodology would allow the County to avoid the expense of conducting extensive deed research and field verification to pinpoint the exact location of the property lines.

As individual property lines are adjusted, abutting parcels will also be affected in a cascading manner. This may be particularly problematic in very rural and undeveloped areas where there are few landmarks. Boundary line adjustments will also result in changes to the coordinates of the parcel centroids. These coordinates currently provide the basis for the unique numbering system used by the County to identify individual properties, and are also referenced in numerous other County systems. To avoid data corruption and broken linkages to these systems it is suggested that the County maintain these values in a historic Parcel ID field. A separate field for the new parcel ID may then be established. Future relational database systems may be linked to this ID, while older legacy systems may use the old ID or be converted to the new format over time as needed.

The County's tax parcels will be utilized in nearly all of the proposed GIS applications, and will also provide the foundation for preparing other required layers such as zoning and district boundaries. It is therefore strongly recommended that the County address these alignment and accuracy problems first, before moving forward with any of the other implementation initiatives. Once the tax mapping updates have been completed the County will also need to adjust other core layers that use these boundaries as a base. These layers include school, fire, historic, election and other district boundaries.

Where the districts are based exclusively on parcel boundaries, the updates may be accomplished through simple GIS operations such as selecting and merging. Where districts are made up of a combination of parcel boundaries, street centerlines, and other natural or man made features, the process may be more complex. In these areas, additional manual effort and digitizing may be required.

Developing an accurate and complete street centerline layer is another priority for the County. Currently the County works with a combination of centerline datasets generated from different sources including tax maps, E911's base maps, and New York State's ALIS data. Each of these layers differs in terms of completeness, naming conventions, format and accuracy. The County would like to unify this information into a single data source. The resulting road network data layer could be enhanced with additional attributes including pavement condition, speed limits, striping patterns and other information for use in thematic mapping and analysis.

The County has also identified several other layers as priority items to include in the proposed applications. These include culverts, hydrants, guide rails, contours/elevation, bridges and access points. These layers would most likely be developed through heads-up digitizing off an aerial base or scanned paper map, or through data collection in the field using GPS. The potential use of LIDAR (Light Detection and Ranging) for data collection has also been discussed with County representatives. LIDAR is a remote sensing technique that may be used to locate very detailed ground features, vegetation and topography using short wavelength light transmissions, in a manner similar to the way radio waves are used for radar applications. However, using LIDAR to capture the entire County could cost several hundred thousand dollars, and is not within the limits of available funding provided by the NYS Archives. The County may wish to consider alternative funding sources if it considers pursuing this initiative.

As the County moves forward with developing additional GIS datasets it should be cognizant of developing metadata as well. Metadata contains useful information about how and when a GIS data layer was created, its intended purpose, its scale and projection, and whether any restrictions apply to it. Metadata is essential to any GIS implementation or data development effort. It allows subsequent users to review information about how the datasets were prepared and what their appropriate usage should be.

Software

The Needs Assessment process has revealed that the majority of the County staff's application requirements involve simplifying and expediting responses to basic information requests. These applications would allow users to perform basic operations such as searches, point and click inquiries, creating overlays and printing. In most cases no data editing or update capabilities are required. The County has also expressed a desire to share some of these applications with non-networked agencies (e.g., WCWSA or SWCD), local municipalities, and the public. These types of lightweight applications are clearly best implemented using web-based GIS solutions.

As noted previously in the Overview of GIS Deployment Options section of this report, there are many alternatives available for implementing web-based mapping applications. Based on our review of the requirements identified during the needs assessment, our knowledge of the County's existing computer systems, and our experience in developing similar applications for other local governments, we recommend that an open source technology such as MapServer should be utilized for application development. Open source web tools provide equivalent functionality to commercial products such as ArcGIS Server and are completely compatible with all ESRI and MapInfo-based data formats, as well as AutoCAD .dwg files. Because MapServer is an open source program, the software is available at no cost and there are no licensing fees. Saving money on these items would allow the County to devote more of its implementation budget toward data development and improvement.

It is recommended that two levels of web-based applications should be developed to provide access to County staff and the public. The public application would be open to all citizens. Users would have access to basic mapping layers such as aerial photographs, parcel data, streets, mass

transit information, parks and historic sites. They would also have the ability to search for features, turn layers on and off, zoom, pan, measure distances, and conduct simple inquiries to obtain attribute data.

Designated users within County agencies and local municipalities should also be provided with access to a staff only version of the mapping application. A user name and password would be required to access this application, which could contain additional sensitive data layers (such as emergency management data) not available to the public. If desired, multiple agency-specific logins could be established to allow departments to access their own data layers and custom mapping tools, but restrict other agencies from viewing them. Examples of department specific tools could include a mailing list application or custom thematic mapping tools.

Both the public and staff only versions of the application would be accessible via the Internet using only a web browser. Using open source technology for the development would also help the County avoid incurring any "per user" charges, and allow the applications to be open to an unlimited number of end users without additional charges or licensing fees.

The County has also demonstrated the need for a number of desktop GIS applications. These include any applications that require more complex spatial analysis, feature editing, or the preparation and plotting of higher quality large format maps. A number of County agencies are already utilizing ESRI ArcView software, and the vast majority of existing GIS data layers are stored in an ESRI shapefile format. The Planning and Highway Departments each have one seat of ArcView 9.2. A limited number of other GIS users within the County are still utilizing ArcView 3.2. It is recommended that the County purchase several new seats of ArcView 9.2 to upgrade all users to a common platform and provide an additional license for the Planning department. Users of this software would include E-911, Emergency Management, Planning and Real Property staff. Because there may be many users within each of these departments that will access this software on a limited basis, it is suggested that the County purchase 3-5 floating licenses of ArcView. Obtaining 1-2 additional stand-alone licenses is also recommended. Having these licenses will give the County the flexibility to load ArcView on laptop computers. These laptops might be utilized for demonstrations at public meetings or for conducting fieldwork where connectivity to the network license server is not available.

The County may also be able to extend the power of ArcView by utilizing ArcReader to deliver read-only versions of ArcView created maps to other users within the County. Because ArcReader is freely available and provides a significant portion of the core functionality of ArcView, it can provide a cost effective means for distributing maps and simple GIS applications. The Highway Culvert map and Crime/Accident Analysis Applications could also potentially be deployed using this technology.

Several of the County departments including DSS, Probation, and the Sherriff's Office expressed an interest in using routing software to help plan field visits and optimize driving routes for multiple destinations. There are a number of specialized commercial products that provide this type of functionality. ESRI's ArcLogistics Route software provides all of these features as well as route balancing, fleet management, customer order management, and reporting. ArcLogistics Route costs approximately $12,000. A lower cost alternative is Microsoft MapPoint which costs

approximately $250. MapPoint allows users to view and print maps and directions. It also allows users to import and geocode address lists for building optimized driving routes. Optimized routes to multiple destination points may be calculated and adjusted based on user preferences. MapPoint also provides capabilities for integrating GPS and an API for customizing the application interface. Based on the basic nature of the routing needs expressed during the interview process, this program may be well suited to Wayne County's needs. It is suggested that the County purchase a limited number of copies of MapPoint and pilot the application as part of a potential larger scale routing solution.

The County may also wish to consider purchasing a license of CommunityViz for the Planning Department. This software could help automate many of the more time consuming GIS operations that Planning must currently perform. CommunityViz is a commercially available extension to ArcGIS that offers a variety of tools to allow users to more quickly and efficiently perform build out analyses, model alternative development scenarios, and visualize development patterns. The application is fairly low cost, and provides access for up to 3 users per site license.

Along with the GIS applications listed above it is important for the County to continue to maintain and update its desktop productivity tools such as Microsoft Word, Excel and Access, PowerPoint. These tools play an important role in managing GIS records and working with related attribute data. The County may also investigate the potential benefits of other desktop tools such as Microsoft Publisher, Project and Visio.

Hardware

Wayne County already has much of the computing infrastructure required to host a web-based application in place, including web server and firewall applications, backup procedures, and Internet connectivity for all required County offices. However, the County's existing web server is running a number of resource intensive applications, and features limited available disk space for hosting large GIS data sets.

To host the proposed web GIS applications in house, the County would most likely need to acquire an additional server for the associated software applications and data. The cost of a new server may range between $8,000 and $10,000, plus any additional installation and setup costs. Having a dedicated GIS server would greatly reduce the load on the current web server, help avoid any potential compatibility issues with other existing web applications, and provide added storage space for the development of future GIS datasets. Adding a new server, however, would require additional administrative support from IT as well as incur ongoing hardware and software maintenance costs.

As an alternative, the County may consider outsourcing the hosting and administration of the web GIS applications through an external Application Service Provider (ASP) or data center. Under this arrangement the web server, map server and all supporting hardware would be maintained and operated by the web host in exchange for monthly or annual hosting charges. Web hosting service fees typically range between $2000 and $4000 per year. By hosting its applications off site, the County would be able to minimize other ongoing maintenance demands

and costs such as hardware and software maintenance fees, disk storage space, Internet bandwidth loads, and support time for County IT staff.

Wayne County's existing desktop computer infrastructure is well positioned for implementation of the proposed GIS applications outlined in this report. The following factors contribute to this assessment:

- Most users throughout the various facilities already have access to the County's shared network.
- Sufficient bandwidth is already available for the level of network traffic that is anticipated to be generated by these applications, as all offices are linked by 100 MB fiber or 1 GB fiber connections.
- Most County personnel have access to the Internet via a high-speed connection.
- The County backs up data and records stored on its network on a regular basis.

The County is also pursuing a plan to implement wireless access within the next 2 to 3 years. This plan would provide agencies that do not currently have access to the County's existing Wide Area Network (WAN) with a means to access shared GIS applications and data.

In general, the County's existing desktop PCs are sufficient for running traditional desktop GIS applications or custom web-based applications. This is due primarily to the County's recommended standing policy of upgrading CPUs every 3 to 4 years. The minimum system requirements for running ArcView 9.2 include Windows 2000, XP or Vista operating system, 512 MB RAM, and a 1 GHz processor. Increasing to 1 GB of RAM is strongly recommend for most users.

It is not anticipated that any significant PC upgrades or hardware purchases would need to be made to support the proposed desktop applications. In general, PCs are upgraded by the County every 3 to 4 years, and most currently possess sufficient capacity to support ArcView 9.2 and any of the other proposed desktop tools. The County may consider purchasing a laptop with a dedicated stand alone license of ArcView as means of providing a mobile platform when providing demonstrations at public meetings or completing field work. The County's existing plotters, printers, scanners and other peripherals are adequate for current printing and processing demands. As GIS usage becomes more intensive, the County may wish to consider adding more memory to its plotter or upgrading other peripheral devices as needed. The County Highway Department has recently obtained a new GeoXT GPS unit capable of sub-meter accuracy, and it is not anticipated that any additional GPS units would need to be purchased. Although most of the County's equipment is adequate for the applications, it is also critical that the County budget sufficient funds for the ongoing maintenance of these items. Funds should be set aside annually to account for expansion, upgrades and hardware replacement.

Personnel

In planning for implementation the County must make certain that it has the appropriate staff resources, procedures and training programs in place to support the new system. The process of establishing and documenting various responsibilities for managing the day-to-day operations and upkeep of the system is one of the most important aspects of establishing a successful GIS.

Based on the feedback obtained from the Needs Assessment process, the County should consider designating staff for the following roles:

GIS Administrator

One of the most pressing needs identified during the interview process was the demand for establishing a County GIS Administrator position. This individual would be responsible for overseeing the County's GIS applications and managing its data library. The Administrator would also assist other County users with tasks including map making, plotting, technical support and data conversion, and data development. Other duties would include coordinating data exchange among County agencies and municipalities; providing basic user training; keeping GIS documentation, policies and metadata up to date; and arranging quarterly meetings of a County-based GIS users group.

Because Planning exhibits the strongest GIS capabilities and support network, it is anticipated that the County would establish the Administrator Position within this department. As the County's GIS program grows the demand for support will increase tremendously. The benefits of establishing a dedicated resource with appropriate expertise who is devoted to addressing these issues cannot be underestimated. These benefits include improved response time for resolving support issues, increased capacity to manage larger volumes of data in a timely fashion, improved data sharing and cooperation among agencies, and increased efficiencies within various other County departments.

GIS Consultants

When required, the County may also utilize professional GIS consultants to provide general technical support and system administration assistance, or to complete specific tasks such as software and hardware upgrades and additional application development services. However, the addition of a dedicated GIS Administrator position would help minimize the demand for outside assistance.

Data Stewards

It is recommended that the County designate staff to become the stewards of various datasets. Ideally, these stewards would be the individuals who work most closely with specified data on a day-to-day basis. They would be responsible for the maintenance and upkeep of selected data layers, as well as developing policies to ensure the security of their data (e.g., policies regarding data backup and data access control). For example, guidelines should be established to restrict access to potentially sensitive information (such as social services or Sheriff's data).

A formal Data Maintenance Plan should be adopted to document these policies, outline the process and frequency with which layers would be updated, and to identify which individuals would fill the roles of data stewards.

Application Users

Implementing web-based GIS data viewer applications would allow all County staff and the Public to become users of the GIS. Because these applications would feature basic functions and be delivered through a familiar web browser interface, minimal training is anticipated. It is recommended, however, that the County arrange a brief training session for its staff prior to rolling out the web applications. Staff from local municipalities may also be invited to the training to familiarize them with application features and capabilities.

Users accessing ArcView for data management, analysis and mapping will require more specialized training. It is recommended that the County arrange an in-house ArcView training session for a small group of users, or send individuals to any of the standard 3-day Introductory ArcView training classes provided by ESRI. It is expected that designated users from Planning, E-911, Emergency Management, Real Property and the Highway Department would attend this type of training. To supplement this training, users may also wish to enroll in some of the free or low-cost on-line courses offered through the ESRI website's Virtual Campus.

It is also suggested that users in the Real Property Tax Department should attend an advanced AutoCAD Map training session. This training would provide information on tools available for working with spatial data within the CAD environment as well as bridging the gap between CAD and GIS. This type of course would be very beneficial for helping staff to find more efficient techniques for preparing and converting CAD-based tax maps to GIS format.

The Planning department may also wish to consider arranging a CommunityVIZ training session. CommunityViz training is offered through Placeways, LLC. Instruction is available on site or via the web.

Conclusion

Wayne County has identified and prioritized a number of GIS applications designed to address its most critical records management needs. The County's ability to successfully implement these applications will be dependent upon the capacities of the underlying hardware, software, data and personnel that support them.

The County's most critical need in this area will involve improving and expanding its library of base mapping data sets. Correcting the underlying alignment problems in the County's tax maps should be the initial focus of this effort. Once the base data layers have been established, a combination of web-based applications designed for staff-only and public uses may be implemented. These types of web-based applications will allow the County to provide a wide range of users with access to GIS data without incurring per user software and licensing fees.

The use of free, open source tools for developing and delivering these applications could also help to further reduce web development and maintenance costs. These web-based applications could be supplemented by implementing a limited number of additional desktop programs for data maintenance and advanced GIS processing needs.

In general, the County's existing computer systems and network infrastructure would need minimal modifications to support the proposed web and desktop applications. However, the County should plan to budget for the acquisition of a dedicated GIS application server to prevent conflicts with other existing applications, and accommodate future growth.

The County must also ensure that adequately trained personnel would be in place to operate and maintain the new applications once they are implemented. Without appropriate personnel in place to support the GIS, it cannot succeed. A number of training options have been outlined in this report, and the County should be certain to include the costs of these alternatives as part of its implementation budget.

Establishing a dedicated GIS Administrator position at the County level is also a vital part of this initiative. This position would be able to focus exclusively on managing the GIS and supporting the underlying hardware and software components. Most importantly, this position would provide a knowledgeable and accessible resource for supporting other County staff that would be using the GIS on a daily basis.

This report offers a conceptual overview of the preferred GIS architecture and system configuration options recommended for Wayne County. These options have been selected with the intent of meeting the County's established goals of making its spatial records more easily accessible while also improving efficiency and reducing ongoing maintenance costs.
As a next step, these recommendations will be refined and expanded as part of a final Implementation Plan. This plan will provide more detailed system specifications, cost estimates and a proposed implementation timeline.