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Geoenabling A Rural Community Through Web GIS: A Case Study Of The City Of Hays, Ellis County Kansas

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Geoenabling a Rural Community Through Web GIS:
A Case Study of the City of Hays,
Ellis County Kansas

being

A Thesis Presented to the Graduate Faculty
of the Fort Hays State University in
Partial Fulfillment of the Requirements for
the Degree of Master of Science

by

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ABSTRACT

The objective of this study was to describe the internet GIS implementation in the City of Hays and Ellis County, Kansas, then compare it to examples of implementation from other similar communities. Geospatial resources were consolidated from both agencies and used to develop two web mapping applications for employee and public access. Both mapping applications were developed on the ArcGIS Server platform using the .NET Web Application Developer Framework. In addition, a HTML website was developed to accommodate common data requests and an online map repository.

The implementation approach of the City of Hays and Ellis County is similar to the reviewed community case studies, though additional Python and JavaScript programming was required to accommodate the needs of both agencies. Follow-up interviews indicate that the implementation of the online web mapping application has yielded a savings in office labor, time and revenue for city/county staff members, and provides easy data access for the staff and citizens of the City of Hays and Ellis County.

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OVERVIEW

The intent of this research was to compare the approach taken by the City of Hays and Ellis County in developing an online geographic information system (GIS), to approaches taken by other government locales and recommended industry trends. Over the past decade, Internet-based GIS has become an increasingly popular delivery mechanism for government agencies to distribute public information. Comparing local implementation strategies to those of similar agencies and industry trends allows the City of Hays and Ellis County to maximize system efficiency, assists with future application development, and ensures current security design conforms with recommended configurations.

The Internet and GIS

The Internet has transformed the way that geographic content is delivered, viewed, and used. Through the Internet, geographic information, applications, and standards have been developed, providing the means for end users to connect and share geographic information at a new level of simplicity. Moreover, the ability to create and disseminate geographic information from a variety of additional platforms include: personal computers, GPS units, cellular phones, and other mobile devices. Geographic information can be shared in real-time utilizing the Internet over cellular networks, and may be accessed in remote locations void of cellular availability through satellite modems (Lyle and Mulcare, 2006).

The Internet serves as a medium to distribute and share geographic content both at the global scale and at the local government level. Live and static geographic content are

used in conjunction and compared with each other for a variety of applications in commercial, private, and public sectors. Real-time location-based services are used as a marketing avenue for commercial companies by targeting consumers with geographically relevant advertisements; in the transportation industry for delivery scheduling, fleet management, vehicle tracking and vehicle routing; in the government sector for records management or public safety applications such as severe weather mitigation and response, or may be used by the general public for in-car navigation or recreational purposes like route tracking and geocaching events (Dumitrescu and Fuciu, 2010; Mitchell, 1998).

Web GIS has become an affordable solution for local governments to publicize and disseminate geographic information (Richardson, 2010). By making data and other geographic resources available online, local governments are able to distribute information without having to generate hardcopy or digital reproductions. This yields savings in materials and labor, software licensing fees, and offers a significant time savings for the end-user requesting the information. Access to local government information using the Internet has become a common public service practice in many agencies, and has numerous advantages compared to traditional hardcopy data distribution (AGIMO, 2003).

Study Area

Ellis County, located at the intersection of I-70 and U.S. 183, has the largest county population in northwest Kansas with a 2009 estimate of nearly 28,000 residents (U.S. Census Bureau, 2009). The City of Hays, incorporated in May of 1885, is the

largest municipality in Ellis County with an estimated population of approximately 20,000, and also serves as the county seat (U.S. Census Bureau, 2000). In addition to having the largest regional population, Ellis County functions as a regional economic hub with its top employers in retail, education, healthcare and services sectors (Ellis County Coalition for Economic Development, 2009).

Ellis County outperforms most Kansas counties in the Kansas Department of Revenue's 2009 County Trade Pull Factors (CTPF) – a measure of the relative strength of a community's retail business, calculated by dividing the per capita sales tax of a county by the statewide per capita sales tax. A high CTPF is a good indicator of future market growth and community expansion, and GIS has proven to be a valuable tool in managing the planning and development of urban expansion (Maantay and Ziegler, 2006). Ellis County ranks second out of 105 counties with a CTPF of 1.60, indicating local businesses are drawing over one third of consumer trade from outside Ellis County borders (Kansas Department of Revenue, 2010).

GIS Application in the City of Hays and Ellis County

The City of Hays and Ellis County have been using GIS in a variety of daily workflows across several departments including property valuations, property taxation, 911 call plotting and infrastructure planning/development. Geospatial datasets are typically generated and maintained by the governing department that uses the information on a day-to-day basis.

The datasets developed by various departments in Ellis County and the City of Hays were not readily available to all departments, between organizations, or shared with

the general public. Requests made for geospatial data were typically provided in hardcopy format, requiring office visits or incurring postage fees. Additionally, the City of Hays and Ellis County currently had no effective electronic delivery format; CD-ROMs and DVDs were generated by some departments, but available electronic data was usually not generated per request, rather, several data discs were created at once (generally bi-annually), which degraded the temporal accuracy of the information.

GIS information obtained from the City of Hays and Ellis County also had inherent problems when the data was used in the same geospatial software environment. Different departments utilize different map projections, have different database schemas, update information on different schedules, and identify equivalent physical features with differing unique identifiers. This causes problems with overlaying different datasets, cross-referencing datasets, updating datasets and joining database information from other sources.

The City of Hays and Ellis County have agreed to pursue an Internet-based GIS system that combines information from a variety of in-house data sources and external data sources with the goal of creating an all-inclusive geographic information system that may be accessed and shared by city and county employees as well as the general public. This study will compare the steps taken in the local online GIS implementation with approaches taken in similar communities.

OBJECTIVES

Summary

The objectives of this study were to describe the implementation of Internet GIS in the City of Hays and Ellis County, Kansas; determine common industry standards towards implementation; and compare findings with the approach taken in the City of Hays and Ellis County. According to Harnish-Doucet and Wright (2007), a suitable system should assist city and county staff and commissions with decision making, promote inter-departmental convenience and efficiency and support daily workflows. Furthermore, it should provide accurate and timely data access to support departmental functions, improve accessibility of city/county information to the public, and encourage data sharing between city and county entities.

Specific to Ellis County and the City of Hays, geospatial information contributed from different departments had to: exist in the same software environment, use similar map projections for data overlay applications, provide options for posting data updates at unscheduled intervals, and support a common identification field for cross-referencing or joining separate datasets together for analysis. In this study, the following system components implemented in the City of Hays and Ellis County are described:

- A repository of commonly requested digital maps in a format easily viewed and reproduced by the end user.
- Online GIS data viewer including data related to the City of Hays and Ellis County, with simple query and search capabilities.
- An interface allowing end users to download or connect to geospatial

datasets for use in a variety of GIS applications.

- Method for submitting unique digital and/or hardcopy requests.

To determine common industry standards towards implementation, a literature review was completed to identify suggested implementation phases and common implementation approaches in other local government agencies. Findings in the literature review are compared with the approach taken in the City of Hays and Ellis County.

APPROACH

City of Hays / Ellis County Implementation Criteria

Before developing the online GIS for the City of Hays and Ellis County, a set of criteria were created to guide system implementation. To determine the most effective approach to creating a GIS that addressed the needs of the City of Hays and Ellis County, the following criteria were developed based on previous research and examples of successful implementation:

- Inventory current use and application of GIS in the City of Hays and Ellis County and examine available data resources.
- Interview individual city and county department staff members to identify common goals and issues regarding the current use and future of GIS in the City of Hays and Ellis County.
- Formulate an approach towards implementation of an Internet-based GIS and put the proposed system into service.
- Determine results of the implementation and propose methods for future improvement.

Establishing Familiarity with Current GIS Environment

Because the proposed GIS was heavily reliant on the existing city/county network architecture, initial interviews were held with the City of Hays and Ellis County Information Technology (IT) staff. The objective of the interviews was to gain a thorough understanding of the city/county network configuration, how the two networks communicate with each other, and typical hardware specifications for personal computers

connecting to these networks. Software licenses were examined along with currently developed geographic datasets and their respective network locations.

Identifying Common GIS Goals and Limitations

Individual departmental meetings were conducted with city and county staff to identify shared perceptions of GIS use in Ellis County, and what changes could be made to promote efficiency and enhance user involvement. Staff members were asked to identify goals, deficiencies, and limitations of their current system, and how a browser-based GIS could assist them in daily workflows. Responses were recorded documenting data types, data locations, update schedules, and departmental workflows. Findings were summarized to identify common goals and support software platform selection.

Development and Instantiation of Internet GIS System

Departmental meetings yielded several commonalities that assisted with software selection, hardware selection and web application development. Data resources identified at staff meetings were assembled in a single geodatabase and used as source data for the web mapping application. Additional geospatial data and maps were collected and organized into network directories for easy retrieval.

Hardware/software selections were made based upon departmental interview responses, industry trends, and examples of successful implementation. A web mapping application was developed and tested on the City of Hays and Ellis County local area network (LAN), and later deployed on the World Wide Web for public access.

Literature Review & Implementation Comparison

A literature review of current Internet GIS trends and benefits, implementation in

local government and common implementation stages was completed in order to identify the best practices pertaining to online GIS implementation. The literature review focused on methods and practices for constructing an Internet-based GIS system for local government. In addition, data standards and trends are investigated along with GIS implementation guides produced by communities similar in nature to the City of Hays and Ellis County. These findings are compared with the approach taken by the City of Hays and Ellis County.

LITERATURE REVIEW

Both the Internet and Geographic Information Systems have served as information delivery mechanisms for over three decades (Leiner et al., 2010; Mark et al., 1997). Since the advent of the World Wide Web twenty years ago (Berners-Lee et al., 1992), web mapping applications have evolved from static HTML maps to 3-dimensional virtual globes, providing end users with easy-to-use interfaces and seamless access to a variety of data sources (Plewe, 2007). Today, user-generated content has become prevalent among many web mapping applications, providing a dynamic environment where users may contribute, update and share both map content and location-based information via the Internet (Helft, 2009). Many small, rural communities have taken advantage of GIS, which has become an integral part of daily government work functions. Many of these local governments utilize online mapping applications as a tool to disseminate information for a broad variety of applications (Tunceli et al., 2003).

Evolution of Internet GIS

Peng and Tsou (2003) define Internet GIS (also known as Web GIS) as a “network-based geographic information service that utilizes both wired and wireless Internet access to deliver geographic information, analytical tools and GIS services.” GIS has slowly transitioned from existing exclusively on mainframe computers and servers, later becoming available on desktop computers, and finally to distributed GIS Internet connections. Today, Internet GIS data connections may be accessed through web browsers on lightweight computer platforms and mobile devices (Peng and Tsou, 2003). With this transition, GIS no longer requires proprietary software installation, and

therefore has become more accessible to a broader audience, specifically Internet users (Sahin and Gumusay, 2008).

As the popularity and use of GIS grew, spatial databases applied different data schemas and formats to geo-referenced information. Web GIS has further promoted a large number of GIS users to generate spatial information on different platforms, which has resulted in interoperability issues when working with data generated from different sources (Stoimenov et al., 2005). Data available online as web services may be easily combined in an online mapping application for analysis, regardless of differences in data format. In particular, disaster management information combines different data models and formats, and has a heavy dependence on real-time data feeds and mobile access, making it an ideal candidate for web mapping application platforms (Associated Press, 2004; Sahin and Gumusay, 2008).

Data Standards

Over the past decade, several data standards have been developed for transferring geographically referenced information across Internet connections, and are used for data interoperability across different software platforms and applications (Open Geospatial Consortium, 2011). Using OGC standards, developers and users use common interfaces to create and share spatial information and geographic analysis tools that may be interpreted by different web mapping applications, desktop applications, and Internet mashups (Sahin and Gumusay, 2008). As related to this study, the data service standards include (OGC, 2011):

- Keyhole Markup Language (KML): an XML language focused on geographic

visualization, including annotation of maps and images for encoding representations of geographic data for display in an earth browser.

- Web Coverage Service (WCS): a standard interface and operations that enables interoperable access to content such as satellite images, digital aerial photos, digital elevation data, and other phenomena represented by values at each measurement point.
- Web Feature Service (WFS): a feature access service but also includes elements of a feature type service, a coordinate conversion/transformation service and geographic format conversion service. Allows clients to only retrieve or modify the data they are seeking, rather than retrieving additional unwanted data.
- Web Map Service (WMS): HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. A WMS request defines the geographic layer(s) and area of interest to be processed, the transparency of layers, and the returned format (i.e. JPEG, PNG, etc.).

Web Mapping Applications

Internet GIS viewers, or web mapping applications have existed since the early 90's, with one of the earliest examples being the Xerox Palo Alto Research Center (PARC) Map Viewer in 1993, which allowed users to turn on and off layers, change projections, and add place marks to the display, using nothing more than HTTP, HTML, and PERL scripts (Putz, 1994). In the past, many Internet map viewers employed reduced dimensions when compared to modern map pages. This is primarily a consequence of

limitations in monitor size, network speeds, and screen real-estate, as developers aimed to maximize map performance while also accommodating advertisements (Haklay et al., 2008).

As early as 1998, reports forecasted “new virtual ‘worlds’” to be mapped, analyzed, and manipulated’ (MacEachren, 1998). In mid-2005, Google launched a free 3D mapping project called Google Earth, based on technology originally developed by Keyhole Incorporated in 2001, and allowed users to seamlessly navigate from space to street level perspectives and overlay multiple data layers with geographic reference (Google Press Center, 2005). Shortly after, Microsoft announced the availability of Virtual Earth 3D (now known as Bing Maps 3D) (Microsoft News Center, 2006). Today, end users and local communities can develop their own map services and render them in lightweight web mapping applications, or may import these services into virtual globes such as Google Earth or Bing Maps 3D to view their data in a virtual 3D environment (Holmes, 2005; ESRI, 2009).

Benefits and Limitations of Web Mapping Technologies

Web mapping technologies provide an effective means of distributed data access, especially when compared to hardcopy media, or digital media stored in centralized information systems (Tsou, 2004). Over the past decade, the number of Internet connectivity options and available bandwidth has increased, providing new options for online public participation and community collaboration using web GIS (Banger, 2002, Haklay et al., 2008). Internet access is also becoming more prevalent at public access terminals in educational facilities, libraries and municipal centers, further broadening the

availability of web mapping application access (Carver et al., 2001). Moreover, the data is available 24 hours a day, 7 days a week; web mapping applications have a larger temporal availability than data resources available only during regular operational hours (Kingston et al., 2000).

Several authors have demonstrated the value of web GIS in public participation and policy making, and how collaboration efforts are supported by the availability of geographically relevant information to the audience (Hoyt et al., 2005; Kingston, 2007; Kyem and Saku, 2009; Yaakup et al., 2004). Web GIS provides upper-level government decision makers perspectives from local communities (Daun-Barnett and Affolter-Caine, 2005), and allows smaller rural communities with less monetary resources access to data visualization tools previously available only to urban areas with larger budgetary reserves (Fulcher and Kaukinen, 2004).

Many web mapping applications are browser-based, and are generally easier to use than traditional desktop GIS applications which reduce learning curves and results in lower training costs (Hogan, 1999). Results from a study done by Carver et al. (2001) show that many users show proficiency in navigating simple web mapping pages, but more complex web mapping environments, especially 3-dimensional map environments can often be confusing for many first-time users.

Posting data updates is easier in a server-client environment as data changes only need to take place on the server, and are then reflected to clients during their next session, or as the browser is refreshed (ESRI, 2009). This allows web mapping applications to have frequent update intervals and display current and real-time data, such as election

results (Neumann, 2008).

Multiple map layers from a variety of Internet GIS servers may be used in the same browser-based web mapping application, regardless of the software platform the application is running on (Vermes, 2006). This requires that the map services comply with OGC specifications, but allows users to share data and processing power, eliminating the users need for high-end workstations, client-side licensing and complex data conversions (Haklay et al., 2008). This yields both cost and time savings to the end user, and promotes collaboration and sharing of geospatial data (Jackson and Rambeau, 2010).

While there are benefits to using server-client architecture, limitations also exist. A web mapping application requires an active Internet connection, and if the connection is lost, the web mapping session terminates. Dynamic and cached information generated during a web mapping session, such as display extents, query and geoprocessing results, may be lost if there is an interruption in Internet connectivity during a user session (Kolbe et al., 2005).

While the ability to generate and modify geospatial information through web mapping applications is possible, it is typically recommended for 'lightweight' editing and geoprocessing tasks. 'Heavier' editing, such as topological edits and complex geoprocessing functions, are recommended to be completed on dedicated machines with local or network data sources because of processing and bandwidth requirements (Hopkins, 2010).

Under a server-client architecture, users only obtain the segments of information

they request, not the dataset in its entirety. This can be problematic if the comprehensive dataset is needed for additional study or specific geoprocessing tools are not available through the web mapping application (Rao and Vinay, 2009).

Stages of Implementation

A large volume of web GIS implementation literature is available describing design and integration strategies for Internet GIS into small local governments. Many implementation guides share commonalities, which have been summarized in this study and compared to the Internet GIS implementation in the City of Hays and Ellis County. Implementation and system design documents were reviewed and summarized from communities of similar size, nature and complexity to the City of Hays and Ellis County. Based on this review, the following implementation stages were derived:

- Planning
- Analysis
- Design
- Construction
- Implementation

Planning

The first stage in web GIS implementation is becoming familiar with the organization's current environment. The first priority should be familiarization with organizational staff. This may be completed by reviewing job descriptions and conducting face-to-face meetings (Parr, 2008). Interviewing department staff provides insight into the departmental functions and responsibilities. Staff members have unique

end-user perspectives and their involvement during the planning stage is crucial in ensuring user requirements are fulfilled. For staff members not familiar with GIS and its applications, a description of geospatial technology and applications should be provided so that staff members may effectively participate in implementation discussions (Somers, 2001). To define the scope of GIS goals, individual departmental meetings should be held to identify how GIS fits into current projects, and to draft procedures for GIS implementation into daily workflows (PAR, 2007).

Analysis

The analysis stage includes identifying all current and future GIS users and applications. This is completed through interviewing current and potential users, and creating a list of functionality requirements (Alesheikh et al., 2002). During the interview process, an inventory of data and software licenses should be completed, along with documenting user's GIS familiarity and applicable training (Parr, 2008). Department staff can provide insight into currently developed datasets, and Information Technology (IT) staff members are a good source of geospatial data repository and their network locations (GeoNorth, 2007). An audit of current software licenses may be accomplished by contacting IT staff and contracted software vendors (Harnish-Doucet and Wright, 2007). Information gathered during the analysis stage will assist in design formulation and system implementation (Somers, 2001).

Design

After departmental interviews have been completed, commonalities between departmental GIS goals and specific GIS requirements can be identified and used in the

development of design and implementation plans (Somers, 2001). The design process involves determining all related departmental goals and needs, and establishing a hardware and software configuration to support user needs and meet departmental requirements (Peters, 2008). Data inventory and departmental workflow documentation assists in formulating a structure to the GIS database and security configurations (Somers, 2001).

Requested user functions and operational needs should be reviewed to direct the development of the web mapping application (Alesheikh et al., 2002). IT staff can provide insight into software compatibility, system integration, and applying appropriate security measures for installed hardware (Peters, 2008). The results of the design stage should include: a conceptual GIS database design, including relevant data sources; requirements for the web mapping application that meet operational needs and a systems implementation plan that details how the GIS will integrate with the pre-existing network architecture (GeoNorth, 2007).

Construction

In the construction phase, hardware and software components are acquired and assembled into a system that meets the needs of the organization. The construction phase process is drawn directly from the requirements developed in the analysis and design stages (Somers, 2001). Hardware selection should take into consideration current network architecture and should be implemented in a fashion that preserves or enhances network security provisions and data protection, redundancy, and integrity (Peters, 2008). When selecting a software platform for the GIS, organizational training and licenses should be

reviewed, and a platform should be chosen that integrates well with pre-existing software experience and recorded departmental workflows (Rao and Vinay, 2009; PAR, 2007).

Geospatial data should be collected and arranged in a logical structure that conforms to agency structure and workflows. If data resources are distributed among departments, a centralized data repository can be created and maintained with available software technologies (Peters, 2008). A centralized data repository will provide data redundancy, and employing spatial databases provides quality control parameters that ensure data integrity among source files (Peters, 2008; Holmes, 2005). Spatial database schemas should be carefully developed and organized such that they adopt a structure that may be easily maintained by individual agency departments (Holmes, 2005).

Standard data naming conventions should be used and be identifiable by all users (PAR, 2007).

Data resources, particularly those that support Internet access, are vulnerable to unauthorized access and other security threats (Peters, 2008). It is recommended that agency IT staff be consulted about hardware and that software network integration and security considerations are reviewed before system implementation (Peters, 2008).

Implementation

In the implementation stage, web services and mapping applications are developed and deployed, and end-user training and system maintenance intervals are reviewed and scheduled. Initial mapping applications should be built with the most widely used data sets and expanded to be more inclusive with time. Typically there are too many datasets, application features, and system components to implement at once;

early deployment and easy-to-use applications will build familiarity and acceptance of the system (Somers, 2001).

Once initial products are released, feedback may be gathered from users to help guide further development of the application (Holmes, 2005). The accuracy and timeliness of data updates is crucial in forming user confidence in the system, so data update tasks and intervals should be discussed early after deployment (Somers, 2001).

The system is not complete after it is put into operation however; it is the commencement of the next phase of the system lifecycle which includes ongoing enhancements, data updates, and user training (Alesheikh et al., 2002). Guidelines for system updates and data contributor procedures should be established and clearly outlined (Peters, 2008). To increase system usage and grow the user base, training sessions should be held to familiarize users with available content and features (Somers, 2001; PAR, 2007). Feedback gathered at user trainings may be used to further enhance the system (PAR, 2007).

Examples of Community Implementation

Several implementation guides were reviewed from communities with similar department and service structure to those of the City of Hays and Ellis County, KS. The implementation guides include:

- City of Loveland, CO (population 62,000) – *Developing and Maintaining and Enterprise GIS in a Full-service Municipal Government Environment* (Holmes, 2005). The City of Loveland is located in north-central Colorado along the Front Range of the Rocky Mountains. Loveland is home to several

post-secondary schools, a regional airport, and is the second largest city in Larimer County after Fort Collins. Loveland's population has been steadily increasing over the past decade, and recently incorporated the intersection of Interstate 25 and U.S. Highway 34 leading to the development of several events centers, shopping centers, and a medical center near the interchange (Loveland Chamber of Commerce and Visitor's Center, 2010). The department structure of the City of Loveland is most similar to that of the City of Hays and Ellis County when compared to the other reviewed case studies.

- City of Tigard, OR (population 49,100) – *GIS System Architecture Design and Application Design* (GeoNorth, 2007; US Census Bureau, 2009). The City of Tigard is located approximately 10 miles southwest from downtown Portland, and has the one of the lowest tax bases in the Portland metropolitan area. The City of Tigard was incorporated in 1961, and has incorporated area of nearly twelve square miles. Rail transportation has been an important part of the community's growth, from the Oregon Electric Railway built in 1910 to the TriMet transportation system, which provides low-cost mass transit for the citizens of Tigard to most of Portland's metropolitan area (City of Tigard, 2010).
- City of Rome, NY (population 34,220) – *GIS Implementation Plan: City of Rome* (PAR, 2007; US Census Bureau, 2009). The City of Rome is located in north-central New York State, and is closest in population to the City of Hays and Ellis County of the three reviewed case studies. The City of Rome was

incorporated in 1870, and early growth may be attributed to the development of the Erie Canal, which was started in Rome in 1817. The City of Rome is home to Griffiss International Airport, a decommissioned United States Air Force base used for support activities, aerial refueling, and electronic research (Rome Area Chamber of Commerce, 2010).

These community implementation guides, in addition to general best practice GIS implementation guides and whitepapers (Somers, 2001; Alesheikh et al., 2002; Harnish-Doucet and Wright, 2007; Parr, 2008; Peters, 2008; Rao and Vinay, 2009), were compared with each other to identify common GIS development stages.

ANALYSIS

Establishing Familiarity with Current Environment (Planning & Analysis)

Findings from the literature review indicate that the first step in developing an online GIS system is becoming familiar with the organization's current environment through staff interviews, documenting departmental workflows, and reviewing network structure. Before departmental interviews were scheduled, job descriptions were obtained for all positions in the City of Hays and Ellis County. Job descriptions were reviewed and conclusions were drawn on the applicability of GIS to various positions throughout both organizations.

Information gathered from job descriptions was used to draft a document '*What is GIS*' intended to familiarize employees with GIS, and how GIS may be applied to their specific organizational duties. '*What is GIS?*' and '*County Department Uses for GIS*' (Allen and Harnish-Doucet, 2006) were included as email attachments to staff members when scheduling meeting dates and locations (Appendix 1, 2). During departmental meetings, PowerPoint presentations and question-and-answer periods were provided to assist staff members not familiar with GIS technology in contributing to discussions.

As suggested by Parr (2008), Information Technology departments were interviewed first so that GIS software purchases and maintenance agreements could be reviewed. A license audit was conducted to identify the total number of GIS software licenses, license types, and which city/county computers the licenses are assigned to. Current maintenance agreements and license counts were verified with software vendors. A summary of available software licenses for the City of Hays and Ellis County may be

found in Table 1. The assessment of preexisting software licenses and end-user software familiarity assisted in the selection of an online GIS platform.

Supervisory information technology staff were asked to provide a summary of current end-user hardware and software specifications. While an overall PC specification summary was not available, IT supervisors acknowledged that all computers on the city/county networks met the following minimum specifications:

- Operating System: Windows XP
- Processor Speed: 1 gigahertz (GHz)
- Random-access Memory (RAM): 512 megabyte (MB)
- Hard Disk Space: 40 gigabytes (GB)

Information Technology staff provided Internet traffic statistics for the City of Hays home page. Statistics such as network connection speeds, browser types, screen resolutions, and bit depths were collected. Recorded traffic information was summarized (Table 2) to determine typical public sector computer system specifications to ensure the selected GIS platform and mapping application would be compatible with users visiting city and county web pages. Internet traffic statistics were not available for the Ellis County homepage.

Network structure was discussed with IT staff and documented by constructing a network diagram (Figure 1). The diagram provided visual reference for identifying user connections, existing GIS data repositories, bandwidth allocation, security safeguards and IP packet routing. The network diagram assisted in the design process and was also used in on-site department meetings to describe the GIS implementation.

Interviewing all current and potential users is considered to be an important step in the planning process (Alesheikh et al., 2002; GeoNorth, 2007). User training, GIS familiarity and departmental software licenses were confirmed with each department's staff (Table 1). Department employees were questioned about project workflows, project timelines, available geospatial datasets, and how current and future projects could be supported through an online GIS system. Staff members were asked to brainstorm specific tools and web mapping application functionality that would support their daily operations and any current or future projects. Users responsible for generating GIS data were involved in a discussion regarding GIS database structure, and what types of database schemas would best fit their current workflows. A list of sample questions asked during departmental interviews may be found in Appendix 3. Responses were recorded during departmental interviews, and later used to support online GIS platform selection.

Identifying Common Goals and Limitations (Design)

Interview responses and network resource information should be summarized so that any commonly requested datasets, application functionality, or network deficiencies can be identified (Peters, 2008). Based on the interview process, few departments were associated with GIS data generation, and many departments functioned strictly as data users. Interview results showed that 2-3 departments generated most of the geospatial data, thereby supporting the data needs of the remaining departments. The most widely used datasets were identified for each department, and common public data requests were also noted. Commonly requested datasets, along with requested user functionality is summarized in Figure 2.

While many departments host online data retrieval systems, staff members expressed interest in consolidating access to these resources through a single interface. Data formats and storage locations were reviewed to ensure appropriate network resources could be allocated and the selected software platform would integrate into existing data flows. Data layers required to meet the requested user functionality were summarized by department (Figure 3).

Platform selection should be based on staff responses, should fit into an organizations daily workflows and current project, support available software licenses and PC hardware specifications, and easily integrate with the organizations network (Holmes, 2005; PAR, 2007). As determined from the visitor site statistics from the City of Hays (Table 2) and the average PC specifications collected from city/county IT departments, average public users and organization staff would be supported by implementing ArcGIS Server and a Web Application Developer Framework (ADF) mapping application. In addition, the ArcGIS Server suite was an ideal match to budgetary resources, staff training and software familiarity (Table 1), and requested user functionality (Figure 2).

ArcGIS Server has the ability to convert native Map Documents (.mxd) into Web Mapping Services, thereby allowing pre-existing map files generated by the City of Hays and Ellis County to be shared in an online environment without data format conversion. IT staff was consulted to grant appropriate network privileges to access source data so that department-generated data could be replicated on to the implemented GIS server. It was agreed that GIS data would be collected and assembled using a filing structure that

separated source data by department. A draft geodatabase schema was developed to support multi-source datasets that included separate feature datasets for different source locations. The database structure would allow differing update schedules, differing map projections, and support topological editing in the geodatabase.

It was found during IT staff interviews that the City of Hays and Ellis County do not host any web pages in house; rather, all city/county Internet content is hosted by outside vendors. This required that the system implementation include a web-server component that may be accessed from the city/county networks. The most secure configuration, suggested by Peters (2009), includes two servers; one server accessible by network users that houses GIS data, and a second web server separated from the network by a firewall (Figure 4). This configuration is similar to the dual-server system implemented by the City of Tigard (GeoNorth, 2007), and to the system implementation completed by the City of Loveland, which includes a separate server to support Internet users (Holmes, 2005).

City of Hays and Ellis County network structure was reviewed, and IT staff agreed to develop a De-Militarized Zone (DMZ) on their networks to support a web server, and place an internal GIS data server on the Ellis County network. Both servers were licensed with ArcGIS Server so that datasets could be developed and tested internally, and upon successfully meeting quality control guidelines, may be transferred to the web server for public access.

Development of Internet GIS System (Construction & Implementation)

Two servers were procured by the City of Hays and Ellis County to support the

online GIS system. The first server, a Dell PowerEdge 2950, was implemented as the GIS Data Server for internal access, and therefore needed to be able to support more strenuous tasks such as multi-user editing, concurrent data connections, replication, and an internal development web mapping application. The second server, a Lenovo ThinkServer RD120, was implemented as the GIS Web Server, with the specific function of supporting the online web mapping application. Because of the anticipated increased user load on the GIS Data Server, a better quality server with superior hardware specifications was implemented. A summary of server hardware specifications may be found in Table 3.

Both servers were installed in Ellis County's server rack, located in the Ellis County Courthouse. Ellis County's network structure supported the addition of both servers while allowing City of Hays staff direct access to the GIS Data Server. The web server was placed in a DMZ, and through firewall IP packet filtering and routing rules, only one-way communication (initiated by the GIS Data Server) was permitted (Figure 5).

A variety of ArcGIS Server platforms are available (Appendix 4), but after comparing requested user functionality and the estimated number of concurrent system users, the ArcGIS Server Workgroup Standard software package was best scaled to organization user counts. This software package will support 10 simultaneous connections to the geodatabase, with a maximum database storage capacity of 10GB – sufficient for the needs of the City of Hays and Ellis County's staff size and online GIS implementation.

Based on total annual visitors to the City of Hays homepage, it was anticipated that there would be fewer than 30 visitors per hour to the online mapping application (Table 1). According to Peters (2008), both servers fall within acceptable performance thresholds to support 30 users per hour in an ArcGIS Server Standard deployment based on their chipset's speed (Figure 6).

The geodatabase schema discussed with city/county data developers was designed and implemented on the GIS Data Server using ArcCatalog. As recommended by the City of Rome's GIS Implementation Plan (PAR, 2007), the structure of this geodatabase lends itself to being easily updated by city/county staff as data is logically structured by department and update intervals. For instance, the 'Base' feature dataset is updated by City of Hays Public Works department on a monthly basis, while the 'Parcels' feature dataset is updated by Ellis County's Appraiser's Office bi-weekly. By segregating feature classes into separate feature datasets, data was more easily aggregated from source files across the two networks. The implemented geodatabase schema and network data resource diagram may be found in Figure 7.

A default .NET installation of the ArcGIS Server runtime was installed on the GIS Data Server and GIS Web Server. Installation options were carefully monitored during software installation to ensure directory structure remained identical on both servers to ensure a seamless replication environment. Because city/county staff lacked web-programming experience, the ArcGIS Server Web Application Developer Framework for the Microsoft .NET Framework (.NET Web ADF) was also installed on both servers. The .NET Web ADF includes a web-mapping application template, which

may be populated with data layers using a step-by-step interface in ArcGIS Server Manager, and without any web application programming required (ESRI, 2010).

In addition to publishing the web mapping application, ArcGIS Server also publishes a directory of all data layers in OGC-compliant formats including KML, WCS, WMS and WFS. These data layer services may be accessed using a variety of software platforms including, but not limited to ArcMap, ArcGIS Explorer, ArcGIS Explorer Online, AutoCAD, Google Earth, and standard Internet browsers (ESRI, 2010).

An ESRI map document (.mxd) was created that contained the most requested and widely used data layers in the City of Hays and Ellis County (Figure 8). ArcGIS Server Manager was used to convert the .mxd directly into a web mapping application. While the ArcGIS Server Manager interface was used to publish the web mapping application and add/configure search tools, additional HTML and JavaScript was added to the “identify” tool results to hyperlink the mapping application to other online resources (Figure 9). Hyperlinked data resources, along with data housed in the geodatabase, may be accessed using the “identify” tool in the web mapping application interface (Figure 10).

Once the web mapping application was deployed on the GIS Data Server, its availability was announced for employee access. Each of the city and county departments was revisited and provided with a brief web mapping application training session. Over the following four months, the internal web mapping application was tested by City of Hays and Ellis County staff members.

User traffic was monitored using SmarterStats Free Edition, a web analytics

program that summarizes site activity and visitor traffic (Figure 11). The first four months of internal site visitor statistics may be found in Table 4. During the four-month testing period, any site issues or suggested enhancements were submitted via email by users.

Through user feedback, the most common issues identified included inaccuracies in source data, discrepancies between data layers, and map application lease time. These issues were addressed accordingly by correcting departmental source data and extending the web mapping application lease time on the server. Several requests were made for additional layer search functionality, so “search subdivisions”, “search roads”, and “search quarter section” tools were added using the ArcGIS Server Manager interface.

Upon successful testing by City of Hays and Ellis County staff members, the geodatabase and web mapping application were replicated from the GIS Data Server to the GIS Web Server. To prevent any outside Internet traffic from requiring accessing to the GIS Data Server, all dependent files, including property images, subdivision scans, and digital portable document files were also replicated to the GIS Web Server. Directory structure remained identical on both servers so that additional changes would not have to be made to the geodatabase or web mapping application after replication. Replication was accomplished using Microsoft SyncToy, a free utility created by Microsoft that searches and updates changes between two file directories. The Microsoft SyncToy utility was scheduled for weekly one-way data replication from the GIS Data Server to the GIS Web Server.

Once the data had been replicated to the GIS Web Server, a real-world IP address

was assigned to the server to provide an Internet connection to the World Wide Web. Internet Information Services 7 (IIS7) was activated on the GIS Web Server, and used to direct incoming Internet traffic on port 80 to the replicated web mapping application instance. Because SmarterStats Free Edition is limited to a single web page, Google Analytics was used to monitor site traffic on the GIS Web Server. A Google Analytics tracking script was inserted at the end of the page code, and a free Google account was created to access site activity statistics (Figure 12).

Many departments developing geospatial data also generate copies of maps and other cartographic products in digital format. During departmental interviews, there was a common request that these electronic documents be available through the Internet in addition to the web mapping application. A directory was created on the GIS Web Server and populated with digital map files from city/county networks.

A basic HTML website was created so that the electronic documents may be easily navigated by users. JavaScript was used to render document previews and hyperlink to electronic map documents generated by city/county departments (Figure 13). The HTML website also provides a list of hyperlinks to all web services published by the city and county through the ArcGIS Server web services directory (Figure 14). To extend the opportunity for public users to submit suggestions, comments, request site enhancements or additional data, two additional HTML pages were created. A “Contact” and “Requests” page provide users with options for requesting digital and hardcopy data in addition to contact information for city/county GIS staff (Figures 15-16).

An organization-neutral domain name, “www.geodataportal.net”, was registered

to the GIS Web Server's real-world IP address. The web mapping application and HTML page hosted on the GIS Web Server was tested to ensure all application tools and website features were functioning properly, and that the site was accessible using the registered domain name. After successfully testing the web mapping application, a press hearing was held to announce the launch of the site. A press release statement was printed on the front page of the local newspaper two weeks before the external website launch to notify the general public of the site's availability (Appendix 5).

SUMMARY

In this study the City of Hays and Ellis County online GIS implementation was described and compared to common implementation methods identified in current literature. Literature sources included other local government case studies and implementation strategies proposed by industry software vendors and user groups. In general, the approach taken by the City of Hays and Ellis County conforms to suggested implementation approaches found in the literature review and many of the results from implementing an Internet GIS are similar to those found in reviewed community case studies.

Two web mapping applications were implemented in the City of Hays and Ellis County: one accessible only by city/county staff members through the city/county network, and one accessible to citizens through the Internet. As noted by the City of Loveland (Holmes, 2005), running two simultaneous web mapping applications ensures that down time is limited to a single server at a time, and produces an environment where new application functionality and data layers may be tested before public release. The dual-server configuration has proven to be a suitable development environment for the City of Hays and Ellis County, while also providing adequate network security.

A HTML page was developed in addition to the web mapping applications to support electronic document retrieval requested from city/county departments. While reviewed case studies indicated that other government agencies allowed users to print content from their web mapping applications, they did not develop a separate online repository for commonly requested maps. City and county office staff have indicated that

the online map repository is a valuable resource as they can defer public data requestors to the website for commonly requested map products, which has resulted in saved time, labor, and resources for both staff and requestors.

Because the implemented system is browser-based, any user with Internet access may visit the website and navigate GIS content through the web mapping application. Site traffic data shows that over the first four months of implementation, both websites averaged over 500 visitors per month (Table 4). Visitor counts on the internal employee web mapping application dropped in the month of April when compared to previous months (Figure 11), which may be attributed to the availability of the public access web mapping application which was launched April 5. The public access application may have been used by city and county staff in place of the internal web mapping application because it is accessible online, and its availability is not limited to the city or county network. It was estimated the GIS Web Server would have to support fewer than 8 users per hour based on average visitor activity on the City of Hays homepage. This estimate proved to be accurate, with initial visitor counts averaging around 24 page visits per day.

After the online web mapping application had been available for 4 months, staff members asked about the functionality, usability and integration of the mapping applications. In general, staff members indicated that the web mapping applications had great value, both in their specific job responsibilities, and to outside agencies and citizens requesting information. Several departments reported that over 50% of information requests could be deferred to the web mapping application, which led to a reduction in office labor and material costs.

When questioned about the usability of the applications interface, users familiar with GIS software indicated that the transition to using the web mapping application was virtually seamless, with little or no difficulty accessing desired information. Responses from users less familiar with GIS software generally said it took less than 15 minutes to become familiar with site navigation and tool functionality. Others indicated that the availability of a 'Help' link provided them with the necessary instruction to navigate the site and locate relevant information. All respondents acknowledged that the web-based platform provided faster access to data sources than desktop GIS platforms, and typically was more inclusive in regard to data layers than departmental GIS files.

Several departments maintain software license agreements strictly for viewing geospatial data. These departments are currently re-evaluating their software license agreements with the availability of web mapping application, which provides the data-viewing functionality required by department employees. A reduction in software maintenance agreements would lead to cost savings in departmental licensing fees. In addition, three departments access the web mapping application using in-vehicle consoles over mobile Internet connections, reducing the number of return office visits to acquire property information through traditional GIS software.

While the ArcGIS Server platform is advertised as a complete solution to seamlessly transfer map data to the internet, incorporating all requested information into the web mapping application required additional programming. HTML and JavaScript code had to be implemented to link online data resources with web mapping application resources. In addition, the Ellis County Appraiser's Office draws parcel boundaries and

assigns parcel identification numbers within the AutoCAD Map 3D software environment.

In order to generate layer files compatible with the ArcGIS Server platform, a geoprocessing tool was developed using ESRI's ModelBuilder and Python scripting. The tool allows users to select AutoCAD parcel files, then choose a parcel attribute resource such as a table or database. Running the tool converts the AutoCAD file into a feature class, corrects polygon geometry errors, and joins parcel attribute data, such as addresses, owner names, and tax units, to parcel polygon features (Appendix 6).

Data layers were contributed from different agencies, which resulted in layer overlay issues between separate datasets. For example, the City of Hays tries to preserve street right-of-way when drawing property boundaries, whereas Ellis County tries to preserve property dimensions when drawing property boundaries (Figure 12). It was assumed that this would be an inherent problem when working with data from multiple agencies, and was addressed by developing the geodatabase schema and mapping application layer structure in a way to incorporate both layers with the ability to turn on and off each layer depending on user's required information. Data overlay issues were explained during user training sessions so that staff members were aware of the matter, and so that data layers were being used for the correct application.

Because multiple agency data layers can be overlaid in the same software environment, the quality of GIS data has been improved since the implementation of the web mapping application. City and county departments overlay datasets from both organizations in the same application, and may visually cross reference them for any

discrepancies. Errors in datasets have been identified and corrected through this method, further improving the accuracy and integrity of data in the system and in city/county departments.

It was found in other case studies that geodatabase replication, a feature available in ESRI software suites, was used to update information within geodatabases. The geodatabase replication feature proved to be problematic because of city/county network security policies. In addition, both the geodatabase and dependant files such as property images and scanned plats had to be replicated. Microsoft SyncToy was used in place of ESRI's geodatabase replication functionality because it allows entire directories to be synchronized and operated under enforced security policies.

Future work may entail ongoing system maintenance, additional data inclusion, and further web mapping application development. Ongoing interviews and user feedback would provide insight into the usage and applicability of the mapping application, and additional tools and functionality can be developed based on user responses.

Constructing a map cache, or set of pre-rendered layer images, would allow for faster web mapping application display, and could be implemented to enhance the mapping application's performance. Generating a map cache would require that all map layers be segregated into individual web map services, not combined in a single web service as in the city/county's implementation. Segregating layers into individual web services would also support the development of new specialized mapping applications that combine only pertinent web services and serve a specific purpose, such as utility or

parcel mapping. A mapping application designed for a specific purpose can incorporate specialized tools and typically has higher clarity with the omission of unnecessary information (ESRI, 2009).

Implementing a web-based GIS system is relatively low cost compared to traditional desktop software licensing, which may have greater appeal to community commissioners. In the case of the City of Hays and Ellis County, the ArcGIS Server platform was easier to justify to city/county commissions as it provides data viewing capabilities to all agency staff members, previously only available to staff with desktop software, for the same cost as two desktop licenses. In addition, the implementation made data resources available to the public that were otherwise unavailable, or required a specific office request to obtain.

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Retrieved from: <http://www.gisdevelopment.net/proceedings/gisdeco/2004/paper/ahrispf.htm>

TABLE 1
Available software licenses and GIS software experience

Department	ArcMap Licenses	AutoCAD Licenses	ArcMap Experience	AutoCAD Experience
<u>City of Hays</u>				
City Clerks	0	0	0	0
City Manager	0	0	0	0
Fire Department	0	0	0	0
Information Technology	2	1	2	1
Parks	0	0	0	0
Police Department	5	0	10	0
Public Works	2	2	3	2
Utilities	1	0	2	0
<u>Ellis County</u>				
Appraisers	3	3	3	5
Attorney	0	0	0	0
Clerk	0	0	0	0
Emergency Medical Services	0	0	0	0
Emergency Management	1	0	0	0
Information Technology	1	0	0	0
Public Works	1	1	2	2
Register of Deeds	0	0	0	0
Rural Fire	0	0	0	0
Sheriff	2	0	0	0
Treasury	0	0	0	0
Totals				
	18	7	22	10

TABLE 22009 City of Hays home page visitor statistics - <http://www.haysusa.com>

Category	Page Hits	% of Page Hits
<u>Connection Speed</u>		
Cable/DSL	72,800	53.15%
Corporate/T1	56,922	41.51%
Dial Up	5,563	4.06%
Unknown	1,759	1.28%
<u>Browser Type</u>		
Internet Explorer 8	38,412	28.01%
Internet Explorer 7	36,381	26.53%
Firefox 3	25,215	18.39%
Internet Explorer 6	17,663	12.88%
Safari 4	3,071	2.44%
<u>Screen Resolutions</u>		
1024 x 768	43,093	31.43%
1280 x 1024	42,423	30.94%
Other	11,694	8.53%
1440 x 900	11,367	8.29%
1680 x 1050	8,713	6.35%
<u>Bit Depths</u>		
32 Bit	107,753	78.58%
24 Bit	20,587	15.01%
16 Bit	4,995	3.64%
Other	3,717	2.71%
8 Bit	72	0.05%

2009 Total Visitors	71,323
Average Daily Visitors	195
Average Hourly Visitors	8

TABLE 3
GIS Data Server and GIS Web Server hardware specifications

Specification Category	Integrated Hardware
<u>Dell PowerEdge 2950 (Data Server)</u>	
Operating System	Microsoft Windows Server 2008 (R2) Standard
Processor Speed	Intel Xeon Quad-Core X5270 - 3.50GHz (x4)
Random-Access Memory (RAM)	4.00 GB
Hard Disk Space	1.5 TB
Hard Disk Array	RAID 5
<u>Lenovo ThinkServer RD120 (Web Server)</u>	
Operating System	Microsoft Windows Server 2008 (R2) Standard
Processor Speed	Intel Xeon Quad-Core 5160 - 3.0GHz (x4)
Random-Access Memory (RAM)	4.00 GB
Hard Disk Space	1 TB
Hard Disk Array	None

TABLE 4
Internal and external web mapping application visitor statistics

Month	Visits
<u>GIS Data Server (internal WMA, SmarterStats)</u>	
January, 2010	438
February, 2010	468
March, 2010	716
April, 2010	553
Total	2,175
Average Monthly Visitors	543
<u>GIS Web Server (external WMA, Google Analytics)</u>	
April, 2010	666
May, 2010	471
June, 2010	878
July, 2010	889
Total	2,904
Average Monthly Visitors	726

FIGURE 1
City of Hays/Ellis County network diagram.

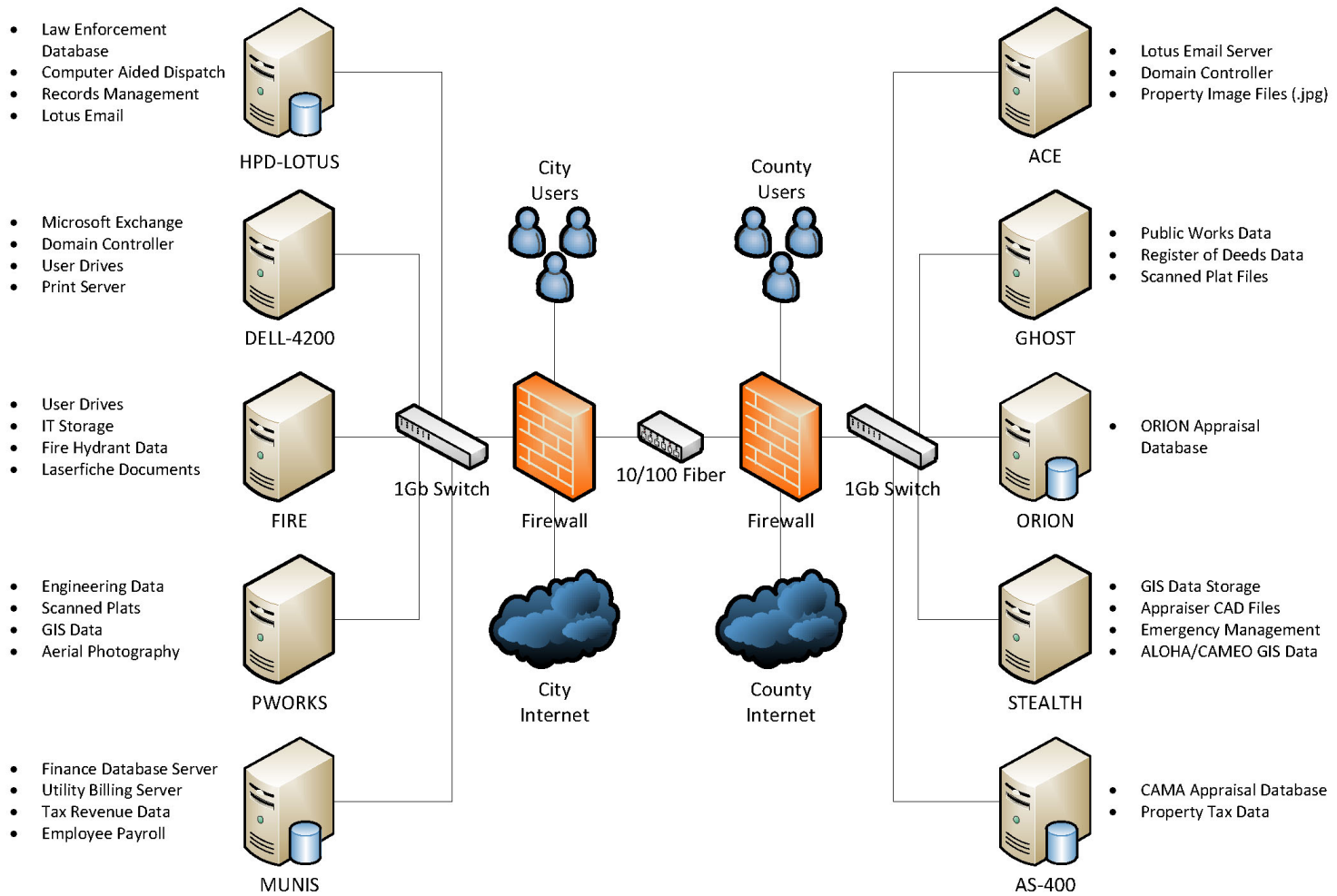


FIGURE 2

Requested GIS content and user functionality recorded at departmental staff meetings.

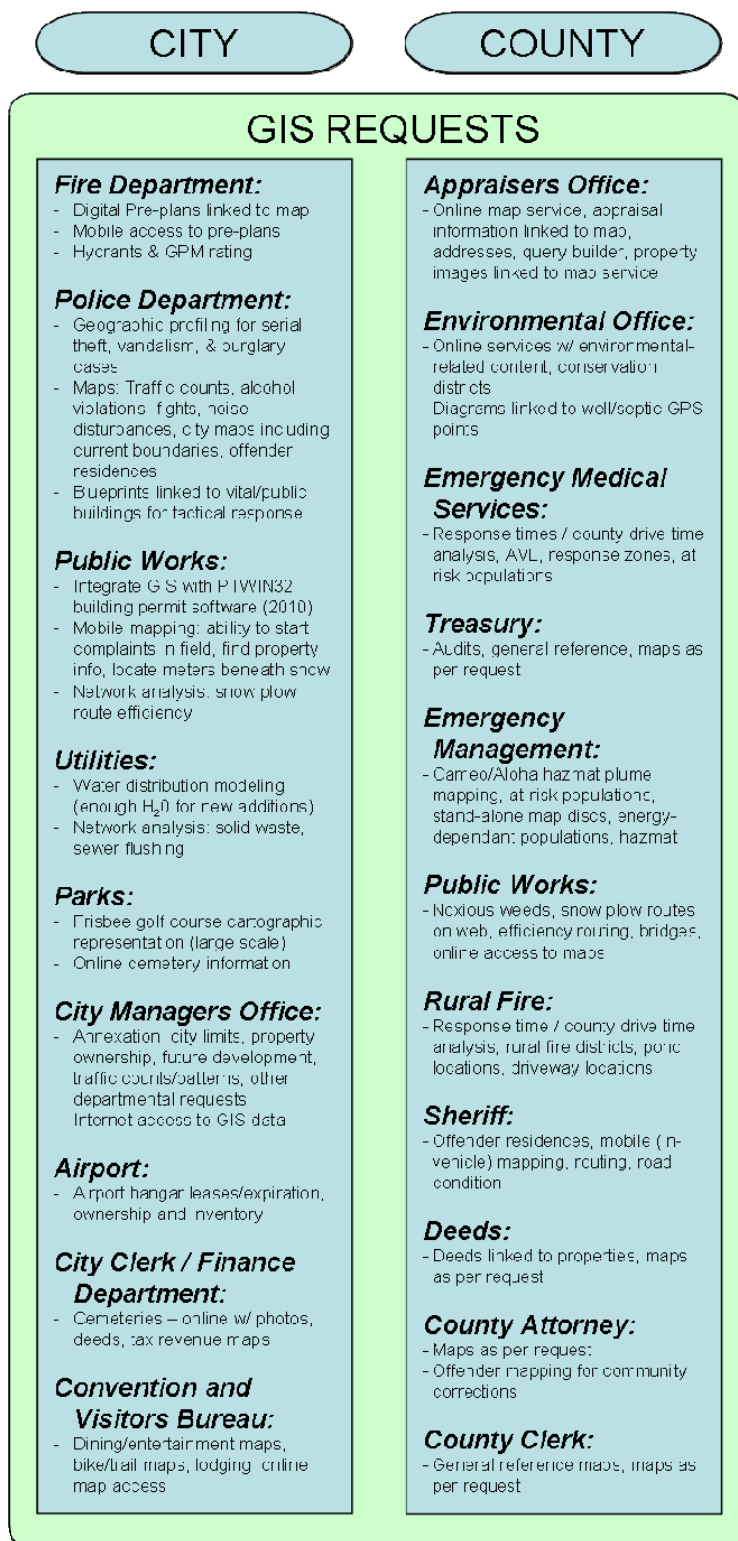


FIGURE 3
Data layers required to meet user requests and functionality.

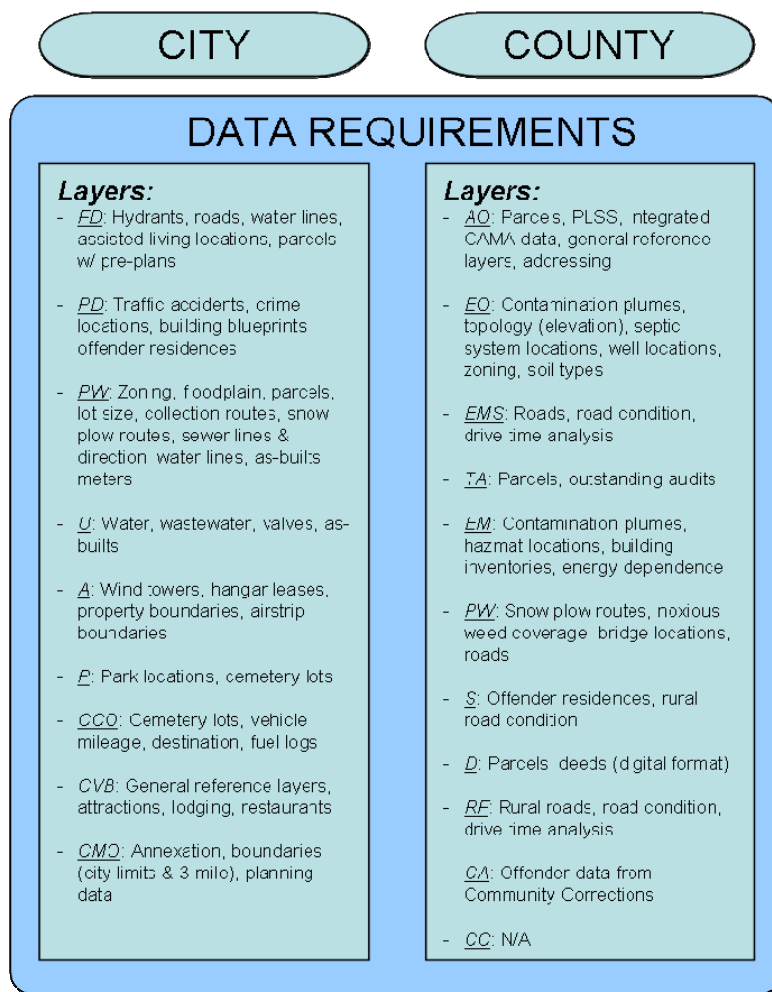


FIGURE 4
All web services components in the DMZ: The most secure web server configuration
(Peters, 2009).

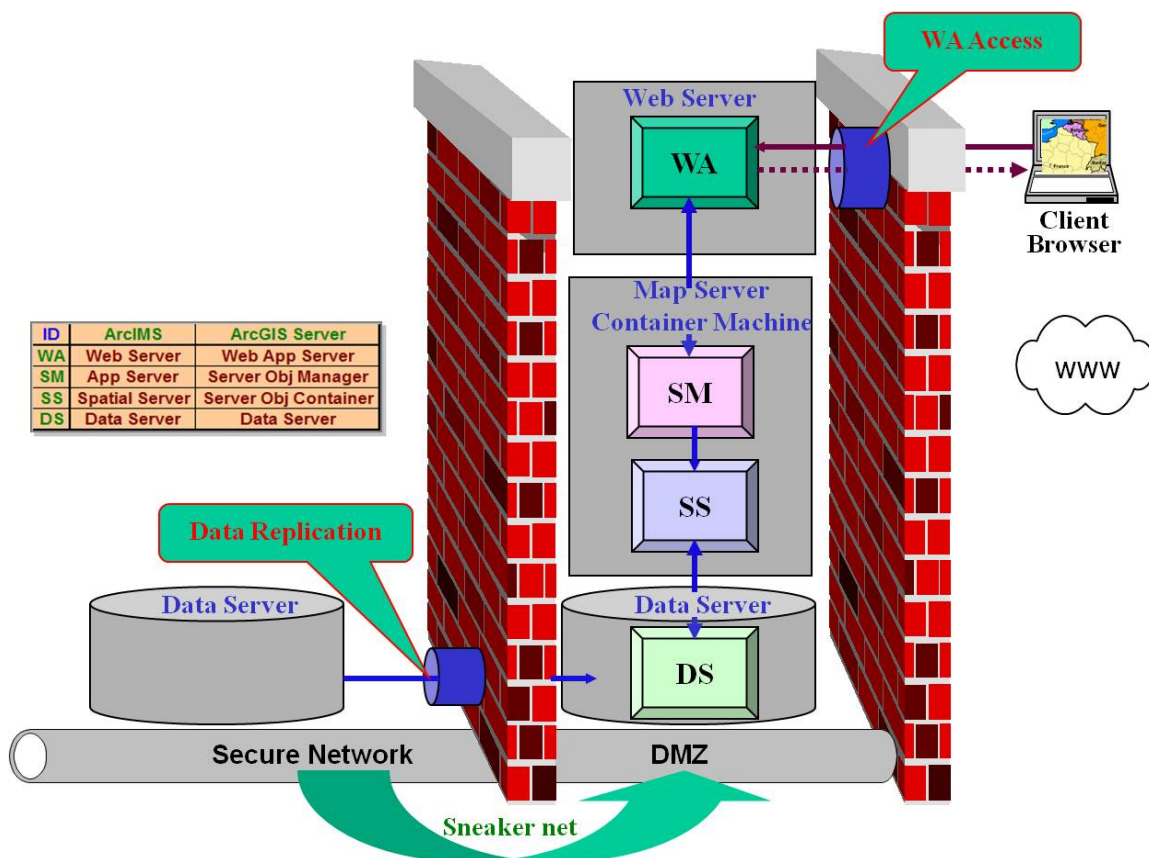


FIGURE 5
GIS Data Server and GIS Web Server network integration.

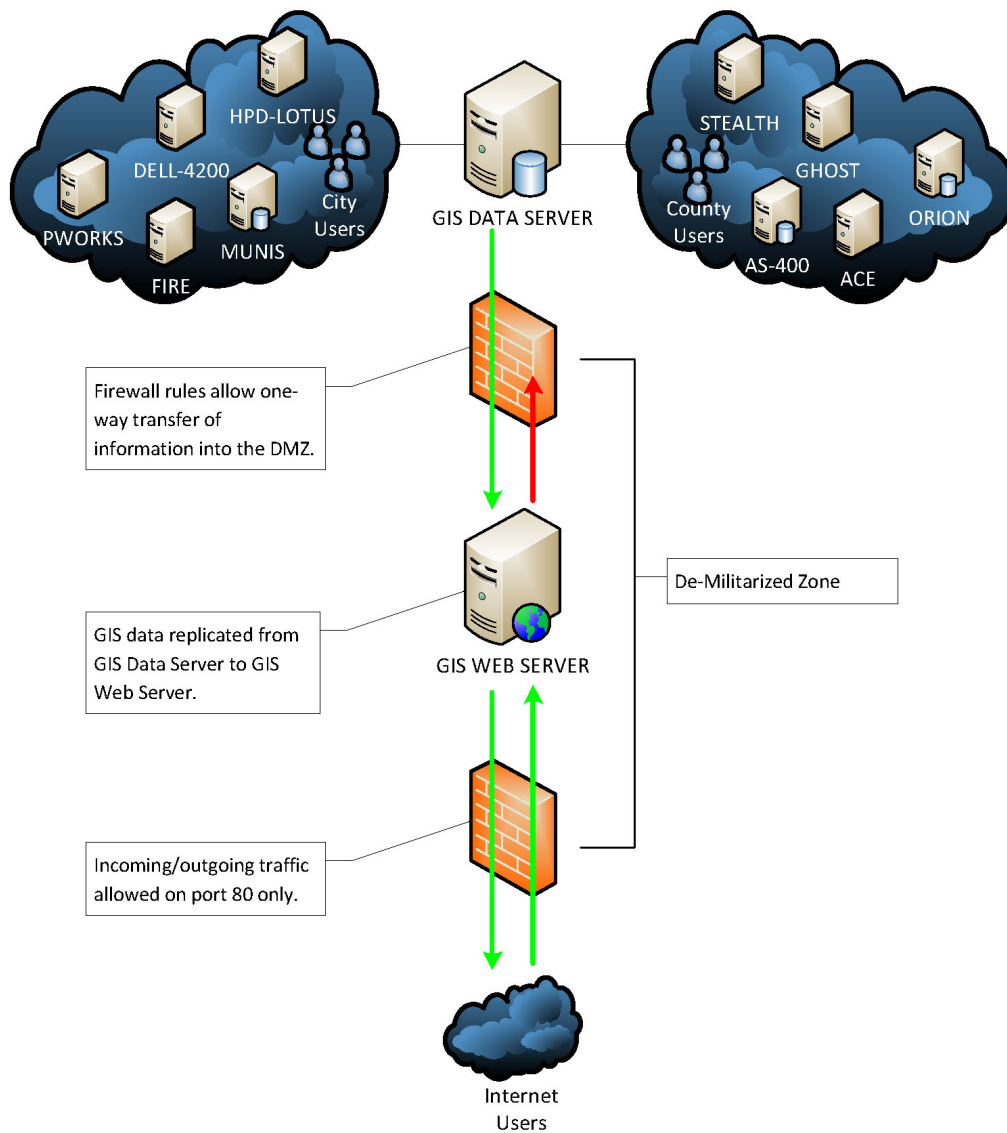


FIGURE 6
 Display Transaction Rates vs. Chipset Speed (Peters, 2008).

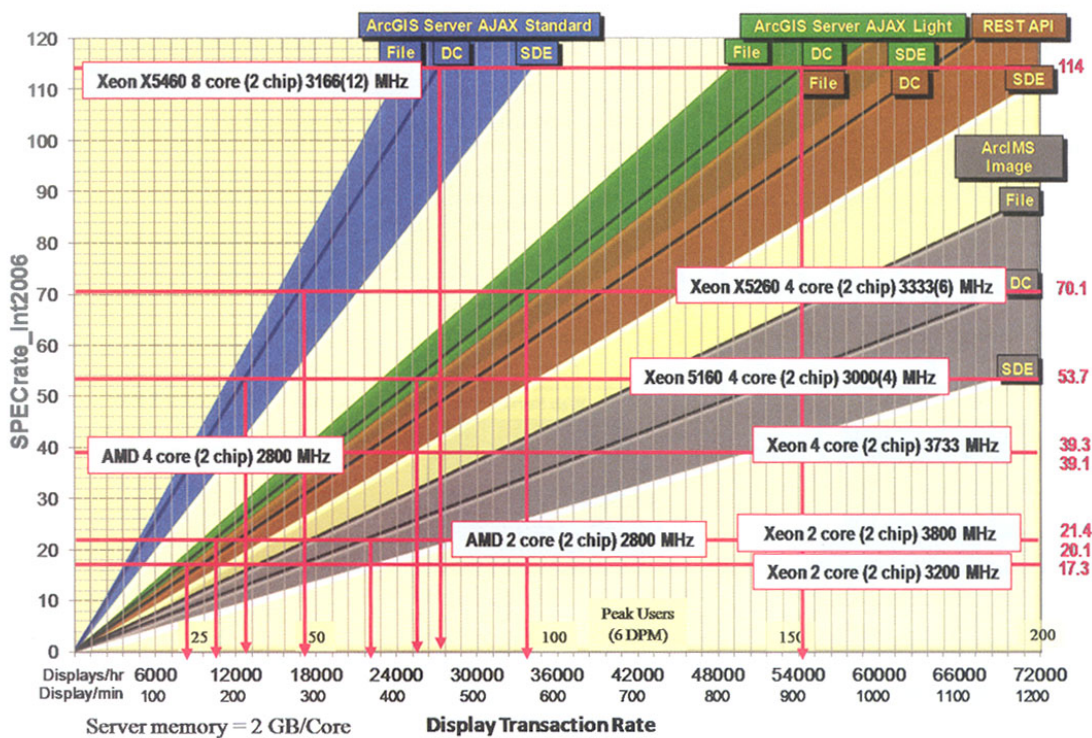


FIGURE 7
GIS Data Server: geodatabase schema and network data resources.

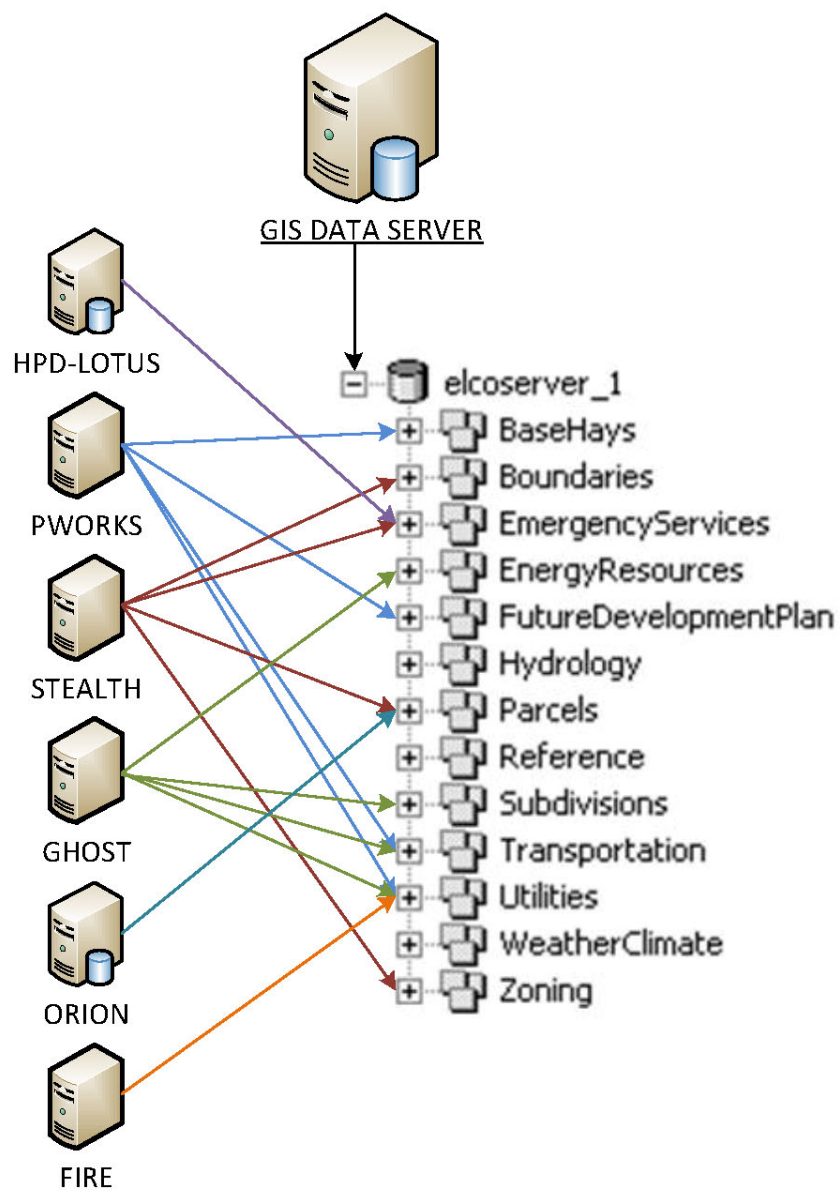


FIGURE 8
Map document developed for web mapping application.

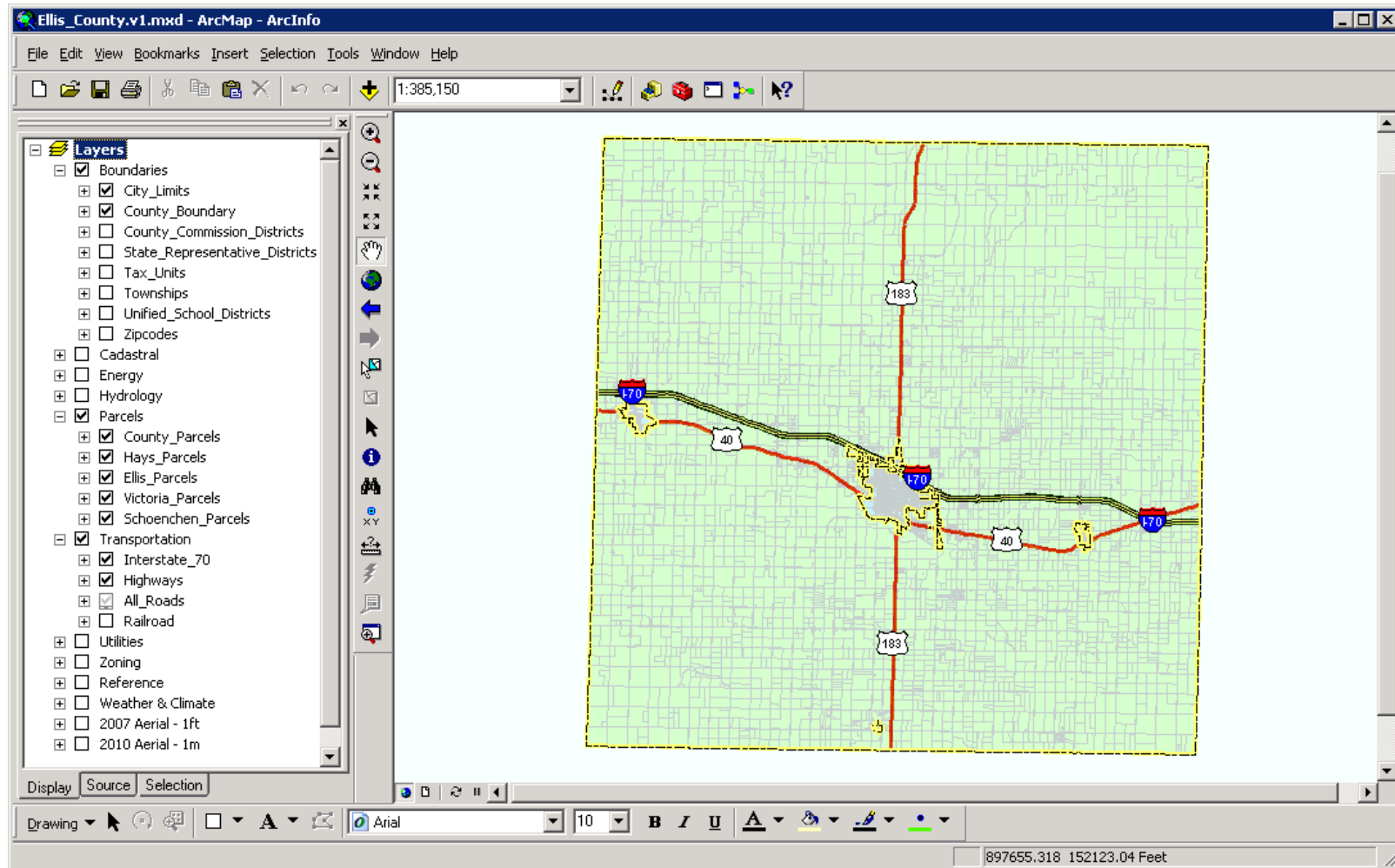
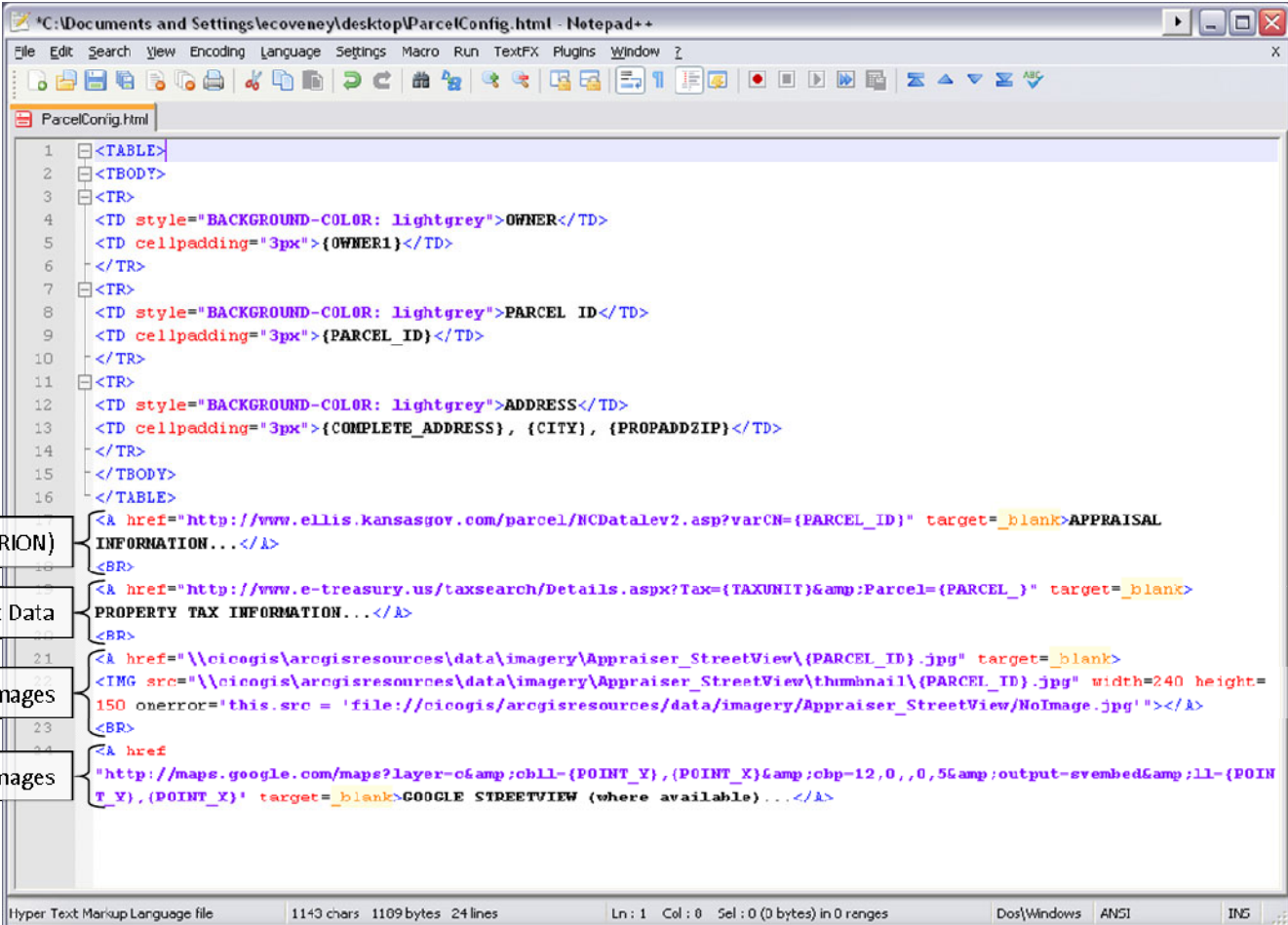


FIGURE 9

Example of HTML/JavaScript code for hyperlinks to external online data resources.



```
1 <TABLE>
2 <TBODY>
3 <TR>
4 <TD style="BACKGROUND-COLOR: lightgrey">OWNER</TD>
5 <TD cellpadding="3px">{OWNER1}</TD>
6 </TR>
7 <TR>
8 <TD style="BACKGROUND-COLOR: lightgrey">PARCEL ID</TD>
9 <TD cellpadding="3px">{PARCEL_ID}</TD>
10 </TR>
11 <TR>
12 <TD style="BACKGROUND-COLOR: lightgrey">ADDRESS</TD>
13 <TD cellpadding="3px">{COMPLETE_ADDRESS}, {CITY}, {PROPADDZIP}</TD>
14 </TR>
15 </TBODY>
16 </TABLE>
17 <A href="http://www.ellis.kansasgov.com/parcel/NCDatalev2.asp?varCN={PARCEL_ID}" target=_blank>APPRAISAL
18 INFORMATION...</A>
19 <BR>
20 <A href="http://www.e-treasury.us/taxsearch/Details.aspx?Tax={TAXUNIT}&Parcel={PARCEL_}" target=_blank>
21 PROPERTY TAX INFORMATION...</A>
22 <BR>
23 <A href="\\cicogis\arcgisresources\data\imagery\Appraiser_StreetView\{PARCEL_ID}.jpg" target=_blank>
24 <IMG src="\\cicogis\arcgisresources\data\imagery\Appraiser_StreetView\thumbnail\{PARCEL_ID}.jpg" width=240 height=
25 150 onerror='this.src = 'file://cicogis/arcgisresources/data/imagery/Appraiser_StreetView/NoImage.jpg' "></A>
26 <BR>
27 <A href
28 "http://maps.google.com/maps?layer=c&cbll={POINT_Y},{POINT_X}&cbp=12,0,,0,5&output=embed&ll={POIN
29 T_Y},{POINT_X}" target=_blank>GOOGLE STREETVIEW (where available)...</A>
```

Ellis County Online Appraisal Data (ORION)

Ellis County Online Property Tax Data

Ellis County Property Images

Google StreetView Images

Hyper Text Markup Language file 1143 chars 1109 bytes 24 lines Ln: 1 Col: 0 Sel: 0 (0 bytes) in 0 ranges Dos/Windows ANSI INS

FIGURE 10
Data in the geodatabase and external data resources accessed using the “Identify” tool.

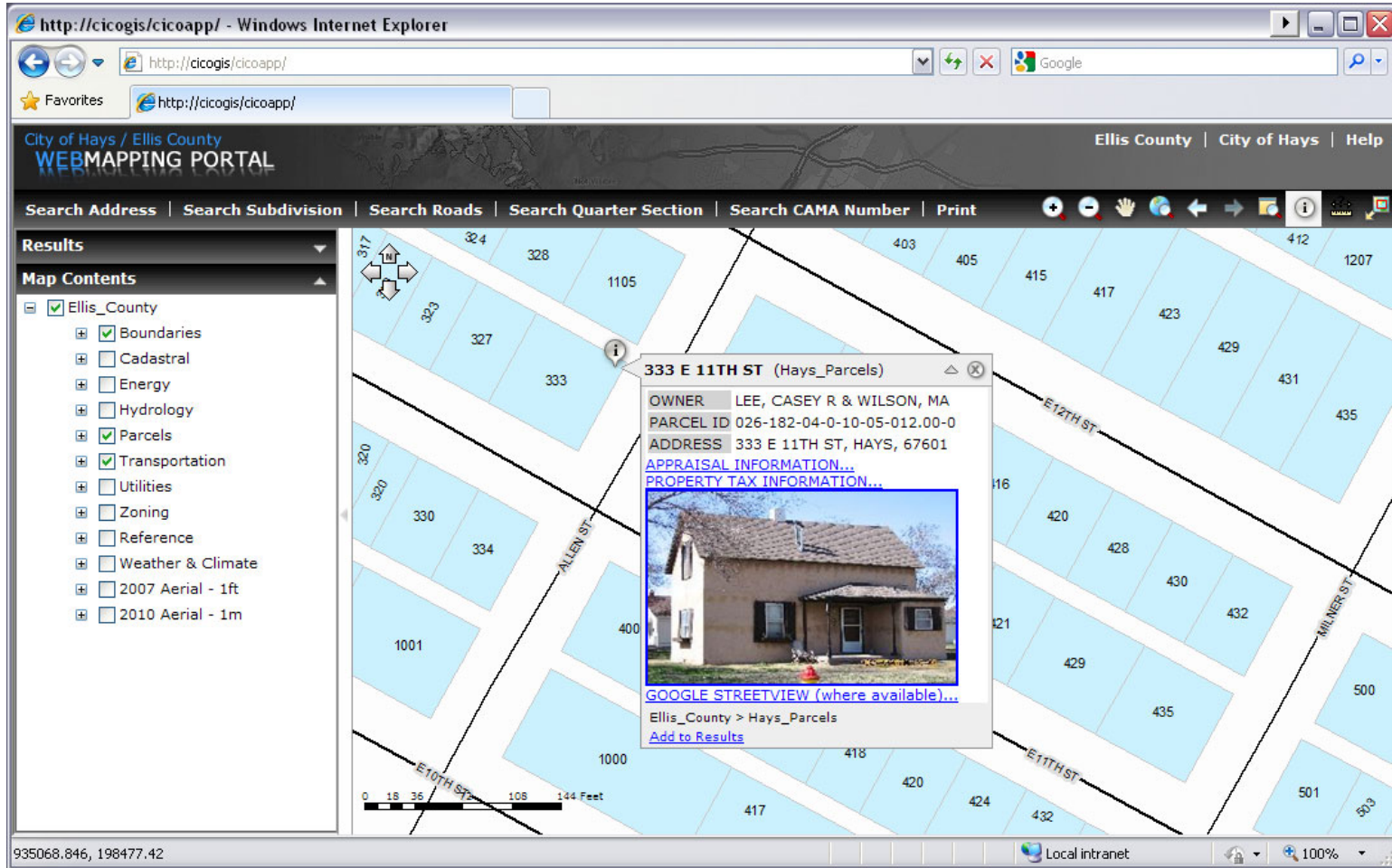


FIGURE 11
Internal web mapping application visitor statistics for January 2010 – April 2010.

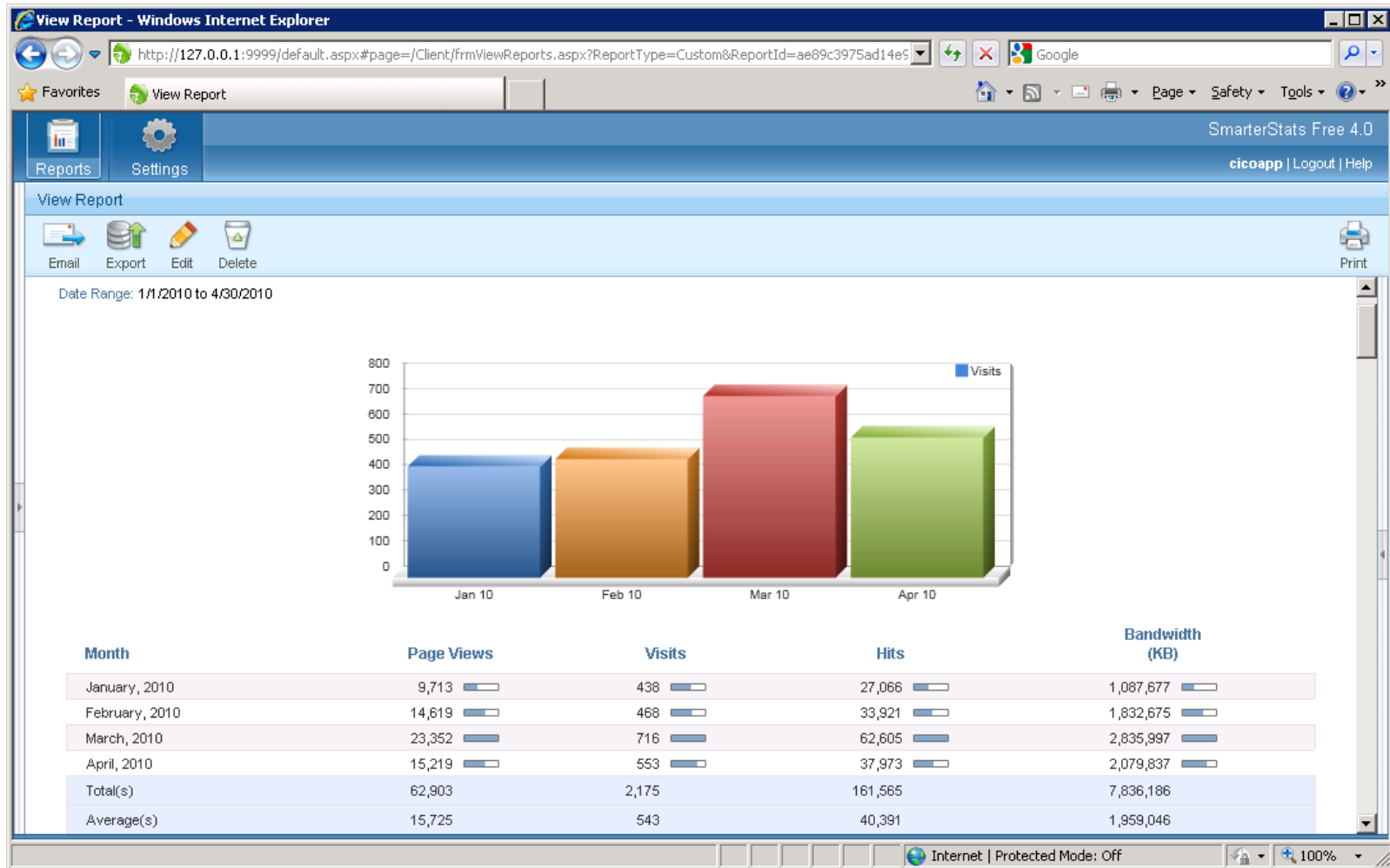


FIGURE 12
Misalignments present between data layers from different agencies.

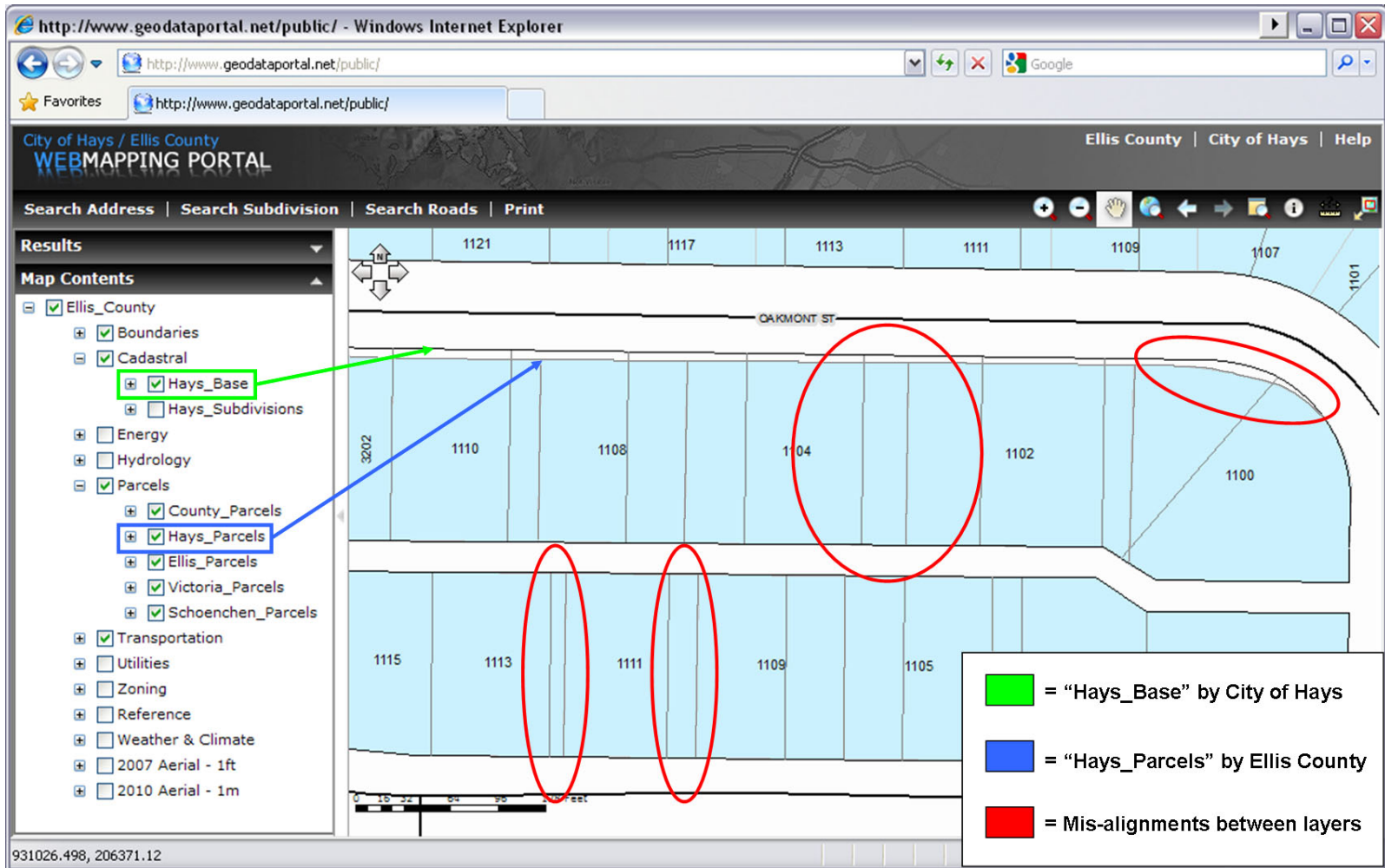


FIGURE 13
External web mapping application visitor statistics for April 2010 – July 2010.



FIGURE 14

Directory of digital map files created by City of Hays/Ellis County staff members – www.geodataportal.net/maps

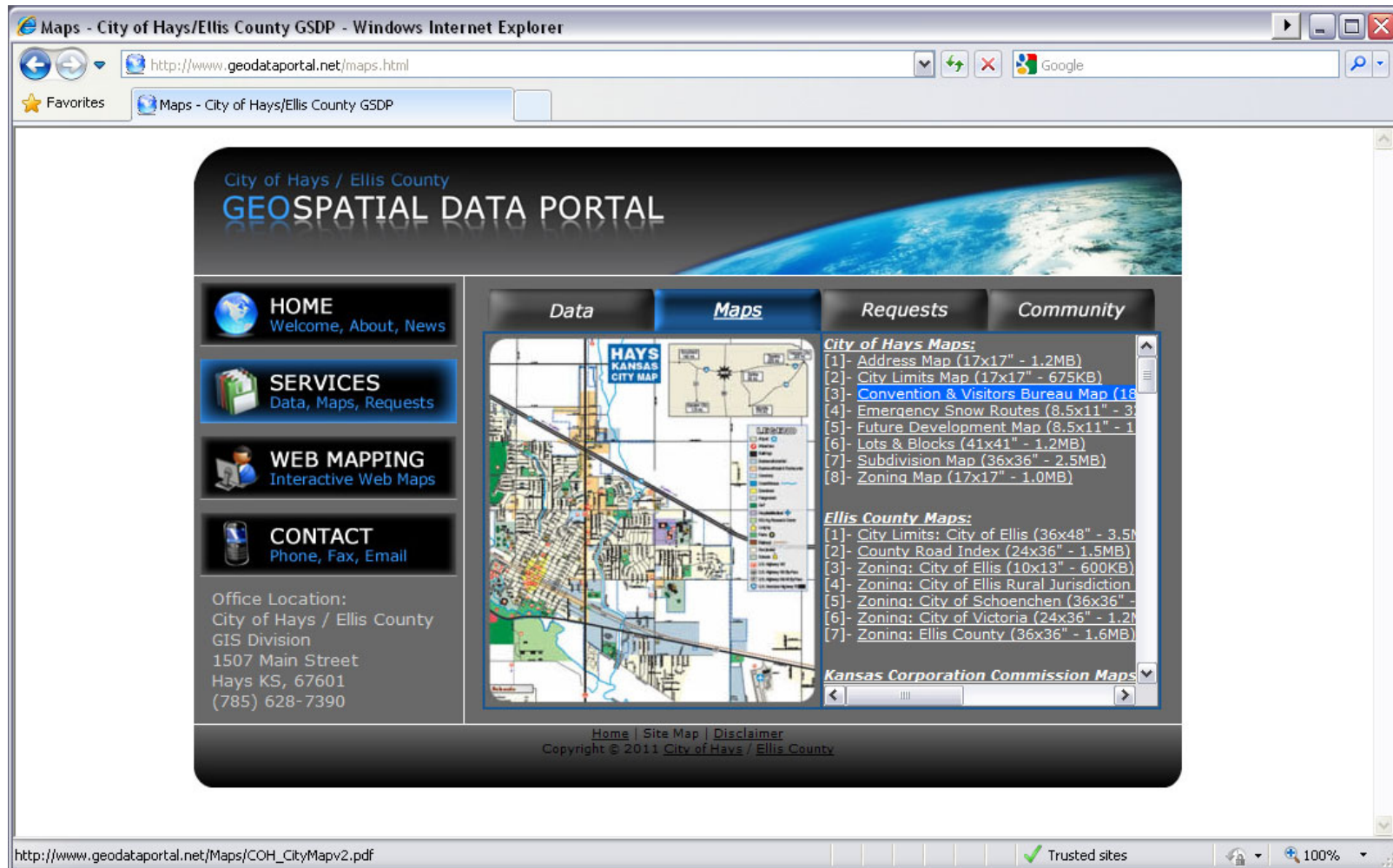


FIGURE 15

Directory of web services published through ArcGIS Server Manager – www.geodataportal.net/webservices_available

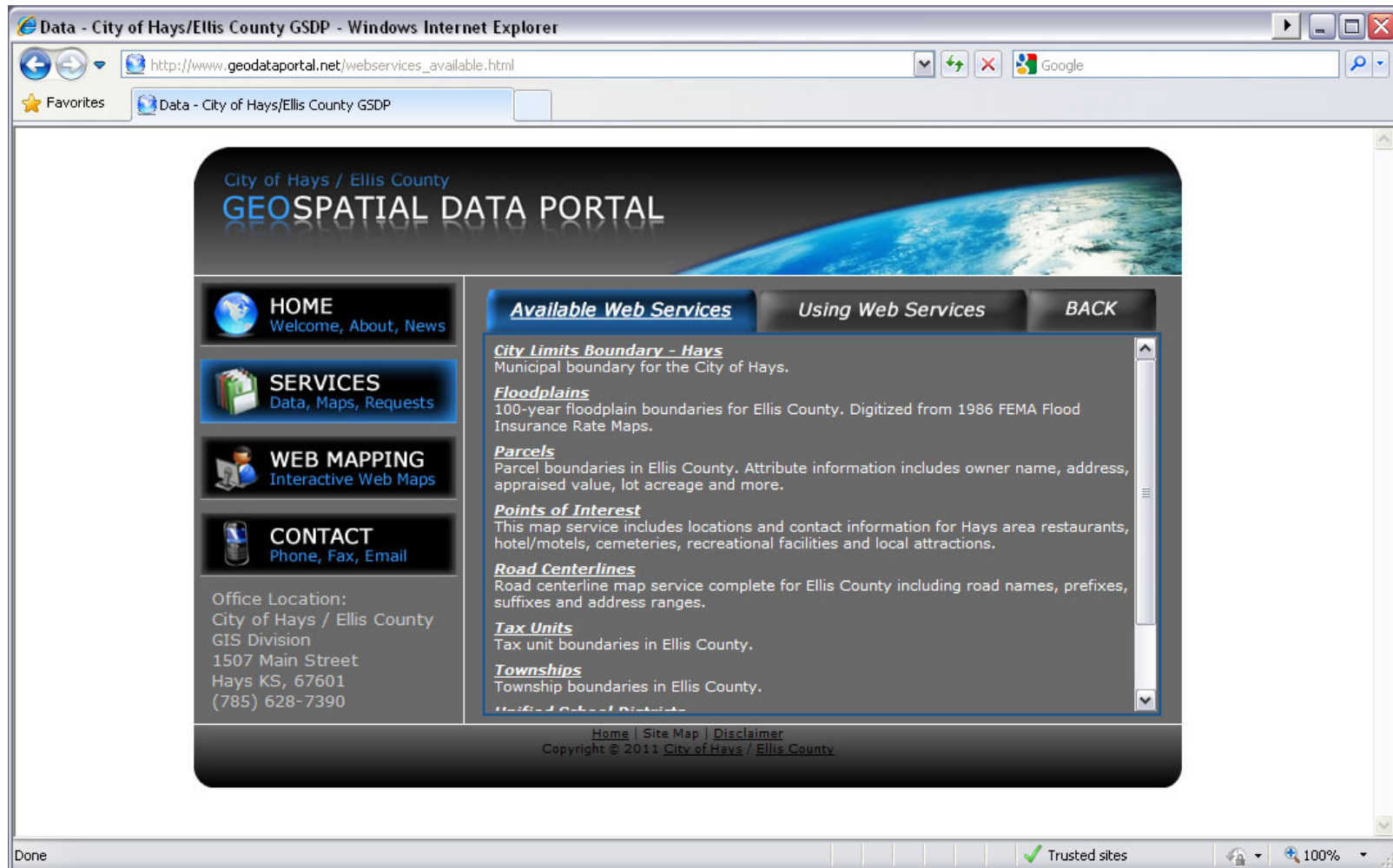


FIGURE 16
Contact information page published to GIS Web Server – www.geodataportal.net/contact

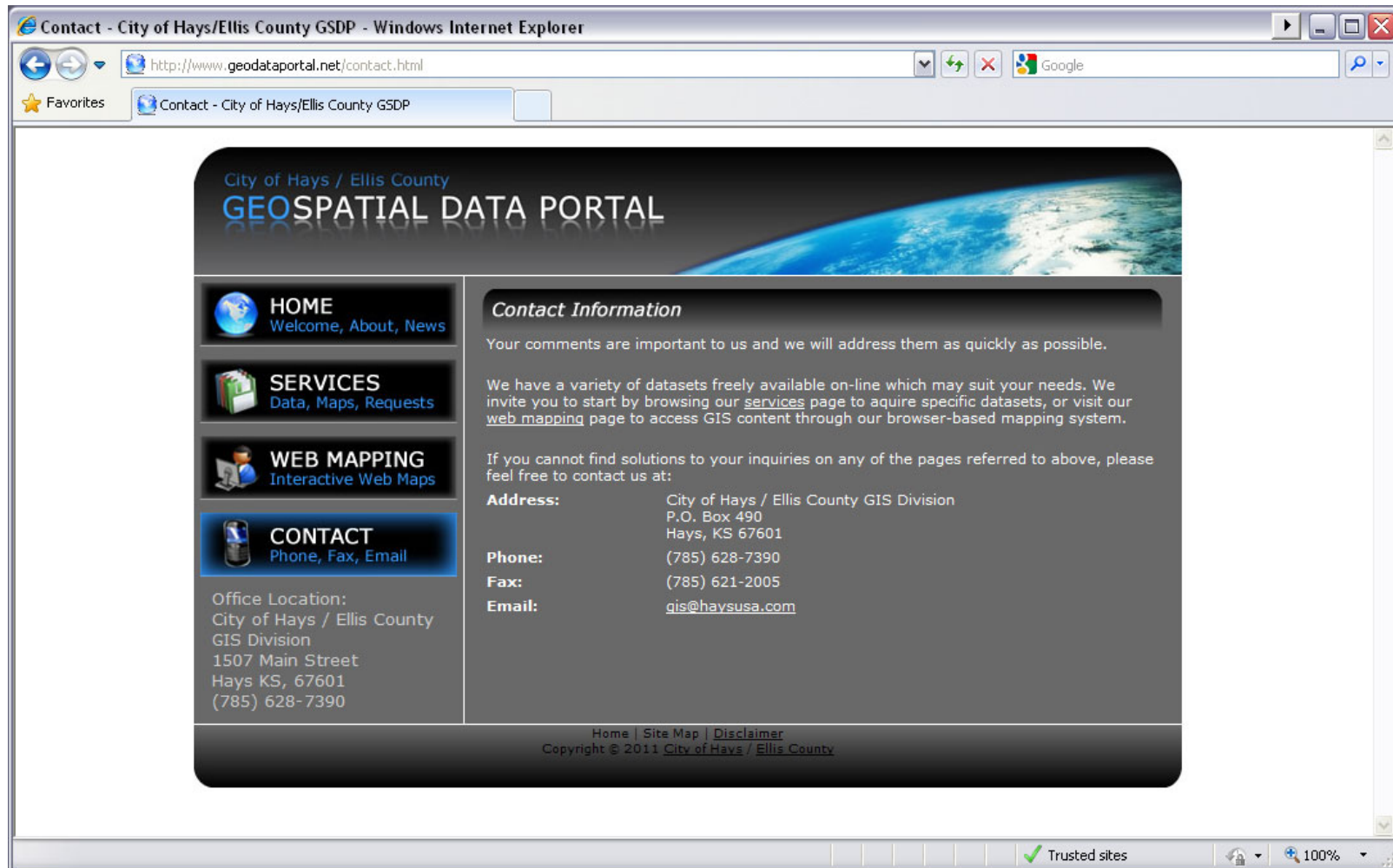
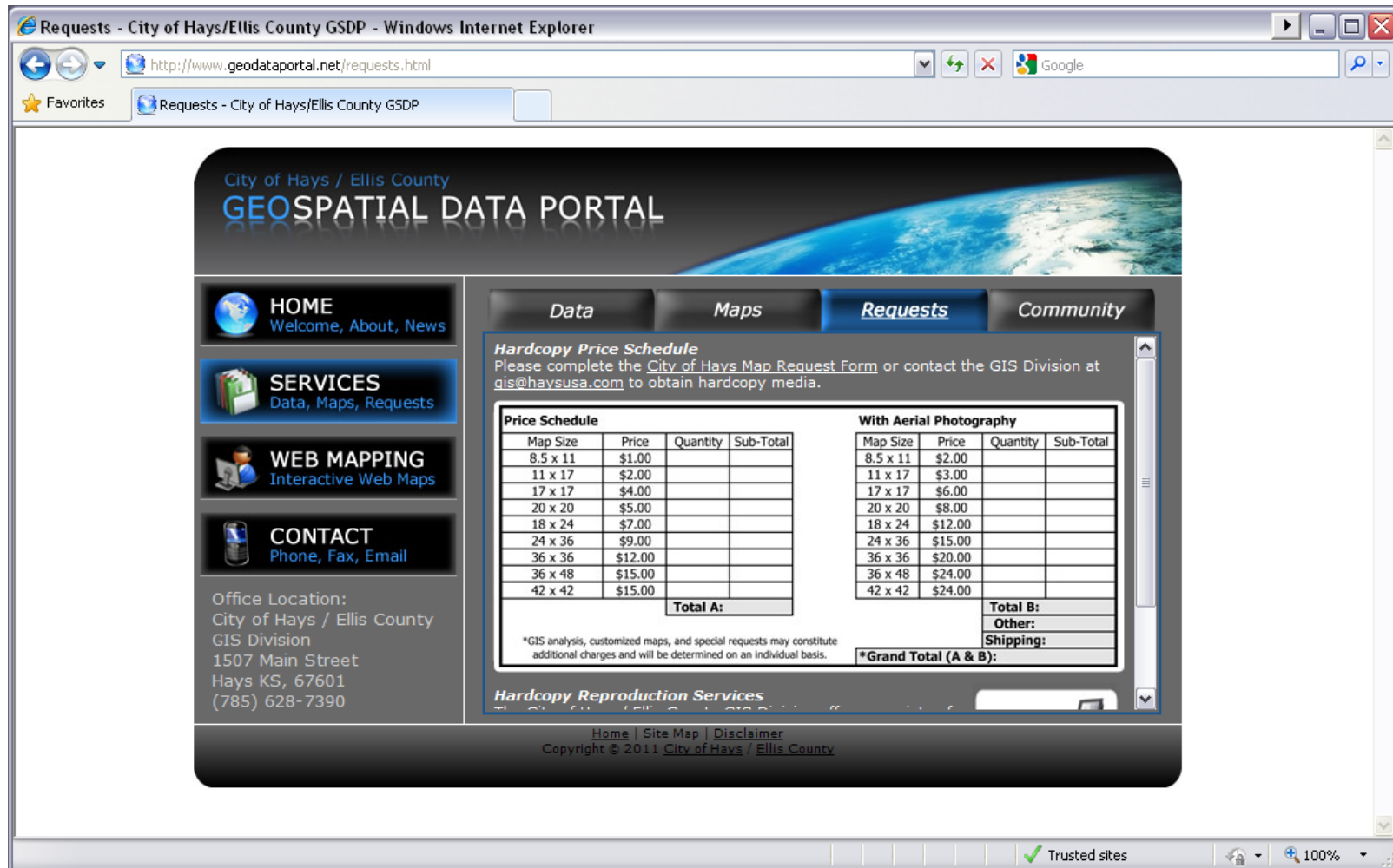


FIGURE 17
 Requests page published to GIS Web Server – www.geodataportal.net/requests



APPENDIX A-1

‘What is GIS?’ – Page 1

GIS/2008 - 1

What is GIS?

GIS is an acronym that stands for ‘Geographic Information System(s)’. As the name implies, it is a computer-based system that houses information with some kind of geographic -or- spatial reference association (e.g., x,y coordinates or latitude/longitude coordinates).

In other words, GIS is a computer technology that combines geographic data (the locations of man-made and natural features) with other types of information (names, addresses, classifications, physical attributes, statistics, etc.) to generate visual maps and reports. GIS is not just a map-making machine; it is a tool that connects decision-makers to the information they need to make sound decisions. Below I have inserted a table summarizing some of the applications of GIS in regional government.

GIS Applications in Local Government			
	Inventory Applications	Policy Analysis Applications	Management/Policy-Making Applications
	(locating property information such as ownership and tax assessments by clicking on a map image)	(e.g., number of features per area, proximity to a feature or land use, correlation of demographic features with geological features)	(e.g., more efficient routing, modeling alternatives, forecasting future needs, work scheduling)
Economic Development	Location of all major businesses and their primary resource demands	Analysis of resource demand by potential local supplier Simulation of alternative development sites	Proactive informing of businesses of availability of local suppliers
Transportation and Services Routing	Identification of bus routes, road capacity, signaling system equipment, and so on; identification of accident sites Identification of sanitation truck routes, capacities, and staffing by area; identification of landfill and recycling sites	Analysis of potential capacity strain given development in certain areas; analysis of accident patterns by time of site Analysis of sanitation truck routing in relation to area pickup needs, routing efficiency, and destination sites	Use of analysis to identify ideal high-density development areas based on criteria such as established transportation capacity Use of analysis to identify potential alternative traffic flow mechanisms (e.g., four-way stops instead of two-way stops) Use of analysis to change routes or to decide where recycling programs or sites should be located
Housing	Inventory of housing stock age, condition, status (public, private, rental, and so forth), weatherization, demographics, etc.	Analysis of levels of public support for housing by geographic area, drive time from low-income areas to needed service facilities, and so on	Use of analysis to direct funding for housing rehabilitation or weatherization; routing of work crews; location of related public facilities; planning for capital investment in housing based on population growth projections in particular areas
Infrastructure	Inventory of roads, sidewalks, bridges, utilities; locations, names, conditions, foundations, most recent maintenance	Analysis of infrastructure conditions by demographic variables such as income, population change	Use of analysis to schedule maintenance and expansion
Health	Location of persons with particular health problems	Spatial, time-series analysis of the spread of disease; analysis of association of disease with environmental conditions	Use of analysis to pinpoint possible sources of disease
Tax Maps	Identification of ownership data by land plot	Analysis of tax revenues by land use within various distances from the city center	Projecting of tax revenue change due to land-use changes
Human Services	Inventory of neighborhoods with multiple social risk indicators; location of existing facilities and services designated to address these risks	Analysis of match between service facilities and human services needs and capacities of nearby residents	Use of analysis to guide facility siting, public transportation routes, program planning, and place-based social intervention
Law Enforcement	Inventory of location of police stations, crimes, arrests, convicted perpetrators, and victims; plotting of police beats and patrol car routing; alarm and security system locations	Analysis of police visibility and presence; officers available in relation to density of criminal activity; victim profiles in relation to residential populations; police experience and beat duties	Use of analysis to reallocate police resources and facilities to areas where they are likely to be most efficient and effective; creation of random routing maps to decrease predictability of police beats

APPENDIX A-2

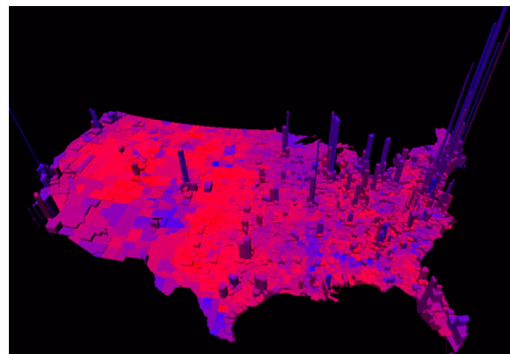
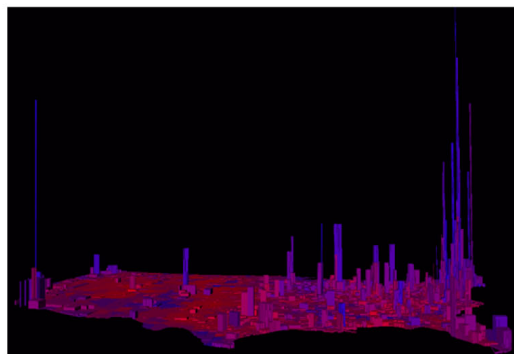
‘What is GIS?’ – Page 2

GIS/2008 - 2			
Land-use Planning	Parcel inventory of zoning areas, floodplains, industrial parks, land uses, trees, green space, etc.	Analysis of percentage of land used in each category, density levels by neighborhoods, threats to residential amenities, proximity to locally unwanted land uses	Modeling of expected industrial, retail, and residential population growth for land-use plan; evaluation of land-use plan based on demographic characteristics of nearby population (e.g., will a smokestack industry be built upwind of a respiratory disease)
Parks and Recreation	Inventory of park holdings, playgrounds, trails by type, etc.	Analysis of neighborhood access to parks and recreation opportunities, age-related proximity to relevant playgrounds	Modeling of potential growth projections and potential future recreational needs and playground uses
Environmental Monitoring	Inventory of environmental hazards in relation to vital resources such as groundwater; layering of nonpoint pollution sources	Analysis of spread rates and cumulative pollution levels; analysis of potential years of life lost in a particular area due to environmental hazards; using multiple overlays of different pollutants to identify areas of potentially negative synergistic effects	Modeling of potential environmental harm and duration of harm to specific local areas; use of analysis of multilayered pollution to guide place-specific pollution abatement plans
Emergency Management	Location of key emergency exit routes, their traffic flow capacity, and critical danger points (e.g., bridges likely to be destroyed by a natural disaster)	Analysis of potential effects of emergencies of various magnitudes on exit routes, traffic flow, etc.	Modeling of effect of placing emergency facilities and response capacities in particular locations
Citizen Information/ Geodemographics	Location of persons with specific demographic characteristics such as voting patterns service usage and preferences, commuting routes, occupations	Analysis of voting characteristics of particular areas	Modeling of effect of placing information kiosks at particular locations

- Adapted from: *Beyond Maps: GIS and Decision Making in Local Government* -

Geographic Information Systems and Interactive Mapping

You can think of GIS as “electronic cartography”; that is to say, GIS creates an electronic map generated from a tabular dataset. This allows the user to change what dataset features they are comparing and see a map display update in real time. This technology reveals spatial relationships that exist within a dataset that may have not been apparent before. GIS also allows us to display data in creative new ways, such as 3-dimensional mapping. Below are two examples of 3-dimensional mapping.



- From: www.princeton.edu -

These maps show the 2004 presidential election results by county (from two perspectives). Counties that appear red tended to vote republican, counties that appear blue tended to vote democratic, and purple counties have a combination of republican and democratic votes. Each county has been extruded by population. As the maps indicate, areas of high population tend to vote democratic, and areas of low population tend to vote republican; a relationship that may have gone unnoticed without the assistance of GIS.

APPENDIX A-3

‘What is GIS?’ – Page 3



GIS/2008 - 3

Real World Examples of Internet-Based GIS

Below are a few links that show how some local governments are currently using web-based GIS. As you will notice, some of the sites are far more developed than others. To load these links in your default browser (though some may only work in IE), hold down the CTRL key on your keyboard while you click the link. For many of these sites, you will have to agree to a data disclaimer before entering the mapping application.

Quick-Start Tutorial

GIS data is organized into layers, and the sites below allow you to turn visible layers "on" and "off". Checking a box and refreshing the map will add the layer to your map, un-checking a layer will remove it from your map display. You also have the option to set one layer to "active". The active layer will display information associated with it when using the "identify" tool (see below).

The three most common tools used in interactive mapping are the "Zoom In/Out" , and the "Identify"  tool. Choose the identify tool and select an object on the map (this object must be part of the active layer) to display any attribute information associated with that feature.

Websites

Link #1: Many of these sites have a common interface system consisting of a series of buttons. For a quick tutorial and list of button functions please click "Link #1".

- http://prairies.c-ciarn.ca/website/information/ArcIMS_ToolbarInfo.htm -

Link #2: This is the City of Salina's Public Access Mapping site. The upper-right hand corner of the viewer allows you to choose between three maps: Utilities, General, and Planning. By selecting one of these options, the viewer automatically selects a pre-defined set of visible layers. Layers can manually be turned on or off below.

- <http://66.210.12.106> -

Link #3: Broome County's Unified Parcel Information System. This system houses a tremendous amount of data including land assessments, tax maps, addresses, and zoning.

- <http://broomegis.co.broome.ny.us/Website/GISWeb/gisapps.htm> -

Link #4: Wisconsin County Web Mapping Sites. This site contains links to online mapping applications for almost every county in Wisconsin. Some are better than others...

- <http://coastal.lit.wisc.edu/wisconsin-ims/wisconsin-ims.htm> -

When viewing these sites, I ask that you be thinking about how GIS could benefit your department, what types of information and interfaces you would like to see, and to record and email me any ideas/questions you may have.

Thank you,
Eamonn Coveney
 GIS Specialist / I.T. Division
ecoveney@haysusa.com
 (785) 628-7390

APPENDIX B-1

'County Department Uses for GIS' (Allen et al., 2006) – Page 1



THE KANSAS
COLLABORATIVE
government working together for better results™

The Kansas Collaborative is a joint effort between the State of Kansas, the Kansas Association of Counties and the League of Kansas Municipalities to foster collaboration and improve government efficiency. By working together, local and state officials improve accountability and maximize public resources – leading to better results for Kansas.

Projects of The Kansas Collaborative are managed and facilitated by TeamTech Inc.

TheKansasCollaborative.com

County Department Uses for GIS

May 2006

Appraiser

1. Mapping the new soils as required by the Department of Revenue, Property Valuation Division. Note: The last time many counties performed this task, it required many hours of manual drawing and calculations.
2. Converting from manual mapping to digital maps with appraisal data attached.
3. Utilizing digital imagery (aerial photography, satellite images, site photo, etc.) to value and identify all taxable properties. (Note: DASC at KU has one meter photography available as a starting point.)
4. For easier and greater access by public and other departments to all the information in the appraiser's office thereby minimizing the need to track down needed information.
5. Tracking hearing information
6. Providing information/intelligence to Sheriff's office, E-911 and Emergency management.

Attorney/District Attorney's Office

1. Crime statistics
2. Jury pools
3. Special maps for events and crimes
4. Mapping drug safety zones around schools

Clerk

1. May be the County Information Officer. Office is responsible for getting information to the media in times of an emergency.
2. GIS can be used for election boundaries, political party information and tax units.
3. Maps of school districts
4. Parcels or land records
5. Maps of polling stations to look at 500 foot circumference

Continued

The Kansas Collaborative
 300 SW 8th Avenue
 3rd Floor
 Topeka, KS 66603

Randall Allen
 Kansas Association of Counties
 (785) 272-2585
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 kathleen@teamtchinc.com

APPENDIX B-2

'County Department Uses for GIS' (Allen et al., 2006) – Page 2

County Department Uses for GIS

Page 2

Commissioners

1. GIS Mapping seems to be the way we will track the county's property in the future. Any money spent moving the county in that direction will likely be money well spent.
2. Using GIS in Commission meetings can bring a visual display that helps in decision-making when approving land uses, rezoning, etc.
3. Maps of commissioner districts
4. Economic development information and planning

Customer Service

1. Providing GIS data via the web as a service to taxpayers and others (i.e.) Appraiser's office can provide data like maps, sales, dwelling data, etc. to fee appraisers (at a cost) that saves staff time

Economic Development

1. Proposed project analysis
2. Available land site maps
3. Labor pool maps
4. Revitalization planning

Emergency Management

1. Resource tracking
2. Special needs populations
3. Damage assessments
4. Flood plains
5. Foreign animal disease planning
6. Ambulance and fire department coordination
7. Helpful in applying for funds such as flood relief or storm damage when physical locations with building values are needed.

EMS -- Fire Depts.

1. Routing for fastest and safest response times. May coordinate with Highway Department if your GIS software has network analysis capability.
2. Emergency Planning with Homeland Security
3. Map out areas for fire planning
4. Location of water sources
5. Location of Hazmat Tier 2 sites
6. Mapping of evacuation routes
7. Parcel data so they know who owns the property
8. Tracking calls over a period of time (where, type of call, etc.) to look for trends

Note: The Kansas Rural Water Association (KRWA) has GPS mapping data for its members. To inquire about data sharing, contact KRWA requesting the data. KRWA will contact the owner of the data (the District or City), relay the request, and then either fulfill or deny the request based on the direction of the owner.

APPENDIX B-3*'County Department Uses for GIS'* (Allen et al., 2006) – Page 3**County Department Uses for GIS**

Page 3

Highway Department

1. Road Signs -- their location, condition, replacement schedules
2. Map roads in County for public use, i.e. farmers, hunters, etc.
3. Track bridge and road repairs, replacements, roads closed
4. Coordinate information with EMS for emergency routing
5. Track utility lines to be located when doing construction on roads
6. Map elevations
7. Track road types and surface
8. Pavement management
9. Track load limits on bridges
10. Track events i.e. accidents
11. Traffic counts
12. Motor grater routes
13. Snow removal, sanding and salting routes and schedules

Health Department

1. Coordinate emergency planning for Homeland Security with Emergency Management, Sheriff and other county departments
2. Add a layer of public health emergency supply locations, decontamination facilities in the county, control center, and facilities to be used in emergencies
3. Location of day care centers, homebound individuals, nursing homes, points of distribution sites, etc.
4. Track communicable disease outbreaks and map contamination, isolation and quarantine areas
5. Mapping of all septic systems, lagoons and wells
6. Mapping of children with elevated lead levels
7. Mapping of mosquito treatment sites
8. Mapping of dead bird calls for West Nile surveillance
9. Mapping of bioterrorism items

Planning and Zoning

1. Zoning changes
2. Land use
3. Variance requests and reviews
4. Notification letters
5. Building permits
6. Addressing
7. Sub-divisions

Sanitarian

1. Source water protection areas
2. Location of sewer lines and storm water/drainage ditches

APPENDIX B-4*'County Department Uses for GIS'* (Allen et al., 2006) – Page 4**County Department Uses for GIS**

Page 4

Sheriff

1. Routing for fastest and safest response times. Should be coordinated with Highway Department through GIS network.
2. Mapping special crime areas
3. Mapping drug safety zones around schools
4. Crime analysis
5. Aerial photography for setting up surveillance

Treasurer

1. Delinquent tax sales
2. Knowing the taxing units
3. Sales tax collection and distribution, destination-based allocation
4. Addressing

Register of Deeds

1. Subdivision maps are an important use for GIS.
2. Tracking right of ways
3. Location of pipelines
4. Lot splits and plats
5. Tracking oil and gas leases
6. Archival function, i.e. scanning old maps

Weed Department

1. Coordinate fields and pastures to be sprayed with landowners by using GIS produced maps
2. Track noxious weeds and their control in the county by mapping weed locations
3. Location where herbicides have been applied

APPENDIX C

Sample questions asked during departmental interviews

1. Is anyone familiar with web mapping applications or online GIS?
2. Does your department maintain any geospatial software licenses?
3. Are there any other types of software or software extensions that are used in conjunction with your geospatial software?
4. How many department staff members are trained in using the software?
5. How many staff members are not “officially” trained, but use geospatial software in day-to-day functions, such as looking up addresses or utility infrastructure?
6. What types of map content is your department responsible for maintaining?
7. Who is responsible for making data updates and map changes?
8. How often are updates made to maps and geospatial data?
9. What are the data sources you use to generate and maintain geospatial data?
10. What format is the geospatial information in and what projection is used?
11. Are there any limitations or known inaccuracies in your department’s datasets?
12. What is the most commonly requested map/GIS information requested from your department?
13. Are there any current projects that are implementing GIS/GPS technology?
14. Are there any planned projects in which GIS/GPS technology may be applied?
15. Would access to geospatial information in the field be of value to your department?
16. What types of web application functionality would be essential to supporting daily workflows?
17. What types of application tools would be of value to your department?

APPENDIX D-1
'ArcGIS Server 10 Functionality Matrix' (ESRI, 2010) – Page 2

ArcGIS Server 10 Functionality Matrix

J-9805

Functionality	Editions		
	Basic	Standard	Advanced
Geodatabase Management	Included	Included	Included
Geodatabase Replication	Included	Included	Included
GIS Web Services	Geodata Service Only	Included	Included
Web Mapping Applications	Not Available	Included	Included
Web Editing	Not Available	Included	Included
Geoprocessing	Not Available	Included	Included
Advanced Geoprocessing	Not Available	With Extensions	Included
ArcGIS Mobile Application/SDK	Not Available	Not Available	Included (.NET only) (Enterprise only)

Additionally, you can supplement ArcGIS Server functionality by adding ArcGIS Server extensions.

Extensions	Editions		
	Basic	Standard	Advanced
3D	Not Available	Not Available	Included
Spatial	Not Available	Not Available	Included
Geostatistical	Not Available	Not Available	Included
Network	Not Available	Optional	Included
Geoportal	Not Available	Optional	Optional
Image	Not Available	Optional	Optional
Data Interoperability	Not Available	Optional (Windows only)	Optional (Windows only)
Workflow Manager	Not Available	Optional (Windows only)	Optional (Windows only)
Schematics	Not Available	Not Available	Optional (Windows only)

For further details on the typical functions and capabilities included with each extension, refer to www.esri.com/software/arcgis/arcgisserver/extensions.html.

APPENDIX D-2

'ArcGIS Server 10 Functionality Matrix' (ESRI, 2010) – Page 3

ArcGIS Server 10 Functionality Matrix

J-9805

Capacity The ArcGIS Server editions described in the previous section are available at two levels, scaled according to capacity: Workgroup and Enterprise.

	Capacity Level	
	Workgroup	Enterprise
Simultaneous connections to multiuser geodatabase	10	Unlimited
Multiuser geodatabase storage capacity	10 GB*	Unlimited
Maximum number of licensable cores	4 cores	Unlimited
Distributed deployment of ArcGIS Server components	Not supported**	Supported

* ArcGIS Server 10 Workgroup ships with SQL Server Express 2008 R1, which is limited to 4 GB. Users can obtain SQL Server Express 2008 R2 themselves to take advantage of the 10 GB database size limit.

** Workgroup-level components can be installed on only one machine.

Selecting functionalities and the capacity level specifies the ArcGIS Server edition and level. For example, ArcGIS Server Standard Enterprise supports unlimited simultaneous connections, a large multiuser geodatabase, and a standard set of functions. For more examples, see the ArcGIS Server Example Scenarios section below.

Functionality Matrix Details

Geodatabase Management

ArcGIS Server allows you to manage your geodata in a variety of database management systems. Data can be stored in a central database and support the concurrent multiuser editing necessary for many data management workflows. With ArcGIS Server, you have the ability to create and load spatial data into geodatabases.

Functionality	Editions		
	Basic	Standard	Advanced
Geodatabase Management	Included	Included	Included

What Is a Geodatabase?

The geodatabase is the common data storage and management framework for ArcGIS. It combines "geo" (spatial data) with "database" (data repository) to create a central data repository for spatial data storage and management. A geodatabase stores geometry, a spatial reference system, attributes, and behavioral rules for data. Various types of geographic datasets can be collected within a geodatabase, including feature classes, attribute tables, raster datasets, network datasets, topologies, and many others.

ArcGIS Server is designed to manage multiuser geodatabases. Multiuser geodatabases leverage ArcSDE® technology, implemented on a relational database management system (RDBMS).

APPENDIX E

'County's GIS site ready for April 5 unveiling' press release (Weber, 2010) – Page A1

THE HAYS DAILY NEWS VOICE OF THE HIGH PLAINS

TUESDAY, MARCH 23, 2010

Obama signs bill



By DARLENE SUPERVILLE Associated Press WASHINGTON — President Barack Obama's youthful health care overhaul drama featured dozens of speeches, contentious debate and a televised summit with lawmakers before a divided Congress passed the bill. An elaborate White House signing ceremony kicked off the next act: selling the sweeping changes to a skeptical public. House and Senate Democrats who backed the bill, as well as lesser-known people whose health care struggles have touched Obama, joined him today for the ceremony in the East Room. Afterward, Obama and much of that audience headed to the Interior Department for an even larger celebration. Act II begins Thursday when Obama visits Iowa City, Iowa, where as a presidential candidate he announced his health care plan in May 2007, to talk about how it will help lower health care costs for small businesses and families. The House late Sunday voted 219-212 — no Republican voted in favor — to send the 10-year, \$936 billion bill to Obama. The measure, which the Senate passed in December, eventually will extend coverage to 32 million uninsured Americans, reduce federal budget deficits and ban such insurance company practices as denying coverage to people with existing medical problems. A companion measure sought by House Democrats to make a series of changes to the main bill was approved 220-211. It goes to the Senate, where debate could begin as early as today. See HEALTH, A6

NEWS TO KNOW



Showing support KANSAS STATE FANS BRING BUNNAGE COLISEUM TO SHOW THEIR SUPPORT FOR THE WALKERS IN THE SWEET 16. Page B1



History lesson PRESIDENT BARACK OBAMA ACHIEVES HEALTH LAW SUCCESS THAT ELUDED PAST. Page A7

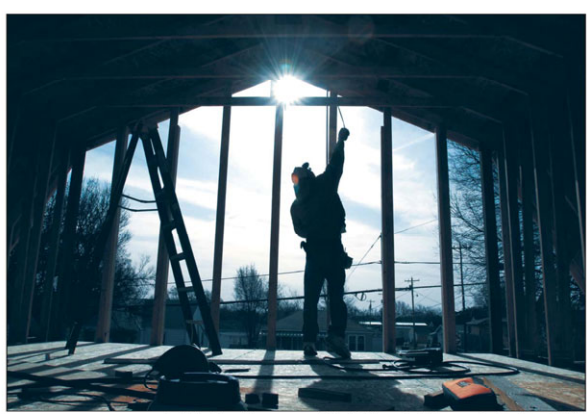


Camp articles DOCUMENTS OF AURCHWITZ DEATH CAMP DOCTORS FOUND. Page B4

Weather watch TONIGHT: CLOUDY SLIGHT CHANCE OF RAIN IN THE EVENING, THEN RAIN LIKELY AFTER MIDNIGHT. LOWS IN THE UPPER 30s. NORTHEAST WINDS 15 TO 20 MPH WITH GUSTS TO AROUND 30 MPH.

HDN salutes ALFRED LAZER, GRANELL. Contact us PHONE: (785) 435-2281 or (800) 667-4617 FAX: (785) 435-0136

Volume 80, Issue 113 2 INCHES, 16 PAGES 75c



Kent Roken, Hays, takes a measurement Monday in Hays as he builds a garage for himself coupled with a playhouse on the upper level for his grandchildren. STEVEN HAUSLER - HAYS DAILY NEWS

Hays High wins three DECA titles

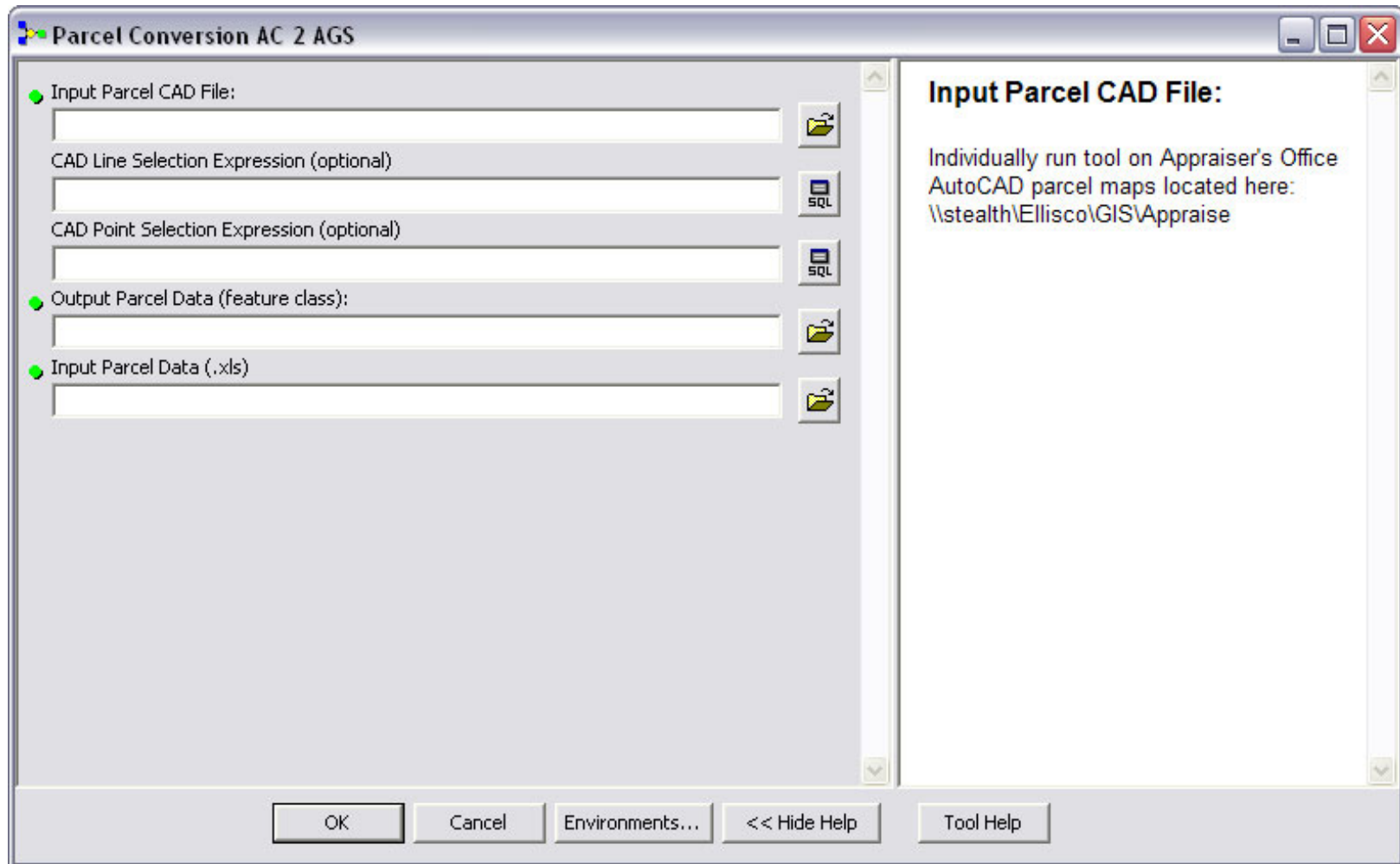
By DIANE GASPER-O'BREN dgasper@haysnews.net Going to nationals as a regional officer didn't turn out to be so much fun for Katie Dinkel a year ago. Going on a competitor hopefully will be more enjoyable for the Hays High School senior. Dinkel qualified for next month's International Career Development Conference in Louisville, Ky., with her state championship performance March 6 and 9 at the Kansas conference in Overland Park. She placed sixth at state as part of the entrepreneurship writing team but was a finalist, a few places shy of qualifying for nationals. But Dinkel will get the chance to travel to Anaheim, Calif., for the international conference as a member of the Kansas officer team — Western Region Vice President. However, she became ill during the conference and missed most of the sessions. So it's no surprise Dinkel really is looking forward to the 2010 international conference. "The experience is the same except for competing," Dinkel said of an officer's session at nationals. "But it's so much rewarding this year, not like it's just a few weeks but that I worked hard enough to get to compete." This year at state, Dinkel joined classmate Ellie Kaars for a first-place finish with their public relations project. It was one place better at state than a year ago for Kaars, who placed second with Hays High's Internet marketing plan team at state as a junior. It was a perfect three-for-three effort for Hays High at state this year. All three entries from Dinkel through's DECA marketing program that HHS took to state won their events. Joining Dinkel and Kaars on stage as state champs were senior Kirby Fross, entrepreneurship participating-franchising, and junior Lindsey Schneider and Stephanie Shoemaker, community service project. With those performances, the HHS students added to the list of state champions for their school this semester. Another HHS organization, Business Professionals of America, also featured two championship efforts at its state competition earlier this month. It marks the 10th straight year Hays High DECA students have qualified for the International Career Development Conference. It was the first trip to state for Schneider and Shoemaker, and the second for Fross, who, like Dinkel, finished in the top 10 at state as a junior. Now, the students have a few weeks to tweak their projects before traveling to Kentucky in late April. "We'll look at our evaluation sheet from state and see where we lost points," Dinkel said. "Then we'll try to improve on it from there. I'm really looking forward to (nationals)." Katie Dinkel, Hays High senior

County's GIS site ready for April 5 unveiling

By GAYLE WEBER gweb@haysnews.net Numerous city, county, state and federal data will be available on a central Web site in Ellis County starting April 5. The information already has been available in-house to city and county employees for about a year, and most of it will become available when the public site launches in two weeks. "Everybody had data, but everybody wanted access to everybody else's data," Geographic Information Systems specialist Estomun Cooney told county commissioners Monday night. So the site, www.goodata.portal.net, was developed. It pulls information from local, state and federal agencies into one browser-based mapping application, according to Cooney. The site allows the property information already available on the county's appraisal database to be presented in map form, as well as county zoning information. Other data such as the location of water supplies, oil wells and cellular phone towers also will be on the site. Information from the Kansas Geological Survey, Kansas Department of Transportation and National Oceanic and Atmospheric Administration, to name a few, also is provided in map form on the site. Cooney said city staff has recommended all city-generated information be accessible to the public on the site, and the city commission will consider the recommendation Thursday. County commissioners indicated Monday night they would not allow public access to address points, which is a data set generated from county dispatch, and emergency service areas, which outline which EMS and rural fire stations take care of each part of the county. Otherwise, the rest of the county-generated data would be available. Cooney said he hoped the site could have future growth with partnerships with other agencies such as Midwest Energy and the National Association of Realtors. The site, which also is accessible through the city of Hays and Ellis County Web sites, should be available for public use April 5.

APPENDIX F-1

Geoprocessing tool dialog used to convert AutoCAD parcel files



APPENDIX F-2

Python script used to convert AutoCAD parcel files

```

# -----
# PythonScript.py
# Usage: PythonScript <Input_Parcel_CAD_File_>
<CAD_Line_Selection_Expression> <CAD_Point_Selection_Expression>
<Output_Parcel_Data__feature_class__> <Input_Parcel_Data__xls_>
# -----

# Import system modules
import sys, string, os, arcgisscripting

# Create the Geoprocessor object
gp = arcgisscripting.create()

# Set the necessary product code
gp.SetProduct("ArcInfo")

# Load required toolboxes...
gp.AddToolbox("C:/Program Files/ArcGIS/ArcToolbox/Toolboxes/Data
Management Tools.tbx")
gp.AddToolbox("C:/Program Files/ArcGIS/ArcToolbox/Toolboxes/Analysis
Tools.tbx")

# Script arguments...
Input_Parcel_CAD_File_ = sys.argv[1]
if Input_Parcel_CAD_File_ == '#':
    Input_Parcel_CAD_File_ =
"C:\\ARCMAP\\Parcels\\ParcelUpdate_20110225\\2010Victoria.dwg" #
provide a default value if unspecified

CAD_Line_Selection_Expression = sys.argv[2]
if CAD_Line_Selection_Expression == '#':
    CAD_Line_Selection_Expression = "\"Layer\" = 'Parcels'" # provide a
default value if unspecified

CAD_Point_Selection_Expression = sys.argv[3]
if CAD_Point_Selection_Expression == '#':
    CAD_Point_Selection_Expression = "\"Layer\" = 'Parcel_id'" # provide a
default value if unspecified

Output_Parcel_Data__feature_class__ = sys.argv[4]
if Output_Parcel_Data__feature_class__ == '#':
    Output_Parcel_Data__feature_class__ =
"C:\\Temp\\ParcelTemp.mdb\\OutputParcelData" # provide a default value
if unspecified

Input_Parcel_Data__xls_ = sys.argv[5]
if Input_Parcel_Data__xls_ == '#':
    Input_Parcel_Data__xls_ =
"C:\\ARCMAP\\Parcels\\ParcelUpdate_20110225\\giscmastms.xls\\giscmastms

```

APPENDIX F-3

Python script used to convert AutoCAD parcel files (*continued*)

```

$" # provide a default value if unspecified

# Local variables...
LineTemp_FeatureToPolygon =
"C:\\Temp\\ParcelTemp.mdb\\LineTemp_FeatureToPolygon"
Output_Feature_Class_5_ =
"C:\\Temp\\ParcelTemp.mdb\\LineTemp_FeatureToPolygon"
Main_Features =
"C:\\ARCMAP\\Parcels\\ParcelUpdate_20110225\\2010Victoria.dwg\\Polyline
"
CAD_Feature_Layer = "Polyline_Layer"
Points_Layer = "Point_Layer"
Temp_Points = "C:\\Temp\\ParcelTemp.mdb\\PointTemp"
Temp_Lines = "C:\\Temp\\ParcelTemp.mdb\\LineTemp"
CAD_Points =
"C:\\ARCMAP\\Parcels\\ParcelUpdate_20110225\\2010Victoria.dwg\\Point"
Output_Parcel_Polygons = "C:\\Temp\\ParcelTemp.mdb\\OutputParcelData"
PointTemp = "C:\\Temp\\ParcelTemp.mdb\\PointTemp"
giscmastms = "C:\\Temp\\ParcelTemp.mdb\\giscmastms"
OutputParcelData_2_ = "C:\\Temp\\ParcelTemp.mdb\\OutputParcelData"
Output_Feature_Class = "C:\\Temp\\ParcelTemp.mdb\\OutputParcelData"
Output_Feature_Class_2_ = "C:\\Temp\\ParcelTemp.mdb\\OutputParcelData"
OutputParcelData_4_ = "C:\\Temp\\ParcelTemp.mdb\\OutputParcelData"
OutputParcelData_6_ = "C:\\Temp\\ParcelTemp.mdb\\OutputParcelData"
OutputParcelData_3_ = "C:\\Temp\\ParcelTemp.mdb\\OutputParcelData"
CentroidTemp = "C:\\Temp\\ParcelTemp.mdb\\CentroidTemp"
Output_Features = "C:\\Temp\\ParcelTemp.mdb\\CentroidTemp_Project"
CentroidTemp_Project = "C:\\Temp\\ParcelTemp.mdb\\CentroidTemp_Project"
OutputParcelData_5_ = "C:\\Temp\\ParcelTemp.mdb\\OutputParcelData"

# Process: Select Data...
gp.SelectData_management(Input_Parcel_CAD_File_, "Polyline")

# Process: Make Feature Layer2...
gp.MakeFeatureLayer_management(Main_Features, CAD_Feature_Layer,
CAD_Line_Selection_Expression, "", "Entity Entity VISIBLE NONE;Handle
Handle VISIBLE NONE;Layer Layer VISIBLE NONE;LyrFrzn LyrFrzn VISIBLE
NONE;LyrLock LyrLock VISIBLE NONE;LyrOn LyrOn VISIBLE NONE;LyrVPFrzn
LyrVPFrzn VISIBLE NONE;LyrHandle LyrHandle VISIBLE NONE;Color Color
VISIBLE NONE;EntColor EntColor VISIBLE NONE;LyrColor LyrColor VISIBLE
NONE;BlkColor BlkColor VISIBLE NONE;Linetype Linetype VISIBLE
NONE;EntLinetype EntLinetype VISIBLE NONE;LyrLnType LyrLnType VISIBLE
NONE;BlkLinetype BlkLinetype VISIBLE NONE;Elevation Elevation VISIBLE
NONE;Thickness Thickness VISIBLE NONE;LineWt LineWt VISIBLE
NONE;EntLineWt EntLineWt VISIBLE NONE;LyrLineWt LyrLineWt VISIBLE
NONE;BlkLineWt BlkLineWt VISIBLE NONE;RefName RefName VISIBLE
NONE;LTScale LTScale VISIBLE NONE;ExtX ExtX VISIBLE NONE;ExtY ExtY
VISIBLE NONE;ExtZ ExtZ VISIBLE NONE;DocName DocName VISIBLE
NONE;DocPath DocPath VISIBLE NONE;DocType DocType VISIBLE NONE;DocVer
DocVer VISIBLE NONE;BUSINESSNAME BUSINESSNAME VISIBLE NONE")

```

APPENDIX F-3

Python script used to convert AutoCAD parcel files (*continued*)

```

# Process: Copy Features3 (2)...
gp.CopyFeatures_management(CAD_Feature_Layer, Temp_Lines, "", "0", "0",
"0")

# Process: Feature To Polygon...
gp.FeatureToPolygon_management("C:\\Temp\\ParcelTemp.mdb\\LineTemp",
LineTemp_FeatureToPolygon, "", "ATTRIBUTES", "")

# Process: Repair Geometry...
gp.RepairGeometry_management(LineTemp_FeatureToPolygon, "DELETE_NULL")

# Process: Select Data (Point)...
gp.SelectData_management(Input_Parcel_CAD_File_, "Point")

# Process: Make Feature Layer...
gp.MakeFeatureLayer_management(CAD_Points, Points_Layer,
CAD_Point_Selection_Expression, "", "Entity Entity VISIBLE NONE;Handle
Handle VISIBLE NONE;Layer Layer VISIBLE NONE;LyrFrzn LyrFrzn VISIBLE
NONE;LyrLock LyrLock VISIBLE NONE;LyrOn LyrOn VISIBLE NONE;LyrVPFrzn
LyrVPFrzn VISIBLE NONE;LyrHandle LyrHandle VISIBLE NONE;Color Color
VISIBLE NONE;EntColor EntColor VISIBLE NONE;LyrColor LyrColor VISIBLE
NONE;BlkColor BlkColor VISIBLE NONE;Linetype Linetype VISIBLE
NONE;EntLinetype EntLinetype VISIBLE NONE;LyrLnType LyrLnType VISIBLE
NONE;BlkLinetype BlkLinetype VISIBLE NONE;Elevation Elevation VISIBLE
NONE;Thickness Thickness VISIBLE NONE;LineWt LineWt VISIBLE
NONE;EntLineWt EntLineWt VISIBLE NONE;LyrLineWt LyrLineWt VISIBLE
NONE;BlkLineWt BlkLineWt VISIBLE NONE;RefName RefName VISIBLE
NONE;LTScale LTScale VISIBLE NONE;Angle Angle VISIBLE NONE;ExtX ExtX
VISIBLE NONE;ExtY ExtY VISIBLE NONE;ExtZ ExtZ VISIBLE NONE;DocName
DocName VISIBLE NONE;DocPath DocPath VISIBLE NONE;DocType DocType
VISIBLE NONE;DocVer DocVer VISIBLE NONE;ScaleX ScaleX VISIBLE
NONE;ScaleY ScaleY VISIBLE NONE;ScaleZ ScaleZ VISIBLE
NONE;LANDUSE_NUMBER LANDUSE_NUMBER VISIBLE NONE;LANDUSE_TEXT
LANDUSE_TEXT VISIBLE NONE;DISPLAYED_PARC DISPLAYED_PARC VISIBLE
NONE;CALC_ACRE CALC_ACRE VISIBLE NONE;CALC_TEXT CALC_TEXT VISIBLE
NONE;PARCEL_ID PARCEL_ID VISIBLE NONE;BUSINESSNAME BUSINESSNAME VISIBLE
NONE;Parcel_id Parcel_id VISIBLE NONE;PropertyOwner PropertyOwner
VISIBLE NONE;SitusAddress SitusAddress VISIBLE NONE")

# Process: Copy Features3...
gp.CopyFeatures_management(Points_Layer, Temp_Points, "", "0", "0",
"0")

# Process: Delete Field...
gp.DeleteField_management(Temp_Points,
"Entity;Handle;Layer;LyrFrzn;LyrLock;LyrOn;LyrVPFrzn;LyrHandle;Color;En
tColor;LyrColor;BlkColor;Linetype;EntLinetype;LyrLnType;BlkLinetype;Ele
vation;Thickness;LineWt;EntLineWt;LyrLineWt;BlkLineWt;RefName;LTScale;A
ngle;ExtX;ExtY;ExtZ;DocName;DocPath;DocType;DocVer;ScaleX;ScaleY;ScaleZ
;LANDUSE_NUMBER;LANDUSE_TEXT;DISPLAYED_PARC;CALC_ACRE;CALC_TEXT;BUSINES
SNAME;PARCEL_ID_1;PropertyOwner;SiteAddress;StreetName")

```

APPENDIX F-4

Python script used to convert AutoCAD parcel files (*continued*)

```

# Process: Spatial Join...
gp.SpatialJoin_analysis(Output_Feature_Class_5_, PointTemp,
Output_Parcel_Polygons, "JOIN_ONE_TO_ONE", "KEEP_ALL", "Shape_Length
'Shape_Length' false true true 8 Double 0 0
,First,#,C:\\Temp\\ParcelTemp.mdb\\LineTemp_FeatureToPolygon,Shape_Leng
th,-1,-1;Shape_Area 'Shape_Area' false true true 8 Double 0 0
,First,#,C:\\Temp\\ParcelTemp.mdb\\LineTemp_FeatureToPolygon,Shape_Area
,-1,-1;PARCEL_ID 'PARCEL_ID' true true false 28 Text 0 0
,First,#,C:\\Temp\\ParcelTemp.mdb\\PointTemp,PARCEL_ID,-1,-1",
"INTERSECTS", "0 Unknown", "")

# Process: Table Select...
gp.TableSelect_analysis(Input_Parcel_Data__xls_, giscmastms, "")

# Process: Join Field...
gp.JoinField_management(Output_Parcel_Polygons, "PARCEL_ID",
giscmastms, "CAMANO", "")

# Process: Add Field 'COMPLETE_ADDRESS'...
gp.AddField_management(Output_Parcel_Data__feature_class__,
"COMPLETE_ADDRESS", "TEXT", "", "", "100", "", "NULLABLE",
"NON_REQUIRED", "")

# Process: Add Field 'ADDR_NUMBER'...
gp.AddField_management(OutputParcelData__2_, "ADDR_NUMBER", "TEXT", "",
"", "10", "", "NULLABLE", "NON_REQUIRED", "")

# Process: Add Field 'CITY'...
gp.AddField_management(Output_Feature_Class, "CITY", "TEXT", "", "",
"20", "", "NULLABLE", "NON_REQUIRED", "")

# Process: Calculate Field 'COMPLETE_ADDRESS'...
gp.CalculateField_management(Output_Feature_Class__2_,
"COMPLETE_ADDRESS", "e", "VB", "dim a
dim b
dim c
dim d
dim e

a = \"_\" & [PROPADDNO] & \" \" & [PROPADDDIR] & \" \" & [PROPADDSTR] &
\" \" & [PROPADDSFX]
b = REPLACE(a, \" \", \" \")
c = REPLACE(b, \" \" , \" \")
d = REPLACE(c, \"_0 \" , \"\")
e = REPLACE(d, \"_\", \"\")

```

APPENDIX F-5

Python script used to convert AutoCAD parcel files (*continued*)

```

# Process: Calculate Field (2)...
gp.CalculateField_management(OutputParcelData__4_, "ADDR_NUMBER", "c",
"VB",
"dim a
dim b
dim c

a = \"_\"&[PROPADDNO]
b = REPLACE(a, \"_0\", \"\")
c = REPLACE(b, \"_\", \"\")

# Process: Define Projection...
gp.DefineProjection_management(OutputParcelData__6_, "PROJCS['KS83-
NF',GEOGCS['GCS_North_American_1983',DATUM['D_North_American_1983',SPHE
ROID['GRS_1980',6378137.0,298.2572221]],PRIMEM['Greenwich',0.0],UNIT['D
egree',0.0174532925199433]],PROJECTION['Lambert_Conformal_Conic'],PARAM
ETER['False_Easting',1312333.333],PARAMETER['False_Northing',0.0],PARAM
ETER['Central_Meridian',-
98.0],PARAMETER['Standard_Parallel_1',39.78333333333333],PARAMETER['Sta
ndard_Parallel_2',38.71666666666667],PARAMETER['Latitude_Of_Origin',38.
33333333333333],UNIT['Foot_US',0.30480060960122]]")

# Process: Feature To Point - Centroids...
gp.FeatureToPoint_management(OutputParcelData__3_, CentroidTemp,
"CENTROID")

# Process: Project...
gp.Project_management(CentroidTemp, CentroidTemp_Project,
"GEOGCS['GCS_North_American_1983',DATUM['D_North_American_1983',SPHEROI
D['GRS_1980',6378137.0,298.257222101]],PRIMEM['Greenwich',0.0],UNIT['De
gree',0.0174532925199433]]", "", "PROJCS['KS83-
NF',GEOGCS['GCS_North_American_1983',DATUM['D_North_American_1983',SPHE
ROID['GRS_1980',6378137.0,298.2572221]],PRIMEM['Greenwich',0.0],UNIT['D
egree',0.0174532925199433]],PROJECTION['Lambert_Conformal_Conic'],PARAM
ETER['False_Easting',1312333.333],PARAMETER['False_Northing',0.0],PARAM
ETER['Central_Meridian',-
98.0],PARAMETER['Standard_Parallel_1',39.78333333333333],PARAMETER['Sta
ndard_Parallel_2',38.71666666666667],PARAMETER['Latitude_Of_Origin',38.
33333333333333],UNIT['Foot_US',0.30480060960122]]")

# Process: Add XY Coordinates...
gp.AddXY_management(CentroidTemp_Project)

# Process: Join Field (2)...
gp.JoinField_management(OutputParcelData__3_, "PARCEL_ID",
Output_Features, "PARCEL_ID", "POINT_X;POINT_Y")

```


APPENDIX G

Glossary

ArcCatalog – an application that provides a catalog window used to organize and manage various types of geographic information for ArcGIS software. ArcCatalog is used to organize GIS contents, manage geodatabase schemas and manage GIS servers (ESRI, 2010 - http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/What_is_ArcCatalog).

ArcGIS Server – server geographic information system software developed by ESRI. is Used for creating and managing GIS Web services, applications, and data (Wikipedia, 2010 - http://en.wikipedia.org/wiki/ArcGIS_Server).

ArcGIS Server Manager – a Web application that supports publishing services, administering the GIS server, creating Web applications, and publishing ArcGIS Explorer maps on a server (ESRI, 2010 - http://webhelp.esri.com/arcgisserver/9.3.1/dotNet/index.htm#components_of_server.htm).

Data Layer – the visual representation of a geographic dataset in any digital map environment (ESRI, 2010 - <http://resources.arcgis.com/glossary/term/605>).

Database Schema – the tables, the fields in each table, the relationships between fields and tables, and the grouping of objects within the database (ESRI, 2010 - <http://resources.arcgis.com/glossary/term/841>).

De-Militarized Zone (DMZ) – a network that exists between two other networks separated by firewalls. Typically the other two networks do not trust each other (Microsoft, 2010 - <http://support.microsoft.com/kb/191146>).

Feature Class – a collection of geographic features with the same geometry type (such as

point, line, or polygon), the same attributes, and the same spatial reference stored in a geodatabase (ESRI, 2010 - <http://resources.arcgis.com/glossary/term/480>).

Feature Dataset – a collection of feature classes stored together that share the same spatial reference (ESRI, 2010 - <http://resources.arcgis.com/glossary/term/482>).

Firewall – a device that allows users network access and prevents unauthorized network traffic based on a set of filtering rules known as permissions.

Geodatabase – database or file structure used primarily to store, query, and manipulate spatial data. Geodatabases store geometry, a spatial reference system, attributes, and behavioral rules for data (ESRI, 2010 - <http://resources.arcgis.com/glossary/term/512>).

Geoprocessing Tool – a tool that can create or modify spatial data, including analysis functions (overlay, buffer, slope), data management functions (add field, copy, rename), or data conversion functions (ESRI, 2010 - <http://resources.arcgis.com/glossary/term/1482>).

GIS Web Server – hardware placed in de-militarized zone used for hosting replicated geospatial information services and web mapping applications made available through the Internet.

GIS Data Server – hardware used to aggregate geospatial information from network source files and support internal network web mapping applications.

Google Analytics – a free service offered by Google that generates detailed statistics about the visitors to a website (Wikipedia, 2010 - <http://en.wikipedia.org/wiki/>

Google_Analytics).

Hyperlink – hyperlink (or link) is a word, group of words, or image that you can click on to jump to a new web page, new document or a new section within the current document (W3Schools, 2010 - http://www.w3schools.com/site/site_glossary.asp).

Hypertext Markup Language (HTML) – the most prominently used scripting language in developing web pages (Wikipedia, 2010 - <http://en.wikipedia.org/wiki/HTML>).

Internet GIS – a network-based geographic information service that utilizes both wired and wireless Internet access to deliver geographic information, analytical tools and GIS services (Peng et al., 2003).

Internet Information Services (IIS) – a web server application for Windows operating systems. Developed by Microsoft. (W3Schools, 2010 - http://www.w3schools.com/site/site_glossary.asp).

JavaScript – a scripting language that runs within a Web browser and interacts with HTML code to enable Web developers to add functionality to their Web sites (ESRI, 2010 - <http://resources.arcgis.com/glossary/term/1642>).

Local Area Network (LAN) – a computer network that connects computers and devices in a limited geographical area such as home, school, computer laboratory or office building (Wikipedia, 2010 - http://en.wikipedia.org/wiki/Local_area_network).

Map Cache – a set of pre-rendered image tiles drawn from a map layer at different scales. Allows for faster layer rendering as data layers do not have to be redrawn on each request.

Mashup – web application that combines data from two or more preexisting sources to

create a new derivative product.

Microsoft SyncToy – a free application that synchronizes files and folders between locations (Microsoft, 2010 - <http://www.microsoft.com/downloads/en/details.aspx>).

Modelbuilder – the interface used to build and edit geoprocessing models in ArcGIS (ESRI, 2010 - <http://resources.arcgis.com/glossary/term/1265>).

.NET Web Application Developer Framework (.NET ADF) – enables you to integrate GIS data and capabilities into your Web applications. The ADF includes a set of Web controls, classes, frameworks and APIs that may be used to build Web mapping applications (ESRI, 2010 - http://edndoc.esri.com/arcobjects/9.2/NET_Server_Doc/developer/ADF/adf_overview.htm).

Port 80 – the port that a web server listens to or expects to receive traffic from a Web client. Port 80 is the standard port used by web servers and http (Webservio, 2010 - www.webservio.net/hosting/glossary.html).

Replication – a means of copying and distributing data from one database to local, remote, or mobile users and then synchronizing between these databases for consistency (ESRI, 2010 - <http://resources.arcgis.com/glossary/term/2867>).

SmarterStats – a website statistics and search engine optimization software that provides detailed web analytics for website visitor traffic and helps improve search engine ranking (SmarterTools, 2010 - www.smartertools.com/smarterstats/web-analytics-seo-software.aspx).

Topological Editing – editing that takes into account the spatial relationships between

connecting or adjacent features in a geographic data layer (for example, arcs, nodes, polygons, and points) (ESRI, 2010 - <http://resources.arcgis.com/glossary/term/658>).

Web GIS – *see 'Internet GIS'*

Web Mapping Application – a Web based, interactive map that allows you to display and query the layers on the map. (ESRI, 2010 - <http://resources.arcgis.com/glossary/term/2999>).

Web Service – a software component accessible over the World Wide Web for use in other applications. Web services are built using industry standards and are not dependent on any particular operating system or programming language, allowing access to them through a wide range of applications (ESRI, 2010 - <http://resources.arcgis.com/glossary/term/1332>).