



City of Fredericksburg, Virginia
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City of Fredericksburg, Virginia

GIS Needs Assessment

Prepared by

TIMMONS GROUP 

Original Draft: December 2005

Final Revision: February 2006

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Appendices

- A. GIS User Questionnaire
- B. Summary Spreadsheet of Map Data Layers and Priority GIS Applications As Reported by City Staff
- C. Glossary

Supplements

- 1. Details of the 2006 Virginia Bas Map Program (VBMP) Digital Orthophotography Project

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2. Proposal to the Virginia Information Technology Agency (VITA) for E-911 Digital Addressing Services (Phase I was funded)
3. Proposal for ArcGIS Parcel Conversion Services
4. Revised GIS Implementation Plan and Budget for Phase I based on the availability of a smaller budget.

Introduction

Statement of Purpose

In May of 2005, the City of Fredericksburg contracted with Timmons Group to conduct a comprehensive GIS needs assessment, and develop a system design and implementation plan based on the requirements and priorities communicated by City staff. In all, about 30 City staff representing 17 City departments were involved in this project.

The project scope of services included:

- Educating City staff on the benefits of GIS technology in a local government organization
- Analyzing how GIS can be applied to City business processes
- Evaluating the current map-related data and applications to determine how to best use the current resources (data, hardware, software) to fulfill the functional needs
- Identifying functional area human resource and training requirements
- Evaluate existing data, necessary data conversion, and data development required to provide the data necessary for City functional applications
- Develop recommendations for GIS implementation
- Development of a budget to implement the recommendations

The ultimate goals of this project are to develop a GIS implementation plan that will enable the City to achieve:

- Workflow efficiency gains through automation
- User convenience - easier access to information
- Improved data integrity and currency
- Standards compliance
- Data Security
- Enhanced user functions and new capabilities
- Integration of legacy systems, where necessary or desirable

Project deliverables include:

- GIS workshop presentation materials in softcopy and printed form
- GIS User Questionnaires
- A final report summarizing the City's stated GIS needs, with recommendations on how best to satisfy them
- A presentation to the City summarizing and discussing the final report

Methodology

This comprehensive Needs Assessment Report represents the end result of a number of inter-related investigative tasks performed by Timmons Group and City of Fredericksburg employees as part of the citywide GIS Needs Analysis project. A systematic approach was taken for the purpose of acquiring and analyzing the various pieces of information required to support the GIS needs analysis recommendations presented in this document. Each of the completed individual planning and design tasks is summarized in the following bulleted list:

- GIS TECHNOLOGY WORKSHOP
- USER QUESTIONNAIRES
- USER INTERVIEWS
- CORE APPLICATION DEFINITION/REFINEMENT
- GIS DATA DEFINITION
- DATA CONVERSION PLAN
- STAFFING ASSESSMENT/ TRAINING PLAN
- GIS HARDWARE and SOFTWARE ASSESSMENT
- INFORMATION TECHNOLOGY ASSESSMENT
- IMPLEMENTATION BUDGET

Details of each element are provided in the following sections of the report.

GIS TECHNOLOGY WORKSHOP – The Timmons Group Project Manager and GIS Specialist conducted a workshop at City Hall on May 25, 2005. All City departments were invited to attend, and the goals of the workshop were to:

- Educate attendees on GIS technology and the implementation process
- Define the City's overall GIS objectives
- Identify the City's desired system functionality and core application requirements
- Identify the project's critical success factors
- Identify primary and secondary users of the planned GIS system

USER QUESTIONNAIRES – Following the GIS Technology Workshop, a GIS User Questionnaire was developed and distributed to City staff by e-mail. The questionnaire was administered for the purpose of gathering information about map-related data and work processes currently in place throughout the various City departments. Specifically, City staff had two (2) weeks to complete the questionnaire and submit the following information:

1. Participant Information
2. Department's Mission
3. Interdepartmental Interactions
4. External Interactions
5. Relevant Departmental Workflows
6. Job Responsibilities

7. Computer & Software Use
8. Data Used (Inventory), Maintained & Desired
9. Existing & Desired GIS Functionality (Applications)

The information collected through the questionnaires was compiled in preparation for the User Interviews. A copy of the User Questionnaire is included Appendix A.

USER INTERVIEWS – Timmons Group staff conducted user interviews at City offices from June 17th through June 23, 2005. The interviews were conducted to clarify and expand upon the questionnaire responses in order to ascertain:

- Map-related data usage, maintenance, and distribution requirements / protocols
- Related individual and department job functions and workflows
- Intra-departmental relationships and workflows
- Desired mapping, analysis, maintenance, and distribution applications and system functionality
- Individual and department visions of the planned GIS implementation

CORE APPLICATION DEFINITION/REFINEMENT – Through the technology workshop and questionnaire a number of potential GIS applications were presented to City staff for consideration. Potential applications are grouped into the following categories:

- Ad Hoc Viewing and Mapping
- Economic Development
- Public Safety
- Health and Social Services
- Real Property Management
- Planning and Growth
- Engineering
- Schools

Based upon the staff input gathered through the User Questionnaires and Interviews, each individual application was evaluated relative to the following criteria:

- Impact upon multiple employees / departments
- Applicability to City defined goals and objectives
- Implementation cost

The highest scoring applications were identified as Core Applications. The resulting Core Applications are the basis for the application development recommendations. Additional applications and enhancements, which are deemed to be of value to the City, may be developed and included in the overall GIS program as the demand arises and funding becomes available.

GIS DATA DEFINITION – A thorough assessment of the GIS data features and attributes required to support the intended GIS functionality is essential to a successful implementation. Utilizing the results of the Core Application definition, the following GIS data issues were investigated:

- Planimetric map features and attributes needed to support the Core Applications
- Required topographic content
- Required scales and accuracies
- Core GIS data development options
- Ability of existing GIS data to support applications

DATA CONVERSION PLAN – Timmons Group conducted an on-site inventory of the City’s maps and other data sources identified during the Questionnaire / Interview process. The inventoried data sets were then evaluated to determine their suitability for development of the various GIS data layers. The following information was acquired and evaluated for each source:

- Background information
- Current data access procedures
- Source features and attributes
- Physical quality
- Mapping redundancies
- Mapping coordinate systems
- Development responsibility
- Source accessibility
- Inventory counts
- Currency
- Data consolidation opportunities
- Data conversion requirements

STAFFING ASSESSMENT/ TRAINING PLAN– We evaluated the existing City staff’s ability to successfully meet the staffing requirements described in the management plan. This evaluation considered the resource availability, use of technology and GIS knowledge. From this analysis we developed training recommendations.

GIS HARDWARE and SOFTWARE ASSESSMENT – Information on the existing computer hardware and software resources gathered during the interviews was compared to the system requirements. This resulted in recommendations for upgrades / updates / acquisition of GIS hardware and software.

INFORMATION TECHNOLOGY ASSESSMENT – An Information Technology Assessment was conducted to:

- Assess the City’s existing IT architecture
- Quantify the available servers and workstations
- Assess the WAN and LAN configurations / throughput capacities
- Identify GIS integration opportunities

IMPLEMENTATION BUDGET– Based on development of the recommended GIS components we prepared a phased cost estimate that includes initial development, and ongoing operations and maintenance costs.

Analysis and Planning

In this section we will analyze the impact of developing a GIS for the City of Fredericksburg. We begin with a discussion of the citywide and department business process impact and benefits expected from GIS. Next we review the GIS applications and functionality. We then focus on the resources required to support the applications including the data, staffing, training and computer systems.

GIS Impact

The implementation of an organization-wide geographic information system will provide the City of Fredericksburg with its own powerful set of tools capable of supporting comprehensive planning and management. A fully functioning and well maintained GIS allows for the development, maintenance and sharing of consistent and accurate data among departments. It also provides the ability to integrate multiple data sources for analysis and provides the City with a management and planning tool for sustainable and smart growth.

Through administration of the needs assessment (questionnaires and interviews), a number of significant citywide GIS implementation benefits have been identified. All personnel interviewed indicated their support for the project, and offered significant insight as to how GIS data and applications will support their daily business needs. The following sections present the general and departmental specific results of the needs assessment.

Citywide

As indicated by the City, the Needs Assessment for the continued GIS implementation is intended to:

- Review and evaluate the City's existing computing environment in terms of its ability to support a GIS
- Evaluate existing City data and software applications for use within a GIS network
- Ultimately, the City desires to implement a GIS that integrates real property, engineering, planning & zoning, E911 and administrative records in a manner / environment that supports inter-departmental record sharing and consistency. The implemented system should improve the City's existing planning, management, and administration processes. Additionally, the system should provide accurate, current, and easily maintainable base maps of the City.

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The City has identified the following critical success factors that will define a successful GIS implementation:

- The system must improve the City's overall operating efficiencies
- The system must eliminate redundant data maintenance and entry activities
- The system must provide an effective means of managing and distributing relevant data

Citywide Benefits

Increasingly, local governments are implementing GIS solutions to assist with a wide range of daily activities including:

- Real property management
- Economic development
- Planning and growth
- Public safety / Emergency Management
- Engineering
- Health and social services
- Schools

The City of Fredericksburg is no exception, and will find GIS a useful tool to support these, as well as many other activities. The City can expect to realize a significant number of benefits as a result of implementing a citywide geographic information system, including:

- Rapid access to current, accurate digital data
- Reduction or elimination of data redundancy
- Improved accuracy of information
- Increased data query, reporting, and map production capabilities
- Increased decision support capabilities
- Better informed citizens and employees
- Increased organization and integration of spatially related information
- Elimination of redundant or manual data maintenance functions
- Decreased operating costs
- More efficient management of limited City resources
- Potential revenue and partnering opportunities
- Improved employee morale and job satisfaction
- Improved level of public service

It is anticipated that the City will realize these benefits over time as the GIS matures to a point where it is an integral part of the City's business processes.

City Business Units

City Manager's Office

Project Representative

Mark Whitley – Senior Budget & Management Analyst

Mission

The City Manager is the chief administrative officer of the City and is appointed by the City Council. The City Manager is responsible for enforcing all ordinances and resolutions, supervising the functions of most City departments, preparing the annual operating and capital budgets, and advising the Council of the financial condition and policy requirements of the City.

Business Processes

The City Manager's Office regularly:

- Administers the City under the direction of the City Council.
- Interacts with all departments on a variety of issues.
- Prepares applications for grant funding, and plans for transportation improvements (State & Federal)
- Places requests to outside agencies for City support
- Interacts with neighboring jurisdictions regarding regional issues
- Deals with utility companies regarding Franchise / Right-of-way issues
- Performs ongoing financial monitoring and other issues (e.g. budget transfers)
- Performs other City management duties as necessary

Relevant Data Provided

The City Manager's Office provides and maintains:

- Financial data
- Location of, and details for, capital improvement projects

GIS Benefits

The City Manger's Office would benefit most from GIS by being able to:

- Quickly create their own custom locator maps for City projects, either internal or from outside agencies, neighboring jurisdictions, the state, or federal government.
- Use GIS in a real-time, interactive mode during City Council Meetings to help expedite discussions and decisions that currently require additional time and resources to research.
- Support the City's economic development activities.
- Manage the City's historic district assets.
- Support and enhance grant writing activities (brownfields, transit, greenways, etc.).

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- Support and enhance the City's annual report to the public
- Assist with GASB34 accounting and reporting requirements
- Manage the City's special tax districts
- Support and automate the City's voter redistricting needs

Department of Public Works

Representatives

Doug Fawcett - Director

Dave King – Assistant Director

Lesley Sale – Utility CAD Drafter

Jack Roberts - Superintendent

Mission

The Public Works Department provides project design, contract administration, and construction supervision and inspection for various public works projects. It also oversees the street lighting, sidewalk maintenance, tree trimming, street maintenance, the Virginia Department of Transportation (VDOT) maintenance reports, and the Public Works Capital Improvements Program.

Business Processes

- Provide engineering and administration of water and sewer service
- Provide administration of solid waste collection service
- Provide engineering and administration for street maintenance including pavement, curb/gutter, sidewalk, bridges, street sweeping, and snow plowing
- Provide engineering and administration of storm water drainage maintenance (all underground pipes, ditches, and various ponds)
- Provide engineering and administration of traffic control, including signals, signage, pavement markings
- Provide administration for tree maintenance
- Provide administration of City owned street lights (e.g. colonial lights)
- Provide administration of City landfill (closed)
- Provide administration of City owned railroad spur
- Provide administration of City owned watershed property
- Provide engineering and administration of various capital projects related to department goals and services (Parking Garage, Parks & Recreation Construction)
- Provide reporting on projects to various City, regional, state, and other external organizations.
- Coordinate street closures and other services for major events (festivals)
- Provide corrective services for property maintenance code violations

Relevant Data Provided

- City watershed property maps

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- City street maps (including bridges)
- Water, stormwater, and sewer infrastructure maps
- Maps of traffic signals, light poles, manholes, fire hydrants, storm drains, retention ponds, and trees
- Street intersection maps
- Water, sewer, trash, utility database
- As-built project plans
- Trash collection and water meter routes and schedules
- Work order database
- GASB information for various capital improvements
- Traffic information

GIS Benefits

- More efficient access to interactive maps of City streets, infrastructure, and other map layers relative to the duties of this department.
- Ability for department staff to easily create custom, on-demand maps and map books to support their activities
- Easy access to property boundary, address, rights-of-way and easement information.
- On-demand, interactive access to aerial photography for any part of the City
- Ability to be more proactive than reactive to planning and delivery of department's services, such as snow removal routes.
- Enhanced incident complaint and work order process for more efficiency of planning, dispatching, tracking, and reporting expenditures and services provided
- Better access to map layers for areas adjacent to the City in neighboring jurisdictions, especially: aerial photography, parcel boundaries, topography, hydrography, streets and addresses.

Graphics Department

Representative

Phil Brown - Coordinator

Mission

The Graphics Department is responsible for providing media production/ coordination of in-house support and contractual graphic services. Service categories provided through the department are publication and printed materials, sign designs, illustrations, photography, PowerPoint and other presentations, charts, display materials, mapping and drafting, copy printing, office space planning and conceptual designs (such as parks and parking lots). The department produces and administers these services for the City Council and all departments as requested. These services have also been made available on occasion to local nonprofit organizations involved in projects of city promotion and/or beautification.

Specific goals for the coming year include:

- Pursue acquisition of needs assessment and aerial base mapping in order to begin building a productive GIS for the City.
- Continue improving maintenance of the existing manual block map system (450+ maps) while creating any new maps in the AutoCAD computer program. Maps created in AutoCAD will be available for quick transfer into the GIS.
- Continue to maintain and enhance, where possible, existing levels of service to all departments.

Business Processes

- Provide space planning, building signage services for the Health Department
- Provide upkeep and creation of tax maps from materials submitted by the Commissioner of the Revenue
- Provide maps, photography, publication, presentation and PowerPoint services sometimes using material sent by Planning & Community Development (Zoning)
- Provide maps, plan/profiles, space planning, photography, publication, presentation and PowerPoint services sometimes using material sent by Public Works
- Provide maps, space planning, presentation and PowerPoint services using material submitted by Building & Development Services
- Provide maps and presentation services for the Police Department
- Provide maps and presentation services for the Fire Department
- Provide maps, plan/profiles, space planning, presentation and photography services for Parks, Recreation & Public Facilities, sometimes using material they send
- Provide maps, space planning, photography, publication and PowerPoint services to the City Manager's Office, sometimes using material they send
- Provide space planning, publication and PowerPoint services to Fiscal Affairs, sometimes using material they send
- Provide maps, presentation and PowerPoint services to City Council
- Space planning, publication and PowerPoint services for the Personnel Department, sometimes using material they send
- Graphic design, illustration, signage, scanning, copy and printing services for all City Departments
- Obtain, share, and provide map, plan, and other data to citizens, businesses, and other governments (state, federal, regional, and local)

Relevant Data Provided

- Updated comprehensive maps for the City in paper and digital form
- Custom maps of select areas to meet the service delivery, planning, reporting, and grant application needs of City Departments.

- Map, plans, and other data for the City from other (state, federal, commercial) sources.

GIS Benefits

- Centralized mapping information resource.
- Ability to maintain core City map layers and associated attributes in digital, versus paper, form.
- Provide timely access to the most current City map layers. Updated master map files would be available to City staff, other governments, businesses, and the public (based on policy, need and privilege).
- Be able to receive and utilize site plans in electronic (preferably geo-coded) form so that the map update process can become more efficient and accurate.
- Have computerized access to land record documents from the Clerk's Office, and property information from the Commissioner of the Revenue's Office, in a map environment.

Voter Registration Office

Project Representative

Juanita Pitchford – Voter Registrar / General Registrar

Mission

The Voter Registrar is responsible for managing information related to elections for the City. It is the duty of the registrar to provide for voter registration and voter education. The registrar performs many electoral duties, including managing efficient elections while protecting the integrity of the election process.

Business Processes

The Voter Registrar's Office regularly:

- Maintains and distributes information on election times and places (wards and precincts)
- Handles voter registration
- Participates in redistricting
- Coordinates with the VA State Board of Elections

Relevant Data Provided

The Voter Registrar's Office provides and maintains:

- Location of polling places
- Map boundaries for voting wards and precincts

GIS Benefits

The Voter Registrar's Office would benefit most from GIS by being able to:

- Quickly and accurately determine the polling place for any given address in the City. This capability exists now in the Registrar's Office and on the Web, but would be enhanced by more timely access to street map changes.
- Interact with the voting district map (zoom in/out, query, etc.)
- Track and analyze City voters by select attributes and by location.
- Prepare custom maps and voter information for City Council members as they prepare for local elections.

Social Services Department

Project Representative

Janine Sewell – Director

Mission

The mission of the City's Social Services Department is to enhance the quality of life by our commitment to provide professional, quality services to the community. The Department serves the most vulnerable citizens of the City, those with limited to no income, in need of a wide variety of department services and outside services to assist them in providing for themselves and/or their families. The Department provides protection to adults and children from abuse and neglect.

Summary of Services:

- Temporary Assistance to Needy Families (TANF)
- Auxiliary Grant Program (AGP)
- Medical Assistance (Medicaid)
- State - Local Hospitalization (SLH)
- Food Stamps
- Employment Services (VIEW Program)
- Child Care Services
- Adoption Services
- Child Protective Services
- Foster Care Services
- Foster Home Parent/Family Program
- Adult Services
- Adult Protective Services
- Fraud Services

Business Processes

The Social Services Department regularly performs program duties and services that involve:

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- Administering the programs listed above
- Providing directions to relevant service providers in the City
- Providing information about, and the location of, available resources
- Researching the locations of complaints to initiate a home visit investigation
- Assisting with adult and child abuse investigations
- Working with City Transit to provide transportation to low income residents
- Working with Community Development on housing needs in the City
- Investigating suspected child abuse
- Providing child abuse and neglect education and awareness to school employees
- Providing ongoing support to youth in DSS custody and collaborate services to the youth and families
- Working with the Virginia Employment Commission to provide employment and Training Services.

Relevant Data Provided

The Social Services Department provides and maintains information about:

- The location and nature of services rendered
- The location and resources of relevant social service providers
- Low income housing information and locations
- Relevant public transportation needs

GIS Benefits

The Social Services Department would benefit most from GIS by being able to:

- Quickly and accurately determine the location, with driving directions, for any location in the City. This capability should be available in the office and on the Web so that department staff can do trip planning from home, as needed. This functionality will be enhanced by more timely access to street map changes.
- Interact with the transit bus route map to see schedules, bus locations, and near real-time delay information.
- Track and analyze services provided by select attributes and by location (by neighborhood, school zone, etc).
- Have rapid access to viewing the location of relevant service providers (e.g. low income housing, employers), with driving directions from anywhere in the City.

Transit Department

Project Representatives
Kathleen Beck – Transit Manager
Jennifer Carpenter

Mission

It is the purpose of Fredericksburg Regional Transit (FRED) to provide accessible, affordable, dependable, efficient, environmentally sound, and safe and secure transportation for people who reside or work or visit within the Fredericksburg, Virginia region (i.e., the City of Fredericksburg and the counties of Caroline, King George, Spotsylvania and Stafford).

Business Processes

The Transit Department regularly performs program duties and services that include:

- Coordinate transit planning within the 5 localities served and with FAMPO, for current and long-term use of public transit.
- Plans and manages transportation services for the FREDericksburg Regional Transit System which provides bus services throughout the City and the surrounding areas (Caroline, King George, Spotsylvania and Stafford Counties)
- Establishes policies and procedures and ensures operations comply with all related State, Federal and local regulations and requirements
- Establishes bus routes; identifies needed changes in response to customers needs
- Maintains effective working relationship with Greyhound personnel to coordinate and partner with regards to service and shared resources
- Prepares and manages the department budget; allocates funds appropriately; seeks private funds to support the operations of FRED.
- Writes grants for Federal and State Funding.
- Staffs the Public Transit Advisory Board
- Performs public relations and marketing duties to develop public awareness, interest and support of the transit system. Maintains professional relationships with Federal, State and local agencies affiliated with the FRED System

Relevant Data Provided

The Transit Department provides and maintains information about:

- The location of, and schedule for, current and planned bus routes
- The location of current and planned bus stops
- Ridership info and statistics

GIS Benefits

The Transit Department would benefit most from GIS by being able to:

- Quickly and accurately view the location of all GPS-tagged buses in real time, so that dispatchers can more effectively and efficiently respond to calls from riders about bus locations and delays.
- Determine the location of the nearest bus stop from any address in the region. This functionality should be available in-office and on the Internet. This capability will be enhanced by more timely access to street map changes.
- Be able to tag bus ridership (head count on & off) to bus stop location for geographic and temporal analysis.
- Use reporting functionality to streamline report preparation and information value.
- Have rapid access to viewing the location of points of public interest, such as shopping centers, tourist attractions, recreational activities, festivals and other large events.
- Enhance planning of future bus routes.
- Automate sharing and value of ridership information to other City Departments, such as Economic Development, Planning, Tourism, Parks and Recreation.
- Use aerial photos, utility, and engineering map layers to more effectively plan and design bus stops.

Building and Development Services Department

Representative

T. Michael Naggs - Director

Mission

The Building and Development Services Department enforces the provisions of the [Virginia Uniform Statewide Building Code](#) and enforces the Zoning Ordinance of the City. It performs building and site plan reviews, construction inspections, and records maintenance for all regulated construction activities in the City. The goal of the Department is to promote the health, safety, and general welfare of the public and to insure safety of life and property from all hazards incident to building design, construction, maintenance, use, repair, removal, or demolition.

Business Processes

Building and Development provides three main services – Site Plan Reviews, Building Permits, and Property Maintenance and Code Enforcement.

Site Plan Reviews - A site plan is a detailed engineering drawing depicting the overall development scheme and proposed improvements to a particular tract of land. Information provided on a typical site plan includes, but is not limited to, existing and proposed elevations, erosion and sediment control measures, stormwater management facilities, vehicular and pedestrian access and circulation

plans, parking lot layout, water and sewer facilities, and landscaping. The purpose of the site plan is to facilitate utilization of the most advantageous techniques in the development of land and to promote high standards and innovations in the layout, design, landscaping and implementation of development. Site plans are generally required for all new buildings, large additions to existing buildings, and changes in use of existing buildings.

The Site Plan process is all hardcopy. Site plans are submitted for review and then forwarded to the Planning Commission for approval. The site plan review process typically requires approximately 60 days for completion.

Building Permits - A building permit is required and must be obtained prior to constructing or altering a structure, constructing an addition, demolishing or moving a structure, changing the use of a structure, or installing or altering any equipment which is regulated by the USBC.

An application for a permit may be made by either the owner or lessee of the building or structure, or authorized agent of either. The application must contain a general description of the proposed work and must be accompanied by three sets of plans of sufficient detail where required by the USBC. The building permit review process typically requires 48 hours for minor projects and 2-3 weeks for larger and more complex projects. The permit holder is responsible for assuring that all required inspections have been conducted and approved by the B&DS. A certificate of occupancy, indicating completion of the work for which a permit was issued, must be obtained from B&DS prior to occupying the building or structure.

This system is computer automated. The City uses the BRIGHT AS400 system to keep information about the structures. There is a Microsoft Excel spreadsheet that tracks these permits. Once the permit goes to Zoning, there is no record of the permit being there.

Property Maintenance Code Enforcement - There are three services provided by Property Maintenance Code Enforcement. They are Building Maintenance, Weeds, Grass and Litter, and Inoperative Motor Vehicles.

Building Maintenance – The City has been enforcing the building maintenance code since 1987. These responsibilities are carried out by the Property Maintenance Code Administrator. Following receipt of a complaint and field-verification of a violation, a Notice of Violation is delivered to the building owner allowing 10 to 30 days to correct the violation. After the allotted time has passed, a follow-up inspection is performed to verify that the violation has been corrected. When necessary, B&DS will take building owners to civil court for failing to comply with the City's building maintenance code. All current deadlines are tracked through Microsoft Outlook's calendar.

Weeds, Grass and Litter – Following receipt of a complaint and field-verification of a violation, a Notice of Violation is delivered to the property owner allowing 10 days to correct the violation. After 10 days, a follow-up inspection is performed and any uncorrected violation is forwarded to the City's Public Works Department for

corrective action. The property owner is billed for the work performed by the City and the City Treasurer collects the debt. Depending on the season, B&DS received 5-10 weeds, grass or litter complaints each week and approximately 50% are field-verified violations and receive a Notice of Violation. Approximately 20% do not comply with the Notice of Violation and are referred to the PWD for corrective action.

Inoperative Motor Vehicles – Following receipt of a complaint and field-verification of a violation, a Notice of Violation is delivered to the property owner allowing 10 days to correct the violation. After 10 days, a follow-up inspection is performed and if the vehicle has not been either removed, made operable, or appropriately screened, B&DS will have the vehicle removed from the property by the City's contract towing company. A Notice of Reclaim is then sent to the last known owner of the vehicle. B&DS received 7-10 inoperative motor vehicle complaints each week and approximately 50% are field-verified violations and receive a Notice of Violation. Approximately 10% of those vehicles will be towed due to lack of compliance.

Relevant Data Provided

- Street address for new structures
- Site plans for all new buildings, large additions to existing buildings, and changes in use of existing buildings.
- Status of site plan reviews.
- Building permit applications and status of associated inspections
- Certificates of Occupancy
- Property maintenance code violation information and pictures, complaint details, status, corrective measures, and court actions (if applicable)

GIS Benefits

- Computerize site plan review and status tracking process to enhance efficiency and consistency of the process
- Enable developers to submit digital copy of site plans which could be hyperlinked to GIS data.
- Minimize paper storage requirements (running out of room)
- Ability for other departments to quickly check on the status of a particular project themselves.
- Easy access to GIS data such as zoning, street centerlines, structures, addresses, parcels, parking lots, and utilities to more efficiently evaluate plans.
- Improved tracking of building permits, inspections, and Certificates of Occupancy
- Have a tracking system for permits and the ability to hyperlink documents to structures.
- Provide public web access to building permit status.

GIS Needs Assessment for the City of Fredericksburg, VA

- Enhance inspectors' efficiency by using mobile computer inspection technology with a wireless connection to the office.
- Ability to hyperlink property maintenance code violation pictures to structure and parcel data.
- A rental housing inspection process.
- Ability to access site location and parcel information for immediate view and query
- Capability to print custom small scale maps to be used as a template for site plan creation by the permit holder
- Improve the ability to respond to citizens by using GIS to analyze the complaint area prior to site visit
- Provision of consistent and accurate data sets which may be shared among departments for display and analysis.

Commissioner of the Revenue

Representatives

Lois Jacob – Commissioner of the Revenue

Marilla Haas – Real Estate Supervisor

Mission

The Commissioner of the Revenue is elected by the citizens of the City and serves a four year term at the pleasure of the voters. The Commissioner is the chief assessing officer for those taxes prescribed by state law and local ordinance. This office oversees the appraisal and assessment of all real property in the City, administers the City's real estate tax relief program and land use program, assesses individual and business personal property, issues business licenses, and administers local taxes on meals, lodging, admissions, cigarettes, utility services and mobile communications.

Business Processes

The Commissioner of the Revenue interacts with the citizens, businesses, and public as they maintain the tax parcel maps and property valuation information for the City. The land parcel information represents one of the core GIS data layers for City government. Timely and accurate update of the parcel data is crucial to government operation and GIS efficacy.

Relevant Data Provided

- Tax parcel boundary maps and parcel ID numbers
- Deed and plat book references for parcels
- Land easements / rights of way
- Tax assessment and ownership information (in Bright Computer System)
- Building footprints

GIS Benefits

- Ability to maintain tax maps in a timely fashion
- Ability to interact with GIS to access parcel location and assessment information for immediate view and query in City Offices
- Ability to associate land record documents from the Clerks Office with assessment and GIS map information, and access all this information from a single location.
- On-demand capability to print own small scale or large scale tax maps, with desired map labels.
- Ability to automate the creation of form letters and mailing lists based on geographic selection (by zoning, neighborhood, street, distance from, etc.)
- Land use and valuation analysis
- Parcel and land use information
- Provision of consistent and accurate land data sets which may be shared among departments for display and analysis.

Treasurer's Office

Representatives

G. M. Haney – Treasurer

Marilyn Kelly – Deputy

Mission

The Treasurer's primary responsibilities are the collection and disbursement of all City funds. Related responsibilities include accurate record keeping of all transactions, follow-up collection efforts concerning delinquent accounts, maintenance and reconciliation of bank accounts, investment of idle funds, and the collection and transmittal of state funds to the Virginia Department of Taxation.

Business Processes

The Treasurer interacts extensively with the Commissioner of the Revenue to bill, collect and report revenue for fees assessed on real property, individual and business personal property, business licenses, and local taxes on meals, lodging, admissions, cigarettes, utility services and mobile communications.

Relevant Data Provided

- Tax payment status (in Bright Computer System)

GIS Benefits

- Ability to efficiently view parcel locations and access tax assessment information from a map interface.
- Ability to easily search all City databases for the address of persons that owe back taxes.

GIS Needs Assessment for the City of Fredericksburg, VA

- Ability to associate vehicle locations to parcel addresses for enhanced tracking and tax collection.
- Ability to access address information for surrounding jurisdictions in order to locate persons that owe back taxes.

Tourism and Business Development

Representative

David Holder - Director

Mission

The primary function of the Department is to promote the development of the local travel industry by increasing the amount of tourism related business and activities. The goal of the Department is to enhance the economic health of the community through the generation of tourism revenues, a significant portion of which returns directly to the City government. The primary goals are to:

- Attract and retain leisure visitors to Fredericksburg
- Attract and retain conferences, meetings, and reunions to Fredericksburg
- Attract and retain businesses to Fredericksburg

Business Processes

The Department of Tourism and Business Development performs the following duties to accomplish its mission:

- Interact with the Planning Department to provide land use information and planning assistance for economic development initiatives
- Obtain updates to tax maps and updates to new businesses from Commissioner of Revenue
- Communicate with Building and Development Services regarding site plans for approved or planned construction projects
- Coordinate with Parks & Recreation for building maintenance and event implementation
- Work with Police for relevant parking enforcement
- Coordinate with Public Works regarding infrastructure services for downtown
- Communicate listings of tourism attractions, events & accommodations to the Virginia Tourism Corporation
- Provide information on commercial/industrial space availability & business development leads to the Virginia Economic Development Partnership (VDEP)
- Provide information about space availability and assistance in navigating business approval process to local developers.
- Provide information on tourism attractions, events & accommodations
- Provide information on tourism marketing programs

Relevant Data Provided

- Listings of primary group tour and conference planner contacts
- Location and details of tourist attractions
- Commercial/office space availability
- Tourism statistics

GIS Benefits

- Ability for City and visitors to accurately locate places of interest. This requires the timely update of City street maps and address database.
- Ability to spatially analyze tourism, demographic, and economic development information and communicate that to constituencies in and outside the City government
- Ability to create custom maps needed by the department (walking tour, walking / bike pathways, historical / tourist markers, location of available commercial properties, etc.)
- Streamline site selection analysis through the integration of multiple datasets, enabling the incorporation of multiple site parameters in one evaluation effort, thereby reducing cost for multiple dataset development / procurement and duplication of effort.
- Provide population, labor and demographic data businesses may be interested in when evaluating selecting a site for business allocation / relocation.

Fire Department

Representatives

Eddie Allen – Fire Chief

Charles Sterne - Lieutenant

Mission

To enhance the quality of life of those who live, work or visit the City of Fredericksburg by providing highly trained, courteous personnel for rapid response to their needs. The Fire Department is responsible for the fire suppression, prevention, planning, and inspection programs within the City. It manages the hazardous materials program, the emergency operation plan, career EMS personnel, training programs, and bimonthly drills for the volunteer fire company, and keeps volunteers abreast of activities and changes related to fire service.

The Fredericksburg Fire Department is responsible for all Fire and Emergency Services for the complete independent City of Fredericksburg. The goal of this department is to respond to and mitigate any and all such emergencies as they arise, in the safest and most efficient manner possible. This includes but is not limited to the following: Fires, Auto Accidents, Alarms, Emergency Medical, Water Rescue, Haz-Mat, and overcrowding complaints.

Business Processes

The Fire Department routinely carries out the following duties:

- Responds to, and reports about, emergency situations identified above.
- Carries out fire code inspections to identify and help remedy unsafe situations and code violations
- Coordinates with Public Works for street closings, hydrants, water flow, and power lines.
- Coordinates with Building, planning and Zoning regarding Fire Code Enforcement, Water System Planning, Inspections, and Street Addressing
- Communicates with the volunteer rescue squad regarding E911 / CAD Information and Statistics
- Communicates with the Police Department regarding: Premise Data, NCIC, Police Reports for Fire Marshals, and Fire Code Enforcement.
- Interacts with the Department of Emergency Management regarding: Disaster Planning, Emergency Operations Planning, and Hazardous Materials Response Information
- Prepares grant applications (Homeland Security, etc.)
- Prepares and communicates reports for the City government, citizens, insurance companies, ATF, NEPA, and FEMA.

Relevant Data Provided

- Incident response data (location and details)
- Fire inspection reports for structures
- Haz-Mat data (location and details)
- Fire Hydrant data (location and details)
- Fire Response Route Maps

GIS Benefits

- Access to faster, accurate address location and emergency response unit locations enabling routing analysis in the effort to minimize emergency response time. This requires the timely update of street map information.
- Access to relevant data from the Police Department
- Centralize storage and access to relevant mutual aid information. Connectivity of Fire Department's database and those of other City departments.
- Improve reporting of incident response statistics
- Fast, accurate access to structure/address points, hydrant data, subdivisions, apartments, Mary Washington College, and hazmat information.
- Access to maps showing areas prone to flooding and power outages.
- Link to Assessor's data to access property values for damage assessments.
- Emergency site location maintenance and update, as well as analysis, to ensure proper placing of emergency response units in relation to City population centers.
- Ability to print, on-demand, custom map books

- Computerize and geo-locate fire code inspections (versus paper manual) to enhance analysis and reporting capabilities and efficiency.

Department of Parks and Recreation

Representatives

Robert K. Antozzi – Director

Rodger Daft - Superintendent of Parks & Public Facilities

Mission

The mission of the Fredericksburg Parks and Recreation Department is to enhance the lives of our citizens by providing a diverse package of recreation and park opportunities. The Department provides a comprehensive system of leisure programs, educational opportunities and recreational facilities which enhance the quality of life in the City. The Department will ensure customer service excellence, affordability, equal opportunity, a safe environment and access for all.

Business Processes

The Department of Parks performs duties relative to the administration of activities, events, sports and classes offered by the department.

Relevant Data Provided

- The location, extent, and assets (natural and manmade) of the City's Parks and recreation facilities.
- Information about activity schedules and attendance

GIS Benefits

- Ability to interact with aerial photos and to quickly compose and print custom maps for planning, reporting, and marketing (brochure) purposes.
- Ability to perform planning and analysis tasks more efficiently (measure lawn acreage to be fertilized/mowed, area to be paved, location of trees to be planted.
- Enable citizens to better locate parks and recreation facilities.
- Enhance City planning for major events (festivals)
- Facilitate pathways planning
- Ability to sort, analyze, and map address database for more effective marketing/mailings.
- Coordination of services both intra-departmentally and inter-departmentally
- Environmental Analysis
- Facility and site management
- Facility Location / Site Selection
- Land Use Analysis
- Provision of consistent and accurate data sets which may be shared among departments for display and analysis.

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- Resource Allocation
- The capability to identify potential population and demographic trends in order to optimize recreational facility location and activity development.
- Utility Information Analysis

Planning and Community Development Department

Representative

Raymond Ocel, Jr. – Director/Zoning Administrator

Mission

The Planning and Community Development Department directs the overall and ongoing comprehensive land use planning and development process for the City. The Department provides direct staff support to a number of boards and commissions, including:

- Architectural Review Board
- Board of Zoning Appeals
- Cable Television Commission
- Planning Commission
- Wetlands Board

Business Processes

The Department processes all land use and development applications through the City's Planning Commission. Applications requiring staff review and evaluation, and Planning Commission action include all rezoning requests, special use permits, site plans, and subdivision plat and plans.

Relevant Data Provided

- Zoning map for the City
- Comprehensive land use plan for the City
- Site plans, and subdivision plat and plans
- Flood map for the City
- Chesapeake Bay Map

GIS Benefits

- The ability to interactively view and analyze all relevant map layers, with associated attribute information. This capability is desired in the office and at planning meetings in order to expedite decisions on issues that currently require additional time and resources to research.
- Ability to evaluate land use applications.
- Ability to evaluate potential land development proposals.
- Increased ability to evaluate proposals dealing with the use/sale of City-owned land.
- Compose and print custom maps on demand.

GIS Needs Assessment for the City of Fredericksburg, VA

- Automate the generation of mailing lists and form letters based upon geographic selection criteria (zoning, street, neighborhood, ad hoc, etc.)
- Comprehensive planning analysis for the City. The combination of the multiple datasets in the GIS will provide the capability to analyze areas of growth, or to target areas where planning is needed.
- Provide public access to departments map information via the Web.
- Capability to identify relationships between zoning, transportation, land use and parcel information in one evaluation effort.
- Enhance grant applications and reports with custom maps.
- Mobile access to City map layers would benefit zoning officer's efficiency out of the office.
- Enhance historic preservation activities.
- Enhance hazard mitigation activities.
- Efficient, computerized access to the status of permit applications.
- Environmental Analysis
- Population analysis of growth and trends

Sheriff's Office

Representatives

P.W. Higgs – Sheriff

Mission

It is the mission of the Fredericksburg Sheriff's Office to provide to the Commonwealth of Virginia and the City of Fredericksburg, a responsive, coordinated, composite, city-wide Sheriff's Office; independent yet supportive of other law enforcement agencies; to preserve law and order; to meet goals and objectives of the Office; provide security and safety services in the most efficient and effective manner.

Business Processes

The Sheriff's office deals daily with the citizens of the City of Fredericksburg as an enforcement agency as well as for general information, they also deal with the State Police, the FBI and Surrounding County Police.

- The Office of the Sheriff provides protection and assists anyone in the confines of the Fredericksburg City limits.
- Assists the Fredericksburg Police, Virginia State Police, as well as the surrounding county Sheriff Offices.
- Serves civil and criminal documents.
- Transports prisoners.

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- Provides security and protection to the Judges, Court Clerks and the Citizens while in the Fredericksburg Courthouses.

Relevant Data Provided

- Location of, and details about, incidents responded to.

GIS Benefits

- Ability to print own updated City map books for in-office and in-vehicle use.
- Emergency site location maintenance and update, as well as analysis, to ensure proper placing of emergency response units in relation to City population centers.
- Access and analyze crime data in a geographic context.
- Ability to quickly look up / verify the address of persons.
- Provide accurate address location and emergency response unit locations enabling routing analysis in the effort to minimize emergency response time.
- Provide faster retrieval and display of address locations, streets, and emergency response units with real time query and scenario applications.
- Provision of consistent and accurate data sets which may be shared among departments for display and analysis (e.g. Police and Fire Departments).

Police Department

Representatives

David Nye – Chief

Waverly Musselman - Assistant Commander of Support Services

John Brandrup – Systems Manger

Mission

The police department operates for the safety and well being of the public. This goal is accomplished through the enforcement of state laws and city ordinances. Success or failure is measured by the increase or decline in the crime rate of a particular crime.

Business Processes

The Police Department is organized into three divisions: Patrol, Detective, and Support Services.

The Patrol Division enforces traffic and parking regulations, supports the Community Policing Program giving officers an opportunity to learn and serve various communities in the City, as well as manages the Auxiliary section of volunteer citizens who have undergone the same training as full-time officers.

The Detective Division has responsibility for investigative and narcotics work.

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The Support Services Division provides the administration, maintenance, training, and logistics for the department. This includes emergency dispatchers.

The Police Department performs these duties in support of the services listed above:

- Provide Crime Statistics and Call Analysis Based upon Geographic Areas
- Provide Reports, Statistics on General and Specific Areas of the City
- Update 911 road centerlines
- Update 911 with appropriate layers for emergency services departments
- Coordinates with Graphics Department to maintain street maps for dispatching purposes
- Coordinates parking ticket information with the City Treasurer
- Communicates with the Commissioner of Revenue to locate individuals by their tax billing address
- Coordinates incident response with the Fire Department and Sheriff's Office.
- Communicates the Location and pole number of street light outages to Dominion Virginia Power
- Provides criminal information to a number of regional, state and federal organizations

Relevant Data Provided

- 911 data
- Crime location and details
- Incident information

GIS Benefits

- Ability to print own updated City map books for in-office and in-vehicle use. This requires the timely update of City street maps and addresses.
- Access to aerial photography and map layers for building footprints, utilities, partial centerlines for adjacent jurisdictions, cell phone towers, stop lights, one way street indicators, fire hydrants, storm drains and retention ponds, mutual aid fire, flood zones, through alleyways, landing zones, and school zones.
- Efficient, computerized access to the assessor's database for ownership information.
- Ability to select a parcel and obtain the phone number for that address.
- Ability to integrate maps, demographics, and crime statistics to enhance patrol plans.
- Access, analyze, and report crime data in a geographic context.
- Ability to quickly look up / verify the address of persons.
- Provide accurate address location and emergency response unit locations enabling routing analysis in the effort to minimize emergency response time (efficient routing).
- Provide faster retrieval and display of address locations, streets, and emergency response units with real time query and scenario applications.

- Provision of consistent and accurate data sets which may be shared among departments for display and analysis (e.g. Sheriff and Fire Departments).

GIS Applications

In this section we look at the applications identified from the questionnaires and interviews. We begin by defining GIS applications that are fundamental to the operation and use of the GIS in local government. We then review the ranking of the potential GIS applications by City staff.

What are GIS Applications?

GIS applications are a set of rules, programs, and processes designed to make the use and maintenance of a GIS easier and more efficient. They are focused on a particular business function, such as updating parcel information. They provide the user with a set of pre-defined commands and guide the user through steps of the process. Applications are acquired either as modular add-ons or custom written programs.

Potential GIS Applications

Numerous potential GIS applications, grouped into eight distinct categories, were evaluated for implementation. These potential applications were selected based upon their direct relation to city government business, and their potential for improving Fredericksburg's current operations. A comprehensive list of the applications presented to City personnel for implementation consideration is provided below. Appendix B shows the responses to all potential applications from the questionnaire. Appendix C is a glossary of GIS terms.

AD HOC VIEWING AND MAPPING

- On-Line Data Access – GIS viewing, querying, and reporting functionality provided through standard desktop GIS programs and/or browsers across the inter/intranet
- Automated Mapping – Digital or hardcopy maps depicting the accurate locations (in relation to the base map) and conditions of the City's parcels, political subdivisions, transportation network, utilities, etc.
- Mobile Computing – Real (or near-real) time access to geo-referenced graphic and tabular GIS features for reference and updating
- Address Location and Routing – Ability to location and obtain driving directions to any address (like MapQuest)

REAL PROPERTY MANAGEMENT

- Parcel Data Maintenance – Maintain, access, and distribute real property information including lot line locations, deeds, assessment data (CAMA), zoning, etc. Provide link to Assessor database files.
- Housing Inventory – Track, analyze, and administer available housing by type, age, condition, census tract, etc.

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- Neighborhoods – Track, analyze, and administer neighborhood revitalization efforts, programs, and results, etc.
- Permitting and Inspections – Administer the building permit and property / zoning inspection program and analyze trends, violations, etc.
- Easements – Maintain, access, and distribute current information on easements and rights-of-way on private property.
- Civic and Homeowner Association Boundaries – Maintain, access, and distribute the regions served by homeowner and civic associations with contact and other information.
- Shopping Centers – Maintain and access the location and services of shopping centers, along with contact and other information.

ECONOMIC DEVELOPMENT

- Recruitment – Incorporate various data sets to support the recruitment of potential businesses including available parcels, location of nearest utilities and transportation features, zoning, etc.
- Business Districts – Map and analyze business districts and enterprise development zones
- Business Licenses – Track, monitor, and administer business license program by type, location, etc.
- Brownfields - Track, monitor, and administer information about Brownfields.
- Special Tax Districts - Track, monitor, and administer information about special tax districts.

PLANNING AND GROWTH

- Demographic Analysis – Map and analyze population and related demographic information to support the planning / implementation of required City services
- Comprehensive Planning – Integrate multiple local, state, and federal data sets needed to support planning activities including soils, wetlands, flood zones, etc.
- Capital Budget Planning – Map and analyze the locations and attributes of capital budget items, etc.
- Community Development – Track, analyze, and administer community development activities and programs
- Historic Assets - Track, monitor, and administer information about the historic district and assets.
- Application Tracking – Locate, manage and assess land use applications.

PUBLIC SAFETY

- Computer Aided Dispatch (CAD) – Integrate GIS functionality with computer aided dispatch system to provide dispatchers and responders with real-time locational maps
- Routing – Integrate GIS features with computer aided dispatch system to enable real time routing based on travel time, impedances, in/out service status, etc.
- Crime Mapping – Track, display, and analyze local crime trends in relation to neighborhood locations, schools, parks, etc.

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- Disaster Planning – Perform disaster pre-planning and post disaster analysis of notifications, evacuation routes, shelter locations, etc.
- Reverse 911 – Enables automated phone messages about emergency situations to be sent to addresses in select geographic areas.

ENGINEERING

- Asset Condition Tracking / Management – Monitor and map the type, age, condition, and maintenance history of all public works / utilities assets
- Asset Valuation – Track the installation/construction costs and depreciation of all public works / utilities assets
- Development / Construction Coordination – Coordinate, update, and review of local development / construction activities
- Field Data Collection / Management – Enhance the organization and currentness of data field acquisition through the use of automated mechanisms (GPS, field computers, mobile GIS)
- Hazardous Materials / Underground Storage Tank Monitoring and Management – Map underground storage tank and hazardous material storage locations
- Network Analysis – Model and analyze the water distribution, sanitary sewer, and storm water infrastructure systems
- MISS Utility Marking – Locate and map utility infrastructure features in support of the MISS Utility locating program
- System Operation / Performance Monitoring – Evaluate overall system operations and performance utilizing SCADA, network analysis models, water quality models, ground water models, surface water models, etc. Modeling features and attributes maintained in GIS
- Water Flow Analysis – Map and analyze flow directions utilizing data collected through flushing, dye, smoke, etc. tests
- Water Production Monitoring – Perform trend analyses between water production quantities and consumption (distribution) quantities
- Water Quality Monitoring – Map and analyze the relationships between water quality concerns and customer complaints
- Work Order Management – Increase the efficiencies of work order processing; manage preventative maintenance and inspection programs
- Street Tree Monitoring – Map the trees maintained by the City, along with maintenance information (services performed by date)
- Colonial Street Light Monitoring – Map the colonial street lights maintained by the City, along with maintenance information (services performed by date)

HEALTH AND SOCIAL SERVICES

- Case Management – Assist public and private case workers (health and social services) locate and coordinate services to clients
- Childcare Administration – Map, analyze, and administer childcare facilities by types of services offered, inspections, violations, etc.
- Health Department Inspections – Track, analyze, and administer restaurant and cafeteria inspections, violations, complaints, etc.

GIS Needs Assessment for the City of Fredericksburg, VA

SCHOOLS

- School Bus Routing – Route school buses and other transportation vehicles for pick up / drop off based on shortest distance traveled, shortest travel time, etc.
- School District Mapping – Track, analyze, and administer school zone boundaries based on demographic data, programs provided, etc.
- After School Programs – Administer after school programs based on services offered, demographics, locations, etc.

OTHER APPLICATIONS

- Floodplain Mapping – Access and analyze current floodplain maps provided for the region by FEMA.
- Voter District Mapping – Access, maintain, and distribute the voting district boundaries for wards and precincts, with information about polling places.
- Public Transportation Mapping – Access, maintain and distribute public transportation information (routes, schedules, stops, special services, etc.)
- Pathways Mapping – Access, maintain and distribute current information about the location of walkways and bike paths.

Top Ranked Applications

The following table presents the GIS applications most requested by the City's GIS Needs Assessment project participants. The list is ranked based upon the frequency of interest expressed in a particular GIS application by staff/departments through the questionnaire and interview process.

MOST REQUESTED GIS APPLICATIONS		
APPLICATION CATEGORY	APPLICATION	DEPTS NEED (%)
AD HOC VIEWING AND MAPPING	On-Line Data Access	100
AD HOC VIEWING AND MAPPING	Automated Mapping	100
AD HOC VIEWING AND MAPPING	Address Location and Routing	100
REAL PROPERTY MANAGEMENT	Parcel Data Maintenance	75
REAL PROPERTY MANAGEMENT	Neighborhoods	69
PLANNING AND GROWTH	Demographic Analysis	69
AD HOC VIEWING AND MAPPING	Mobile Computing	56
PUBLIC SAFETY	CAD	50
PUBLIC SAFETY	Routing	50
PUBLIC SAFETY	Disaster Planning	50
REAL PROPERTY MANAGEMENT	Housing Inventory	44
REAL PROPERTY MANAGEMENT	Permitting & Inspections	44
REAL PROPERTY MANAGEMENT	Shopping Centers	44
ECONOMIC DEVELOPMENT	Business Districts	44
PLANNING AND GROWTH	Comprehensive Planning	44
PLANNING and GROWTH	Capital Budget Planning	44
PLANNING and GROWTH	Community Development	44
ENGINEERING	Field Data Collection and Mgt.	44

Core GIS Data

Core GIS applications are those that are required to support basic GIS maintenance, have a broad group of business unit users, or are critical to emergency service support. Without them the GIS would have minimal functionality and use. The following table presents the GIS applications most requested by the City's GIS Needs Assessment project participants. The list is ranked based upon the frequency of interest expressed in a particular GIS application by staff/departments through the questionnaire and interview process.

MOST REQUESTED GIS DATA		
DATA CATEGORY	GIS MAP FEATURE	DEPTS NEED (%)
REAL PROPERTY FEATURES	Streets and Alleys	100
OTHER MAPPING FEATURES	Aerial Photography	94
REAL PROPERTY FEATURES	Parcels (and address info)	88
OTHER MAPPING FEATURES	Subdivision/Neighborhood Boundaries	88
OTHER MAPPING FEATURES	City Boundary	82
REAL PROPERTY FEATURES	Publicly-owned Property	82
REAL PROPERTY FEATURES	Building Footprints	71
PUBLIC SAFETY FEATURES	Fire Hydrants	71
REAL PROPERTY FEATURES	Rights-of-way/Easements	65
ENVIRONMENTAL FEATURES	Hydrography	65
OTHER MAPPING FEATURES	Zoning	65

MOST REQUESTED GIS DATA		
DATA CATEGORY	GIS MAP FEATURE	DEPTS NEED (%)
OTHER MAPPING FEATURES	Land Use Plans	59
REAL PROPERTY FEATURES	Property Assessment Data	53
ENVIRONMENTAL FEATURES	Environmentally-sensitive areas	53
ENVIRONMENTAL FEATURES	Hazardous Materials Locations	53
UTILITY INFRASTRUCTURE	Drainage Basins	53
OTHER MAPPING FEATURES	Transportation Plan (FRED)	53

GIS Data Resources

The City of Fredericksburg and other organizations presently maintain a variety of geographic data sources that will be used to support the development of the City's new GIS. These existing data sources include digital aerial photography and AutoCAD files, paper maps and plans, spreadsheets and other digital database files. The GIS data requirements section of this analysis begins with a discussion of the types and sources of GIS base map data. Next, we focus on the sources of the data sets required to support the GIS applications identified as priorities by City staff. Finally, a brief discussion of map accuracy and data conversion procedures is presented so that the likely locational accuracy and feature detail of GIS map features are better understood. In some cases, digital data can be migrated and/or transformed into the new GIS system. In other cases, where the data sets do not yet exist or are of questionable accuracy/currency/completeness, they should be

created. This section of the report describes the current status map and data sources needed to meet the GIS application requirements expressed by the City. The best approach to migrating and/or creating these map layers for the new GIS is presented in the data recommendations section of this report.

GIS Base Map Data Types

The data sets presented below collectively represent the common base map data that will be used as the foundation for mapping applications that will satisfy the expressed needs of City departments. These base map data sets will be used to build, adjust, maintain and reference the other GIS data sets to be used in specific GIS applications.

Imagery

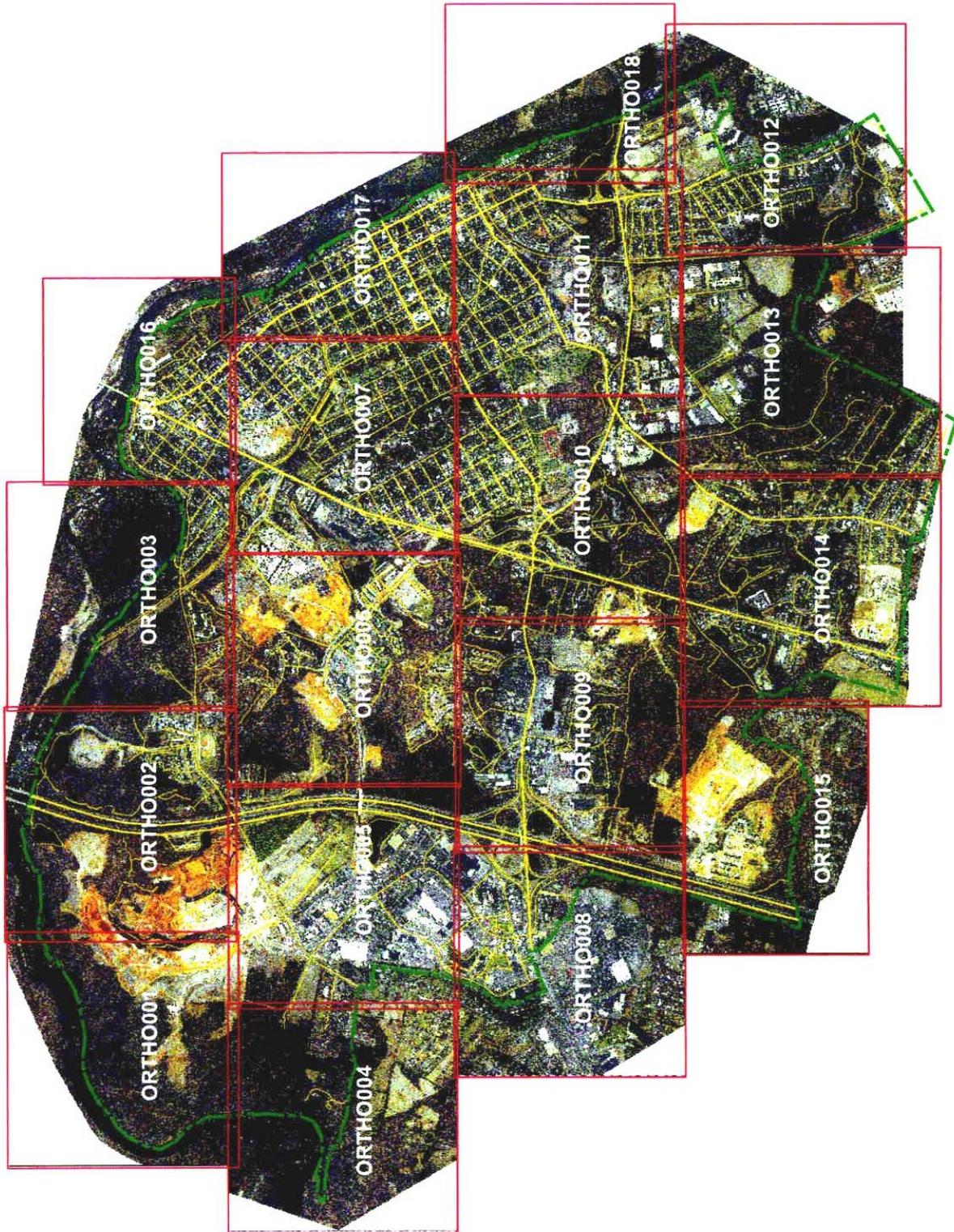
Digital imagery derived from aerial photography and satellites is one of the basic data elements of a local government GIS. Most, if not all, other GIS data layers are tied to or derived from the imagery. The imagery resolution and accuracy are expressed in terms of pixel size and spatial accuracy. Digital images are made up of small colored or grayscale squares called pixels. An image's pixel resolution is a measurement of the amount of detail contained within one pixel. A pixel is the smallest unit of detail within a digital image. As related to aerial photography or satellite imagery, the pixel resolution indicates the size of the ground area covered by each pixel. For example, an image with a 2-foot pixel resolution represents an area 2 feet by 2 feet (4 square feet) within each pixel. The smaller the stated pixel resolution, the more detailed an image will be when viewed at higher zoom, thus enabling the accurate photo-identification of smaller ground features.

In general, the imagery should be developed to meet the most demanding application accuracy. For local governments like Fredericksburg, 1:1,200 (1"=100') provides the necessary accuracy for most non-engineering GIS applications.

In the Spring of 2005, the City contracted with the Timmons Group to prepare the specifications for the aerial photography to be collected for the production of digital orthophotography. Through competitive bid, the aerial photography and photogrammetric production services contract was awarded by the City to TVGA Consultants. Aerial photography was flown for the City on March 22, 2005 and processed to create digital orthophotography with the following parameters:

- Image file format: TIF with world file (.tif)
- Pixel size: 6"
- True Color (24-bit)
- Horizontal and vertical accuracies for the new orthophotos and planimetric data meet or exceed National Map Accuracy Standards for 1"=100' mapping scale.
- Horizontal Control and deliverables use the NAD 83/93 (HARN) adjustment, Virginia State Plane North Zone, US Survey Foot. Vertical data are referenced to the NAVD 88 vertical datum, with NGS Geoid 99 (or newer) model used in derivation of orthometric heights.

The diagram below presents an overview of the image data collected, along with an index overlay showing the position and extent of the individual image tiles that comprise the orthophotomosaic of the City (North is toward the left).



The imagery was produced to provide a visual base map for the City's GIS and to support photogrammetric mapping of GIS layers at a scale of 1" = 100'. Some of the map layers that can be extracted from the photography include:

- **Street Centerlines**
- **Edge of Pavement**
- **Parking Areas**
- **Sidewalks**
- **Building Footprints**
- **2' topographic Contours**
- **Bridges**
- **Railroads**
- **Hydrography**

Until the new digital orthophotography was delivered in June 2005, the City was using color digital orthophoto produced and distributed by the Virginia Geographic Information Network (VGIN). This imagery was captured from aerial photography flown in March of 2002 as part of the Virginia Base Mapping Program. This imagery product is available to the City of Fredericksburg at no cost through this statewide program. This imagery provides a "snapshot in time" and will continue to be a valuable part of the City's GIS. VGIN has proposed another aerial photography acquisition during the Spring of 2006.

Planimetric Features

Planimetric features are defined as those natural and man-made features that define the landscape, and are easily identifiable on the base map images. Examples of planimetric features include, but are not limited to:

- Building footprints
- Hydrography (rivers, lakes, streams)
- Roadways (centerlines, pavement edges, curbs, sidewalks)
- Railroads
- Bridges (over / under passes)
- Fence lines
- Above-ground utility features (manholes, culverts, power poles, storage facilities, transfer stations)
- Vegetation (tree lines, tree stands, cultivated fields)

Local government GIS implementations designed to support real property management, planning, and emergency services applications can typically be supported by a base map product that includes the following minimum planimetric features:

- Road centerlines
- Driveway (access) points
- Building footprints
- Hydrography

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The following table lists the map features that are typically mapped using aerial photography collected at 20, 50, 100, and 200 scale.

LAYER #	LAYER NAME	DESCRIPTION	20 SCALE	50 SCALE	100 SCALE	200 SCALE
MANUSCRIPT FEATURES						
1	M_MODEL_LIMIT	L good model extents				
2	M_PROJECT_LMT	L project limit				
3	M_SHEET_BORDER	L sheet border				
4	M_GRID	L grid line				
5	M_DTM_LIMIT	L dtm limit				
50	M_TXT	S manuscript text				
CONTROL POINTS						
51	S_HORZ	S horizontal control point				
52	S_VERT	S vertical control point				
53	S_PHOTO_HV	S horizontal & vertical control point				
TRANSPORTATION FEATURES						
100	T_ROAD_PVD	L paved road	X	X	X	X
101	T_ROAD_UNPVD	L unpaved road	X	X	X	X
102	T_CURB	L curb	double line	single line		
103	T_DROP_CURB	L drop curb	double line	single line		
104	T_ROAD_GUTTER	L paved gutter	X	X	X	
105	T_SHOULDER_PVD	L paved shoulder	X	X	X	
106	T_SHOULDER_UNPVD	L unpaved shoulder	X			
107	T_CENTERLINE	L road centerline	X	X	X	X
108	T_CHANGE_PAV	L change in pavement	X	X	X	
109	T_EX_JOINT	L expansion joint	X	X		
110	T_BRIDGE	L bridge deck	X	X	X	X
111	T_RR_BRIDGE	L railroad bridge deck	X	X	X	X
112	T_FOOTBRIDGE	L pedestrian footbridge	X	X	X	
113	T_BR_ROAD	L bridge deck road	X	X	X	
114	T_BR_CURB	L bridge deck curb	X	X		
115	T_BR_WALK	L bridge deck sidewalk	X	X	X	
116	T_BR_FOOTER	L bridge footer	X	X	X	
117	T_BR_WINGWALL	L bridge wingwall	X	X	X	
118	T_BR_ABUTMENT	L bridge abutment	X	X	X	
119	T_BR_MISC	L miscellaneous bridge feature	X	X	X	
120	T_RR	L active railroad	double line	double line	single line	single line
121	T_RR_ABANDONED	L abandoned railroad	double line	double line	single line	single line
122	T_AIR_RUNWAY	L airport runway	X	X	X	X
123	T_AIR_PVD	L miscellaneous airport pavement	X	X	X	
124	T_DRIVE_PVD	L paved drive	X	X	X	over 200'
125	T_DRIVE_UNPVD	L unpaved drive	X	X	X	over 200'
126	T_DRIVE_CONC	L concrete drive	X			
127	T_PARKING	L paved parking lot	X	X	X	over 200'
128	T_PARKING_UNPVD	L unpaved parking lot	X	X	X	over 200'
129	T_FLUSH_MEDIAN	L flush median	X	X		
130	T_RAISED_MEDIAN	L raised median	X	X		
131	T_WALK	L sidewalk	X	X	X	
132	T_TRAIL	L vehicular trail	double line	double line over 5'	single line	single line over 20'
133	T_PATH	L pedestrian path	double line over 5'	double line over 5'	single line	
134	T_GOLFCART_PATH	L golfcart path	X	X	X	X
135	T_RAMP	L ramp	X	X	X	
136	T_HC_RAMP	L handicap ramp	X	X	X	
137	T_TRAF_BARRIER	L traffic barrier	double line	double line	single line	
138	T_NOISE_BARRIER	L noise barrier	double line	double	single line	
139	T_PAINT_LINES	L paint lines	special request only	special request only		
140	T_DBL_BOX_BEAM	L guide rail, double-sided box beam	X	X	X	over 200'
141	T_SGL_BOX_BEAM	L guide rail, single-sided box beam	X	X	X	over 200'
142	T_DBL_W_BEAM	L guide rail, double-sided W beam	X	X	X	over 200'
143	T_SGL_W_BEAM	L guide rail, single-sided W beam	X	X	X	over 200'
144	T_WOODEN_RAIL	L guide rail, wooden	X	X	X	over 200'
145	T_CABLE_RAIL	L guide rail, cable	X	X	X	over 200'
146	T_GUIDE_POST	L guide post	X			
147	T_PARKING BUMPER	L parking bumper	X	special request only		
148	T_PVD_DITCH	L paved ditch	X	X	X	
149	T_GAS_CANOPY	L gas island canopy	X	X	X	
150	T_RR_SIGNAL	S railroad signal	X	X		
151	T_REFLECTOR	S traffic reflector	X			
152	T_RUNWAY_LIGHT	S runway light	X	X		
153	T_PARKING BUMPER	S parking bumper	X	special request only		
154	T_BR_SPOT	S bridge elevation spot	X	X	X	
155	T_SIGNAL_POLE	S traffic signal pole	X	X	X	
156	T_TRAFFIC_LIGHT	S traffic light	special request only	special request only		
157	T_TXT	S transportation text	X	X	X	

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LAYER #	LAYER NAME	DESCRIPTION	20 SCALE	50 SCALE	100 SCALE	200 SCALE
PLANIMETRIC FEATURES						
200	P_BUILDING	L building (major)	X	X	X	X
201	P_STRUCTURE	L structure (sheds,ect..)	X	X	X	X
202	P_RUIN/FOUND	L ruin / foundation	X	X	X	
203	P_DECK	L deck	X	X		
204	P_STAIR	L stairs	X	X		
205	P_CONC_PAD	L concrete pad	X	X	over 10'x10'	
206	P_BULKHEAD	L bulkhead	X	X		
207	P_GREENHOUSE	L greenhouse	X	X	X	
208	P_SILO	L silo	X	X	X	X
209	P_TANK	L tank	X	X	public	public
210	P_SMOKE_STACK	L smoke stack	X	X		
211	P_ABOVE_POOL	L above ground pool	X	X	X	
212	P_INGROUND_POOL	L inground pool	X	X	X	public
213	P_REC_FIELD	L recreation field	X	X	X	X
214	P_COURT	L recreation court	X	X	X	
215	P_WALL	L freestanding wall	double line	double line	single line	single line over 20'
216	P_RET_WALL	L retaining wall	double line	double line	single line	single line over 20'
217	P_STONE_WALL	L stone wall	X	X	X	single line over 20'
218	P_FENCE	L fence	X	X	property line	property line
219	P DOCK	L dock, pier	X	X	X	commercial only
220	P_LOADING_DOCK	L loading dock	X	X		
221	P_CEM	L cemetery	X	X	X	X
222	P_QUARRY	L quarry	X	X	X	X
223	P_UNDER_CONSTR	L area under construction	X	X	X	X
224	P_BERM	L berm	X	X	X	X
225	P_PILE	L pile	X	X	over 10'x10'	
226	P_STORAGE/DEBRIS	L storage / debris	X	X	over 10'x10'	over 20' x 20'
227	P_ROCK	L large landmark rock	X			
228	P_RIPRAP	L riprap	X	X	X	over 20' x 20'
229	P_GOLF_COURSE	L golf course	X	X	X	X
230	P_TEE	L tee	X	X		
231	P_GREEN	L green	X	X		
232	P_FAIRWAY	L fairway	X	X		
233	P_SANDTRAP	L sandtrap	X	X		
234	P_SNOW	L snow	X	X	X	
235	P_GAS_ISLAND	L gas station island	X	X	X	
236	P_MISC	L planimetric miscellaneous	X	X	X	
237	P_GROUND_OBS	L ground obscured	X	X	X	
238	P_AGRICULT_FIELD	L agricultural field	special request only	special request only	special request only	special request only
239	P_PORCH	L porch	X	X		
240	P_GRAVE_MARKER	L grave marker	special request only	special request only		
241	P_LANDSCAPING	L landscaping	X	X		
242	P_PLANTER	L planter	X	X		
243	P_PATIO	L patio	X	X	over 10'x10'	
244	P_TRAILER_PARK	L trailer park	X	X	X	X
260	P_POLE	S pole	X	X	X	
261	P_POST	S post	X	X		
262	P_FLAG_POLE	S flag pole	X	X	X	
263	P_MAILBOX	S mailbox	X	special request only		
264	P_SINGL_SIGN	S single post sign	X	X	X	
265	P_DBL_SIGN	S double post sign	X	X	X	
266	P_LARGE_SIGN	L large sign	X	X	X	
266	P_LARGE_SIGN	S large sign	X	X	X	
267	P_OH_SIGN	S overhead sign	X	X	X	
268	P_FILLER_CAP	S filler cap	X	X		
269	P_PARKING_METER	S parking meter	X	X		
270	P_SAT_DISH	S satellite dish	X	X	commercial	
271	P_WELL	S well	X	X		
272	P_TXT	S planimetric text	X	X	X	
273	P_ANTENNA	S antenna	X	X	X	X

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LAYER #	LAYER NAME	DESCRIPTION	20 SCALE	50 SCALE	100 SCALE	200 SCALE
VEGETATION FEATURES						
300	V_TREELINE	L treeline	X	X	X	X
301	V_BRUSHLINE	L brushline	X	X	X	
302	V_HEDGE	L hedge	X	X	X	
303	V_ORCHARD	L orchard	X	X	X	
304	V_NURSERY	L nursery	X	X	X	
350	V_DECID_TREE	S deciduous tree	X	X	X	
351	V_DECID_BUSH	S deciduous bush	X	X		
352	V_CONIF_TREE	S coniferous tree	X	X	X	
353	V_CONIF_BUSH	S coniferous bush	X	X		
354	V_TXT	S vegetation text	X	X	X	
355	V_STUMP	S stump	X	X		
UTILITY FEATURES						
400	U_SUBSTATION	L substation	X	X	X	over 20' x 20'
401	U_TRANS_TOWER	L transmission tower	X	X	X	X
402	U_TRANS_LINES	L transmission lines	special request only	special request only		
403	U_VAULT	L vault	X	X		
404	U_PIPE	L pipe	X	X		
405	U_PIPELINE	L pipeline	X	X	X	X
406	U_PUMP_STATION	L pump station	X	X	X	
407	U_MISC	L utility miscellaneous	X	X	X	
450	U_BOX	S utility box	X	X		
451	U_CB	S catch basin	X	X	X	
452	U_CIRCLE_CB	S circle catch basin	X	X	X	
453	U_DROP_INLET	S drop inlet	X	X		
454	U_FIELD_INLET	S field inlet	X	X		
455	U_HYD	S fire hydrant	X	X		
456	U_MH	S manhole	X	X		
457	U_UTIL_LT_POLE	S utility pole with light	X	X		
458	U_UTIL_POLE	S utility pole	X	X	X	X
459	U_LT_POLE	S light pole	X	X	X	
460	U_DEC_LIGHT	S decorative yard light	X	X		
461	U_GUYWIRE	S guywire	X	X		
462	U_VALVE	S valve	X	X		
463	U_TXT	S utility text	X	X		
464	U_MON_WELL	S monitoring well	X	X		
HYDROGRAPHIC FEATURES						
500	H_LAKE	L lake	X	X	X	X
501	H_RIVER	L river	X	X	X	X
502	H_SWAMP	L swamp	X	X	X	X
503	H_DITCH	L ditch	X	X	X	
504	H_DAM	L dam	X	X	X	X
505	H_WALL	L headwall	double line	double line	double over 10'	double over 20'
506	H_CULVERT	L culvert	X	X	large only	
507	H_PVD_GUTTER	L paved gutter	X	X		X
508	H_POND	L pond	X	X	X	X
509	H_CREEK	L creek	double line over 5'	double line over 5'	double over 10'	double over 15'
510	H_DRY_DITCH	L dry ditch	special request only			
511	H_WETLAND	L wetland	special request only			
512	H_MISC	L miscellaneous hydro feature	X	X	X	X
513	H_WATER	L miscellaneous water	X	X	X	X
550	H_SWAMP	S swamp symbol	X	X	X	X
551	H_CULVERT	S culvert	X	X	large only	
552	H_TXT	S hydro text	X	X	X	
553	H_WATER_ELV	S water elevation spot	X	X	X	

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LAYER #	LAYER NAME	DESCRIPTION	20 SCALE	50 SCALE	100 SCALE	200 SCALE
TERRAIN FEATURES						
600	C_INDEX	L index contour				
601	C_IND_APPRX	L approximate index contour				
602	C_IND_DEP	L depression index contour				
603	C_IND_DEP_APPRX	L approximate depression index contour				
604	C_INTERMEDIATE	L intermediate contour				
605	C_INT_APPRX	L approximate intermediate contour				
606	C_INT_DEP	L intermediate depression contour				
607	C_INT_DEP_APPRX	L approximate intermediate depression contour				
608	NA_DTM_HARD	L hard breakline				
609	NA_SOFT	L soft breakline				
610	NA_EDIT	L edit line				
612	NA_RW_FOOTPRINT	L retaining wall footprint breakline	special request only	special request only		
650	C_SPOT_EL	S spot elevation				
651	NA_DTM_SPOT	S dtm mass point				
652	NA_EDIT	S edit marker				
653	C_IND_TXT	S contour annotation				
TEXT						
800	TXT_WALL	S text label, wall				
801	TXT_RW	S text label, retaining wall				
802	TXT_CONC	S text label, concrete pad				
803	TXT_RIPRAP	S text label, riprap				
804	TXT_OBSCURED	S text label, obscured area				
805	TXT_DECK	S text label, deck				
806	TXT_BRUSH	S text label, brush area				
807	TXT_HW	S text label, headwall				
808	TXT_SIGN	S text label, large sign				
809	TXT_POOL	S text label, inground pool				
810	TXT_A/G POOL	S text label, above ground pool				
811	TXT_SW	S text label, sidewalk				
812	TXT_STORAGE	S text label, storage				
813	TXT_DEBRIS	S text label, debris				
814	TXT_PLANTER	S text label, planter				
815	TXT_GAS CANOPY	S text label, gas station canopy				
816	TXT_TANK	S text label, tank				
817	TXT_SILO	S text label, silo				
818	TXT_SMOKESTACK	S text label, smokestack				
819	TXT_AG FIELD	S text label, agricultural field				
820	TXT_TRANS TOWER	S text label, transmission tower				
821	TXT_SUBSTATION	S text label, substation				
822	TXT_PARKING	S text label, parking				
823	TXT_PIPE	S text label, pipe				
824	TXT_ORCHARD	S text label, orchard				
825	TXT_NURSERY	S text label, nursery				
826	TXT_CEMETERY	S text label, cemetery				
827	TXT_RAMP	S text label, ramp				
828	TXT_H/C RAMP	S text label, handicap ramp				
829	TXT_DAM	S text label, dam				
830	TXT_RUIN	S text label, ruin				
831	TXT_BULKHEAD	S text label, bulkhead				
832	TXT_GREENHOUSE	S text label, greenhouse				
833	TXT_U/C	S text label, area under construction				
834	TXT_PILE	S text label, pile				
835	TXT_SNOW	S text label, snow				
836	TXT_PATIO	S text label, patio				
837	TXT_FOUNDATION	S text label, foundation				
838	TXT_WINGWALL	S text label, wingwall				
839	TXT_RUNWAY	S text label, runway				
840	TXT_FOOTBRIDGE	S text label, footbridge				
841	TXT_LOADING DOCK	S text label, loading dock				
842	TXT_PORCH	S text label, porch				
843	TXT_MISC	S text, miscellaneous				
844	TXT_TRAILER_PARK	S text label, trailer park				
845	TXT_PIER	S text label, pier				

Topographic Features

Topographic (contour) data is used to represent mountains, hills, depressions, and other ground surface undulations in a two-dimensional map product. A contour line is a line that connects two or more points of equal elevation. Topographic data is useful in supporting a variety of GIS applications that require elevation data such as utility location, site selection, flood plain analysis, surface water modeling, etc.

The City currently has 5' contour data from planimetric mapping work that MSAG Data Consultants did in 1996. Changes in topography have occurred due to land development since 1996, and the new 2005 imagery can be used to extract the current contour information at 2' intervals.

While none of the City's selected Core Applications require a topographic data set, it is recognized that a number of additional planning, permitting, and engineering applications (future development) will benefit from the availability of topographic data. For example, the City is on FEMA's list this year to have the Flood Insurance Rate Maps (FIRMs) updated. This update would benefit from the use of new 2' topographic contours, and is a high priority item to be addressed by the City as stated in the Rappahannock Area Development Commission (RADCO) All Hazard Mitigation Plan.

City Boundary Features

Maps of the City Boundary are currently available in paper and digital form (AutoCAD). This boundary is currently maintained on paper survey plans (10 sheets) that cover the City and surrounding region.

Other major boundaries, such as those for subdivisions and neighborhoods, are maintained and available mostly in paper form, and are taken from original subdivision maps and tax maps. Some of these boundaries are available in AutoCAD format in areas where land development activities are relatively recent.

GIS Application Map and Data Layers

The following section of the report describes the map data layers and related data needed to supplement the base map in support of the priority GIS applications identified by the City staff. These supplemental map layers and supporting data are organized by functional categories: real property, environmental, utility / public works, and a general category for "other" mapping needs. Additional data sources available from organizations from outside the City are also explored.

Real Property Features

Land Parcels – The Commissioner of the Revenue maintains the most current set of parcel maps. This is done primarily in paper format on one set of about 500 parcel maps (15" x 24"). Paper map scales and orientation vary. Some of the newer tax maps (subdivisions) were created in digital form in AutoCAD. The paper maps are copied and distributed to other city departments. The parcel maps are updated by the Graphics Department as often as possible, but not on a regular basis. Associated tax assessment and billing information for the City's approximately 7,650 parcels is maintained by the Commissioner of the Revenue in a computerized system from Bright and Associates.

Publicly-owned Property – Information about the location and details about land parcels owned by the City is maintained by the Commissioner of the Revenue and the City Attorney's Office. Locations of publicly-owned property are maintained on the paper tax maps. The associated property details are maintained in computerized and paper files.

Easements – Limited easement information can be obtained directly from the tax parcel map / insert source. However, the majority of the easement information (graphic and attribute) comes directly from the individual deeds and plats recorded in the Circuit Court Clerk's office. This information is supplemented by information on the early maps of the City, such as the 1916 map of the old downtown area and VDOT highway plans.

Building Footprints – The City's tax maps and aerial photography show the locations of buildings and other man-made structures. The building footprints shown on the tax maps are updated in conjunction with development projects and changes recorded in documents in the Circuit Court Clerk's Office.

Streets and Alleys – City streets are maintained on the tax maps, primarily in paper form. New streets are being mapped in digital form using AutoCAD from "as-built" site plans provided by developers. Some information about alleys is available from the Commissioner of Revenue and/or City Shop.

Another source of road centerline data is the Virginia Geographic Information Network, (VGIN) Virginia Base Mapping road centerline project (VBMP-RCL). This project is creating a statewide layer of public, private road centerlines and long driveways. This data set is being created from the 2002 VBMP digital orthophotography.

City roads are assigned names and address ranges by the Building and Development Services Department, in coordination with the Planning and Public Safety Departments.

Environmental / Topographic Features

Environmentally Sensitive Areas – The City maintains paper and AutoCAD maps on a project-by-project basis. Sensitive areas are shown on Chesapeake Bay Protection Area maps and floodplains as identified by FEMA on their Flood Insurance Rate Maps (FIRMs).

Hazardous Materials Locations – There is currently an area-wide HazMat study being conducted by the City in conjunction with RADCO and a private contractor. This study will draw on existing documentation and resources to develop information that can be utilized by the City's new GIS.

Hydrography – Water features such as rivers, streams and lakes are shown on the City's planimetric maps produced by MSAG in 1996. The location of surface water features are also visible on the 2002 VGIN orthoimagery and the new 2005 orthoimagery.

Public Safety Features

Most of the public safety map features listed in the GIS questionnaire are of very high priority (critical or important) to the Sheriff's Office, and the Police and Fire Departments. Specifically, the high priority map features for these organizations are:

- Access Point Locations
- Emergency Service Zones
- Fire Hydrants
- Emergency Landing Zones
- Hazardous Materials Locations
- Mutual Aid Boundaries (surrounding jurisdictions)
- PSAP Boundaries
- Police and Sheriff Districts/Precincts/Beats
- Structure Address Locations

The City's public safety departments maintain these map layers and related information for their use in dispatching and other departmental duties. These departments rely most on other City Departments for street addresses of structures (Building and Development Services) and the location and maintenance of fire hydrants (Public Works Department).

Based upon the results of the GIS Questionnaire, only fire hydrants were a high priority map feature layers for other (i.e. non-public safety) City departments.

Fire Hydrants – The Fire Department and Public Works maintain paper maps and plans showing the location of fire hydrants, along with other information such as flow rates and inspection dates. There are approximately 1,100 fire hydrants in the City, with new ones being added as new construction occurs.

Utility Infrastructure Features

Drainage Basins – Manmade structures for the capture, retention, and distribution of stormwater runoff are an important map feature for a number of City departments, especially Public Works. Public Works maintains paper maps and site development plans that show the location, extent, and topography of drainage basins.

Other Mapping Features

Subdivision / Neighborhood Boundaries – These boundaries are maintained mostly on the City’s set of paper tax maps, and are available on original subdivision plats and plans recorded in the Circuit Court Clerk’s Office. Newer subdivisions may have associated AutoCAD files showing these boundaries.

Land Use Plans – Land use plans are part of the City’s comprehensive plan. This information and associated maps are maintained by the City’s Planning Department.

Zoning – The Planning department maintains a set of hard copy zoning maps that are based on the tax parcel map set. The tax parcel maps are colored to derive the zoning map set. A digital version of the City’s zoning map is available in AutoCAD format.

Transportation Plan (FRED) – FRED provides bus service to transportation for people who reside or work or visit within the Fredericksburg, Virginia region (i.e., the City of Fredericksburg and the counties of Caroline, King George, Spotsylvania and Stafford). RADCO currently maintains the bus route map for FRED in an ESRI GIS format.

Additional Existing GIS Map and Data Resources

A number of City departments expressed a need for map and related information for the region surrounding the City – specifically areas in Caroline, King George, Spotsylvania and Stafford Counties. These other jurisdictions currently use GIS software technology from ESRI, and maintain relevant maps layers (especially roads and addresses) that are of interest to some City of Fredericksburg Departments.

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In addition to GIS activities by staff in these surrounding jurisdictions, GIS data are available to the City from state agencies such as the Virginia Geographic Network (VGIN), as well as the regional planning district commission.

VGIN is the lead public agency in the Commonwealth for spatial data and GIS. VGIN's mission is to facilitate the cost-effective development and use of spatial data, GIS, and related technologies in organizations throughout the Commonwealth. The organization maintains and distributes GIS map data and related resources. The current Web URL for VGIN is:
<http://www.vgin.virginia.gov/index.htm>

The Rappahannock Area Development Commission (RADCO) has had its own GIS capabilities since 1996. Since the program's inception, their capabilities and data library have grown enormously. Data sets include regional transportation layers, zoning, land use and environmental layers for the region and surrounding counties. RADCO also has an extensive library of ESRI GIS shape files developed from the Census 2000 data, including commuting patterns, population patterns and poverty information. They have USGS 7.5 minute quad sheets, color, infrared, and black and white satellite imagery for both the RADCO localities and surrounding counties. Recently acquired is the 2002 aerial photography generated by the Virginia Base Mapping Program for the Fredericksburg region and surrounding localities.

RADCO utilizes ESRI Arc View 3.2 as well as ArcGIS 8.2 GIS software on Windows 2000 Professional workstations. Other equipment includes an HP Design Jet 800 PS plotter as well as a 42-inch VIDAR color scanner. This equipment is utilized to provide custom maps to the localities as well as the region as a whole. Work is also provided to public and private organizations throughout the region and the Commonwealth. RADCO also provides demographic and spatial information to citizens and organizations. RADCO works closely with the City of Fredericksburg and the other surrounding localities to keep spatial layers and data current. The current Web URL for RADCO is: <http://www.radco.state.va.us/>

Summary of GIS Map and Data Sources

The ongoing development and maintenance of GIS base map and other core data are important to the success and utilization of a GIS. These GIS base map and other core data sets were identified through evaluating the department level data needs stated on the GIS questionnaires, and during personal interview. The base and core GIS data sets for City of Fredericksburg are summarized in the table below, along with the current data steward and maintenance process. The data steward is the department responsible for the data maintenance.

GIS Map and Related Data Sets			
Data Set	Data Steward	Source	Notes
Base Map Layers			
Imagery	Graphics	Aerial Vendor / VGIN	New imagery at a scale of 1":100' or better created every 2-3 years
Planimetrics	Graphics	Photogrammetric Vendor	Updated from each new acquisition of Aerial Photography
Topography	Graphics	Photogrammetric Vendor	Updated from each new acquisition of Aerial Photography
City Boundary	Graphics	Paper Maps / Plans	Updates requested by City Manager's Office as needed
Real Property Features			
Parcels	COR / Graphics	Paper maps / AS400 / Clerk's System	Changes are made mostly by hand on maps from recorded deeds. Some AutoCAD files for newer subdivisions
Publicly-owned Property	COR / Graphics	Parcel Maps / AS400	Changes are made by hand on maps from plats
Rights of way/ Easements	COR / Graphics	Paper Maps / Clerk's System / AS400	Changes are made by hand on maps from recorded deeds
Real Property Features			
Building Footprints	COR / Graphics	Paper Maps / Imagery / Plans	Changes are made by hand on maps from imagery and developer "as-built" plans
Streets and Alleys	Bldg & Dev / Graphics	Paper Maps / Imagery / Plans	Changes are made from approved construction plans
Environmental / Topographic Features			
Environmentally Sensitive Areas	Public Works / Graphics	Paper maps	Information is updated by FEMA and other environmental organizations.
Hazmat Locations	Fire / Police / Sheriff	Under Review	Locations and material details to be maintained in computer file

GIS Map and Related Data Sets			
Data Set	Data Steward	Source	Notes
Hydrography	Graphics / Public Works	Imagery & Planimetrics	Updated from each new acquisition of Aerial Photography or as major development occurs
Public Safety Features			
Fire Hydrants	Public Works / Fire	Paper Maps and Plans	Updated as new construction occurs
Utility Infrastructure Features			
Drainage Basins	Public Works	Developer Plans / Planimetrics	Updated as new construction occurs and/or when new aerial photography is flown
Other Mapping Features			
Subdivision / Neighborhood Boundaries	Planning / COR / Graphics	Paper Maps / Plans	Updated periodically based on new construction and property reassessments
Landuse Plans	Planning	Comp plan and paper maps	Updated periodically
Zoning	Planning/ Graphics	Paper maps	Based on tax maps, updated periodically
Transportation (FRED)	Transit / RADCO	GIS Route Maps	Route map changes are made by RADCO as needed

Mapping Accuracies

In order to better understand the capabilities and limitations of GIS applications, it is important to understand the procedures and inherent limitations of creating and/or converting GIS map features. GIS data is developed to meet specific spatial accuracy requirements. The accuracy can be expressed in terms of meeting accuracy requirements at a specific map scale.

Common Scales and Related Accuracies		
Scale	Map Scale	Positional Accuracy (FT.)
1:600	1" = 50'	± 1.25
1:1,200	1" = 100'	± 2.5
1:2,400	1" = 200'	± 5
1:4,800	1" = 400'	± 10
1:7,200	1" = 600'	± 15
1:12,000	1" = 1000'	± 25
1:24,000	1" = 2000'	± 50
1:48,000	1" = 4000'	± 100
1:100,000	1" = 8333'	± 200

The horizontal spatial accuracy of the developed GIS data layers are dependent upon a variety of variables, including:

- The accuracy of the selected base map product(s)
- The pixel resolution of the selected base map (assuming raster imagery is used)
- The selected digital compilation (conversion) method (if other than photogrammetric compilation)

Since many of the GIS data sets are compiled through a “heads-up” digitizing process, a variety of additional variables capable of impacting the resulting spatial accuracies are introduced. These include, but are not limited to:

- The selected on-screen view scale used for digitizing
- The selected feature placement / rectification methodology
- The correlation of reference features between the base map and source data

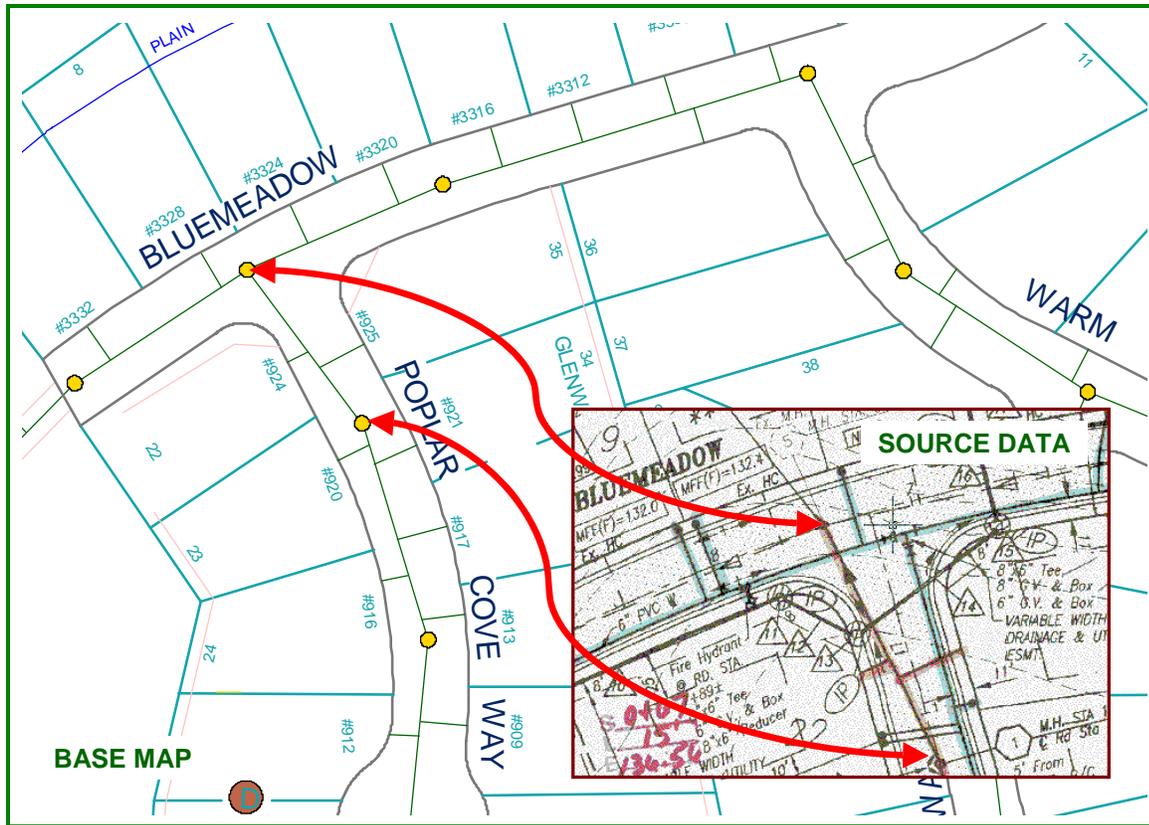


Figure Caption: Example of the correlation of planimetric features between a base map product and source data (the greater the number of planimetric features common to the base map and the source data, the more accurately the infrastructure data can be placed)

By controlling the on-screen view scale and placement methodologies during the conversion process, accuracies approaching that of the base map can be achieved. The best way of controlling the correlation of planimetric features between the base map and source data is to select a base map product that contains the greatest amount of detail possible. The City's new 2005 digital orthophoto base map product will provide the level of detail required to adequately correlate the source documents with the base map features.

The scale and accuracy of GIS data layers are important to keep in mind. It is physically possible to overlay and analyze data features of differing scale and accuracy. The person performing the analysis must consider the differing scale and accuracy when drawing conclusions. For example, parcel information at 1:2,400 overlaid with wetlands data at 1:24,000 could show a specific parcel or part of a parcel as within a wetland. On the border of a wetlands area, this may not be true. In this case, field verification should be done to determine the actual wetlands location with respect to the parcel.

Recommendations

This section of the GIS Needs Assessment Report presents our recommendations to the City of Fredericksburg for establishing a new GIS system. It addresses all the key components of a GIS, including:

- Staffing Recommendations
 - Resources
 - Management
 - Training
- Map and Related Data Recommendations
 - Base Map
 - Priority Application Data
 - Road Centerlines
 - Structure Addressing
 - GIS Support of E-911 CAD
 - EMS Generated / Maintained Layers
 - Proposed EMS Data Maintenance Schedule
 - Optional Data Recommendations
- Information Technology (IT) Assessment and Recommendations
 - Computer Hardware
 - Storage Architecture
 - Data Management
 - Network Connectivity
 - Data Interoperability
 - System Maintenance
 - Back-up and Recovery
 - Core Software Applications

The recommendations presented here are based on the GIS data and software application needs communicated by City staff during the questionnaire and interview phases of this study.

Staffing and Training

Resources

Effective program management and system administration is critical to the success of the City's GIS program. The level of effort required for the administration, development and maintenance of the GIS requires full-time attention. It is recommended that a full-time GIS Coordinator position be created to oversee and undertake GIS activities. This position is responsible for the daily administration, strategic planning, and operation of the City's GIS.

GIS Needs Assessment for the City of Fredericksburg, VA

GIS Coordinator duties include the following:

- Coordination and communication of GIS opportunities, issues and needs to the City Manager's Office and City Council.
- Administration of an accurate, up-to-date GIS database (data maintenance, procurement, etc.)
- Application maintenance to assure seamless performance and integration of the GIS and legacy applications (application development, testing, debugging, etc.)
- Administration of an on-going training program
- Contract development, administration and data procurement and / or development for on-going and special GIS projects.
- Management of additional GIS staff, and coordination with GIS users within City Departments

It is also recommended that a full-time GIS Analyst position be created to provide operational support to the GIS Coordinator and GIS users within the City. It is anticipated that the GIS Analyst will need to be responsible for the day-to-day mapping input operations, especially during the first year while the GIS Coordinator is busy overseeing the overall implementation of the City's GIS and handling other duties, such as graphics services.

GIS Analyst duties include:

- Converting (digitizing) paper maps and associated map attributes into the desired GIS data format
- Migrating digital map and data layers from a third party format into the desired GIS format
- Maintaining map layers and supporting attribute data
- Creating custom maps and reports as directed by the GIS coordinator
- Coordinating activities with, and provide support to, City departments as directed by the GIS coordinator
- Coordinating GIS activities with City vendors that create, maintain, and/or utilize GIS data in support of City business, as directed by the GIS coordinator

It is clear that some City departments will use the new GIS more intensively than others, and may need to consider the assignment of GIS-related duties to specific staff. If existing staff resources are insufficient to handle these duties, then departments may need to consider the addition of part-time and/or full-time staff. For example, it was noted that the Transit Department (FRED) could benefit from the addition of a "Transportation Planner". This person would be given the responsibility of coordinating with the neighboring jurisdictions served by the bus system in order to obtain and incorporate updated transit information that would facilitate effective staff management and public navigation using the MapQuest-like location and routing service described below (see "Web-based GIS Applications").

Management

Local governments typically use one of two types of GIS management configurations: distributed or centralized. The distributed management structure is generally used by larger local governments where the data storage and maintenance tasks area spread throughout all of the government business units. This enables the quick and accurate update of data by those responsible for maintaining each data set (data stewards). This structure requires a more significant investment in personnel, training and licensing.

Smaller local governments typically use a centralized structure. The data storage and maintenance are focused on a few servers and staff trained for data maintenance. Changes to the GIS are fed to the GIS update staff through the data stewards. This insures that the GIS data remains stable and updated in a timely manner.

The City of Fredericksburg currently uses a centralized management structure. Paper and AutoCAD map updates are performed by a limited number of staff in the Graphics Department. It is recommended that the City continue to use the centralized management structure. This approach focuses the extensive staff training and responsibility on a few key individuals. It maximizes the utilization of the software licenses and hardware. With proper training, this approach will work into the future.

More specific recommendations include:

- The Graphics Coordinator should manage a centralized GIS organization for the City. He would directly oversee the duties of the new GIS Coordinator and any additional GIS supporting staff. The City's Graphic Coordinator knows the mapping needs and data sources of the various City Departments better than any other City staff member. It makes good sense for the Graphics Coordinator to direct the GIS activities of new staff that already have the requisite GIS software training and other GIS technical skills.
- The City should reinforce the authority of the Graphics and GIS Coordinators to prioritize and direct GIS activities. Some City departments expressed concern that the having a graphics / GIS group within a single department may not be conducive to setting priorities that objectively reflect the needs and priorities of the City as a whole. An alternative solution would be to establish an independent GIS Department within the City. However, there are additional administrative duties, staff, and cost associated with this independence, and the City may wish to wait until the new GIS is fully operational before considering this option, so as not to place additional responsibilities on the staff while they are busy establishing the GIS.

Training

We recommend that all relevant City staff be trained on the basic concepts and use of relevant GIS software. The level of training is dependent upon the category of user as described below.

Incidental users – Incidental users are infrequent users of the GIS. They are usually not familiar with GIS but have a need to get specific information or maps. Examples of these users would be citizens and most City staff. They will usually access the system through an internet browser (citizens) or through requests to the GIS Coordinator. This category of user will need no technical GIS training. We recommend that the GIS Coordinator hold a series of “brown bag” lunches for this group that will demonstrate the capabilities and uses of GIS.

Casual users – Casual users are City staff who use the GIS on a regular, but limited, basis to perform repetitive queries. Training for this group is focused around using specific applications that have been created for their use. The applications provide a quick point-and-click environment the produces the desired results in a minimal amount of time. This category of user should receive application specific training. They should be formally introduced and trained on the applications relevant to their business process as they are developed and deployed. This training should be carried out with a combination of vendor-based training and periodic updates by the GIS Coordinator.

Advanced users – Advanced users are City staff who routinely perform non-standard and detailed analysis tasks. This smallest group of users requires the largest amount of GIS training. They will typically perform these tasks for the incidental and casual users on an as-needed basis. In addition to the training for casual users they will need to have formal ArcGIS training performed by ESRI certified training facilities. This category of users can be cross-trained for the data maintenance functions as well. This category of user should receive formal technical training at ESRI certified training centers. The training should include: ArcGIS I, ArcGIS II and Geodatabase design concepts. Additional courses should be regularly taken to maintain their technical knowledgebase and efficiency.

We recommend that the City staff (advanced users) responsible for maintaining the tax parcel maps and addressing should be trained in the use of Parcel Maintenance Software tools. This can be done through a 1 to 3 day on-site training class. The duration is dependent on the assigned staff’s current level of GIS and computer knowledge. We recommend that a minimum of 2 staff, (one primary and a backup), receive training. This provides for un-interrupted service when staff absences and changes occur.

It is recommended that the new GIS Coordinator (and GIS Analyst) to be hired should already have formal GIS software training and significant user experience. If this is not possible, these courses are offered at ESRI training centers and at VCU on a periodic basis.

ESRI Training

<http://www.esri.com/training/index.html>

VCU Training

<http://www.vcu.edu/cesweb/training/index.html>

If the City maintains a centralized approach toward managing its GIS, it is important that the few key advanced GIS users are cross-trained to allow for continued operations during staff absences and changes. Casual and Advanced GIS users can learn and maintain their GIS skills, as well as share experiences with their local government peers at GIS user conferences. Two excellent conferences are the ESRI International User Conference held each July in San Diego and the Virginia GIS Conference held each October. There are also regional GIS user group meetings in Virginia.

Map and Related Data Recommendations

This section of the GIS Needs Assessment Report deals with determining the needs and resources required to create and maintain the City's priority GIS data in a timely and accurate manner.

The City has three basic data creation and maintenance options to choose from:

1. Data maintenance can all be performed "in-house" by City staff.
2. It can be outsourced to a vendor who will create and/or perform the data maintenance, and then provide data files back to the City for review.
3. A combination of the first two options, where the City staff may participate in, direct, and quality control data creation, conversion, and/or maintenance activities throughout the duration of the effort.

The best option for the City depends upon a number of factors and may, therefore, differ from one map data layer to another. The cost-benefit factors that should be considered in selecting the best option to create, convert, and or maintain a GIS map data layer are:

- Does City staff have the requisite tools and skills to accomplish the data work?
- Does City staff have the requisite time available to accomplish the data work without negatively impacting quality (accuracy and completeness) and/or other job priorities?
- Are there decisions required during the process that should/must be made by City staff for legal / liability reasons? For example, how to handle the location of a parcel boundary that does not line up on adjoining tax maps.
- Is there cost and/or time constraints that need to be considered over other factors?

The amount of work needed to create and/or convert GIS map layers and attributes for the highest priority features (parcels, streets, addressed structures) will be significant. It makes sense to see to what extent these data creation / migration services can be outsourced to save time, money, and unnecessary burden on City staff.

The following sections summarize the map layers and related data that were identified as highest priority. For each map layer we identify the best method for creating / converting existing data sources to meet the GIS application needs. The potential cost and timeframe for accomplishing these data creation/conversion tasks are presented in the Financial Section of this report.

Base Map Data

Recommendations for the best way to create or convert the map layers composing the foundation of the City's new GIS are presented in the following table.

GIS Map and Related Data Sets		
Data Set	Data Source	Creation / Conversion Recommendation
Base Map Layers		
Imagery	Aerial Photography Vendor / VGIN	New aerial photography at a scale of 1":100' (6" pixels) was collected this year to be used as the image base for creating planimetric features and for registering converted map layers. This base map layer will support GIS activities until significant changes have occurred due to the ongoing land development projects in the City. It is anticipated that new photography will be needed within 2 years. The City has approved acquisition of new aerial imagery by VGIN in March 2006 at 1":100' scale, electing to fund the cost difference for the upgrade from the VBMP standard image scale of 1":200'. (See Report Supplement #1 for details)
Road/ Street Centerlines (RCL)	Virginia Base Mapping Project (VBMP) for Geometry, OSSI CAD dispatch system for road business data (name and address range)	Virginia has established a statewide set of road centerlines for use by State and local governments. It provides a common road network for local, state and federal data. We recommend that the City adopt this data set format as the base RCL layer for the City's GIS. Please see the road addressing section below for a detailed description of the creation / conversion recommendation. Timmons Group was awarded a grant from the State Wireless Board in January 2006 to perform road centerline data development work on behalf of the City to adhere to the VBMP RCL data standard. (Please see Report Supplement #2 for details)
Planimetrics (high priority map features)	2006 Aerial Photography	Planimetric map features can be delineated on images (building footprints, edge of pavement, parking lots, sidewalks, vegetation, hydrography, etc.) and should be created photogrammetrically from the newest aerial photography.
Structures with address number / name	2006 Aerial Photography	The Planimetrically collected building footprints will serve as the basis for development of the structure address point layer for the OSSI CAD system. Please see the structure addressing section below for a detailed description of the creation / conversion recommendation

GIS Map and Related Data Sets		
Data Set	Data Source	Creation / Conversion Recommendation
Base Map Layers		
Topography	2006 Aerial Photography	The current topography of the City will be collected photogrammetrically with a 2' contour interval from the new 2006 VBMP aerial photography. This new, higher resolution data set will greatly enhance the accuracy of the area's Flood Insurance Rate Maps (FIRMs) being planned for update by FEMA in the near future. This planned update by FEMA positions topographic map creation for the GIS solidly in the top priority group.
City Boundary	Paper Maps, Plans, Deeds, Plats	The current extent of the City Boundary should be digitized from best available paper map and plan sources (1983 City Annex Boundary Survey), and visually referenced to the image base map where there are visual cues in the land surface (e.g. roads, river). Alternatively, the City boundary could be more accurately created in the GIS using detailed survey coordinate geometry (with GPS control), if this information is available from recorded deeds and plans.

Priority Application Data

Recommendations for the best way to create or convert the map layers needed to support of the City's high priority GIS applications are presented in the table below.

GIS Map and Related Data Sets		
Data Set	Data Source	Creation / Conversion Recommendation
Real Property Features		
Parcels	Paper tax maps, AS400 Database, subdivision plans, Clerk's Documents	The set of about 500 paper tax maps should be digitized to create a GIS Polygon parcel map layer with associated text attributes (parcel and tax assessment data from the COR) for the City's approximately 7,650 parcels. The recommended approach to doing this is a cooperative project between the City's Graphics/GIS Department and Timmons Group. In the interest of time, we would be able to utilize a number of experienced staff to quickly and accurately digitize the parcel boundary

	<p>lines exactly as they appear on the paper maps and assigned parcel numbers. Any map issues that require the City's guidance would be flagged for action. This approach allows the City staff's time to be focused on making the necessary judgment calls and overseeing the conversion work, and not on the time-consuming and straightforward process of digitizing the parcel lines "as-is" from the paper maps. City staff should direct the conversion activity and provide quality control review of the parcel lines digitized and parcel numbers assigned. City staff may research deeds, plats, and developer plans to resolve any parcel boundary issues that may exist on the current paper tax maps. For newer subdivisions where AutoCAD files may exist with this information, it may be more efficient to migrate the relevant AutoCAD layers into the GIS for review and adjustment. Once the parcel numbers have been assigned and approved, the relevant parcel information maintained by the COR can be linked to the parcels in the new GIS. Please see Report Supplement #3 for details of the proposed parcel conversion methodology.</p>
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GIS Map and Related Data Sets		
Data Set	Data Source	Creation / Conversion Recommendation
Real Property Features		
Publicly-owned Property	Paper tax maps, AS400 Database, Clerk's Documents, City Attorney files	The recommended approach for bringing publicly-owned properties into the GIS is the same as with the parcels described above, with additional information (parcel attributes) possibly being available from the City Attorney's office. Publicly-owned parcels would be properly identified in the GIS attribute file so that a GIS user could easily and quickly highlight/locate/separate these parcels from those that are privately owned.
Rights of way/ Easements	Paper tax maps, historic maps, AS400 Database, Clerk's Documents, developer plans	Rights-of-way and easements can be created in the GIS by digitizing these boundaries as polygons from paper maps and subdivision plans, and/or by more accurately placing these boundaries from legal survey descriptions contained in deeds, plats, etc. For newer subdivisions where AutoCAD files may exist with this information, it may be more efficient to migrate the relevant AutoCAD layers into the GIS for geo-referencing, review, and adjustment.
Building Footprints	Paper tax maps, imagery, developer plans	While it is possible to digitize the building footprints as polygons from the current paper tax maps, it will be more efficient and accurate to have the VBMP vendor collect these maps features photogrammetrically from the new 2006 imagery. Subdivision plans for areas developed subsequent to the acquisition of the aerial photography (March 2006) can be used to supplement the buildings seen on the most recent orthophotography.

GIS Map and Related Data Sets		
Data Set	Data Source	Creation / Conversion Recommendation
Environmental / Topographic Features		
Environmentally Sensitive Areas	Paper maps and AutoCAD files	New flood boundaries and attribute information are scheduled to be produced by FEMA in 2006 from the best available topographic contours of the City (5' interval). Additional environmental information for the Chesapeake Bay Protection Area map can be migrated from the City's existing AutoCAD digital map by georeferencing it to the new orthoimagery. See also the Rappahannock Area Development Commission All-Hazard Mitigation Plan (Sept. 2005 Draft) for GIS-relevant discussion and recommendations.
Hazmat Locations	Under Review – paper and computer files, imagery	The location and description of hazardous materials can be entered into the GIS by associating it with an entire parcel polygon, and/or by a point layer plotted on top of the aerial photography. More specific recommendations can be discussed once the details of the RADCO/contractor study are available, and the specific GIS application needs of City departments are discussed and defined.
Hydrography	Paper tax maps, imagery, developer plans	It will be most efficient and accurate to have the VBMP vendor photo-grammetrically map the City's hydrographic features as polygons (ponds/lakes) and lines (streams) from the new 2006 imagery. Subdivision plans for areas developed after March 2006 can be used to supplement surface water features (drainages) seen on the new ortho-photography. If AutoCAD files exist for new developments, it may be more efficient to migrate the relevant AutoCAD layers into the GIS for review and adjustment.

GIS Map and Related Data Sets		
Data Set	Data Source	Creation / Conversion Recommendation
Public Safety Features		
Fire Hydrants	Paper and AutoCAD Maps and Plans, imagery	The location of the approximately 1,100 fire hydrants in the City can be mapped as points in the GIS from their location shown on maps and plans maintained by the Public Works and Fire Departments. The new orthoimagery may assist the point location of hydrants in the GIS. The required text attribute information (hydrant ID, flow rate, inspection date, etc.) can be associated with each of these point features. Furthermore, individual hydrants can be related to individual water lines in the GIS so that either/both can be displayed, analyzed, and managed in logical groups.
Emergency Service Zones	OSSI CAD	The OSSI system contains ESZ polygon information. This is used to segment the road network by the emergency service zones. The ESN geometry and attribute information will be extracted from the OSSI system using the SHP export feature of the OSSI software. Please see the road addressing section below for a detailed description of the creation / conversion recommendation, and Report Supplement #2 for details of the Timmons Group project funded by State Wireless Board Grant.
Utility Infrastructure Features		
Drainage Basins	Maps and Developer Plans, imagery	The location of existing drainage basins can be digitized as polygons in a separate GIS map layer from paper maps and plans maintained by the Public Works / Graphics Department. Topographic contours (2' interval) that can be derived from the new aerial photography would assist with the delineation of these features in the GIS. Drainage basins created in areas developed since March 22, 2005 can be derived from developer "as-built" plans. If AutoCAD files exist for new developments, it may be more efficient to migrate the relevant AutoCAD layers into the GIS for review and adjustment.

GIS Map and Related Data Sets		
Data Set	Data Source	Creation / Conversion Recommendation
Other Mapping Features		
Subdivision / Neighborhood Boundaries	Maps and Plans (mostly paper)	The location of most subdivision and neighborhood boundaries can be digitized as polygons from the City's paper tax maps maintained by the COR and Graphics Department. These boundaries will need to be co-registered to the parcel boundary layer once that is finalized. Newer subdivision boundaries may be available in AutoCAD format, so it may be more efficient to migrate the relevant AutoCAD layers into the GIS for review and adjustment. Subdivision and neighborhood text attributes can be associated with the GIS polygons for display, analysis, and reporting purposes.
Landuse Plans	Comp plan and maps, imagery	Land use areas can be digitized as polygons from paper map sources maintained by the Planning Department, but it may be more efficient to migrate the relevant AutoCAD layers into the GIS for review and adjustment, where these digital files exist. The new orthoimagery may be helpful in verifying, and clarifying, the extent and location of different land use types. Landuse boundaries will need to be co-registered to the parcel boundary layer once that is finalized. Land use text attributes can be associated with the GIS polygons for display, analysis, and reporting purposes.
Zoning	Paper maps	Zoning can be digitized as polygons from paper map sources maintained by the Planning Department, but it may be more efficient to migrate the relevant AutoCAD layers into the GIS for review and adjustment where these digital files exist. Zoning boundaries will need to be co-registered to the parcel boundary layer once that is finalized. Zoning classification attributes can be associated with the GIS polygons for display, analysis, and reporting purposes.

GIS Map and Related Data Sets		
Data Set	Data Source	Creation / Conversion Recommendation
Other Mapping Features		
Transportation (FRED)	GIS Route Maps	RADCO currently maintains the bus route maps using ESRI GIS software. We recommend that changes to route maps continue to be maintained using GIS software, whether RADCO continues to do this, or if the City takes over this responsibility. We also recommend that the bus route map transition over to using the City road centerlines once that data set is developed. This will insure that the route system model aligns with other City data sets in the future.

Road Centerlines¹

City roads and streets, with associated names and addresses, are the most critical data elements in a GIS for local government because the provision of City services depends on knowing where structures are located, and where people live. Maintenance of a standardized streets map layer in a City-wide GIS is often complicated because street locations, names, and addresses are needed by all departments. In many instances, multiple departments are maintaining their own street maps and address data sets. This is the case in Fredericksburg, where there are currently four (4) separate street databases being maintained for the provision of critical City services.

While it is easy to see that there are clear cost issues associated with the redundant maintenance of four separate street data sets, there are important issues that must be considered before deciding to standardize on a single streets map layer and address database – the most important of which is public safety associated with the dispatching of emergency services. There were a number of fundamental concerns about whether a single streets map layers could be maintained for the City and still satisfy basic operational requirements for emergency services. Specifically, we were asked by the City to carefully examine and address:

1. The concerns that Fire/Police/911 have about the location of the GIS server (in City Hall) and the method, frequency, reliability of replicating GIS data to their server. This is addressed in the IT Infrastructure section below.

¹ Please see Report Supplement #2. It describes the work funded by a grant from the Virginia Information Technology Agency (VITA).

2. The best method for testing/verifying new/updated GIS data before uploading it to the emergency services map data server and risking operational failure/glitches. This is addressed in the road maintenance process below.
3. The process by which Fire/Police/911 currently create and maintain their map data to assess the extent to which the data can/should be as a starting point for creating and/or maintaining the general GIS map layers such as street centerlines and address ranges - versus digitizing these all from paper, from scratch.

Fundamentally, it is **important that any changes related to streets data management do not affect the ability to respond to emergency events**. The following sections of the report addresses these concerns and make recommendations that, if implemented, will allow the City to maintained a single, current, accurate street map layer, and realize the cost savings of not having to maintain four separate street maps and address information.

Current Road Data Sources

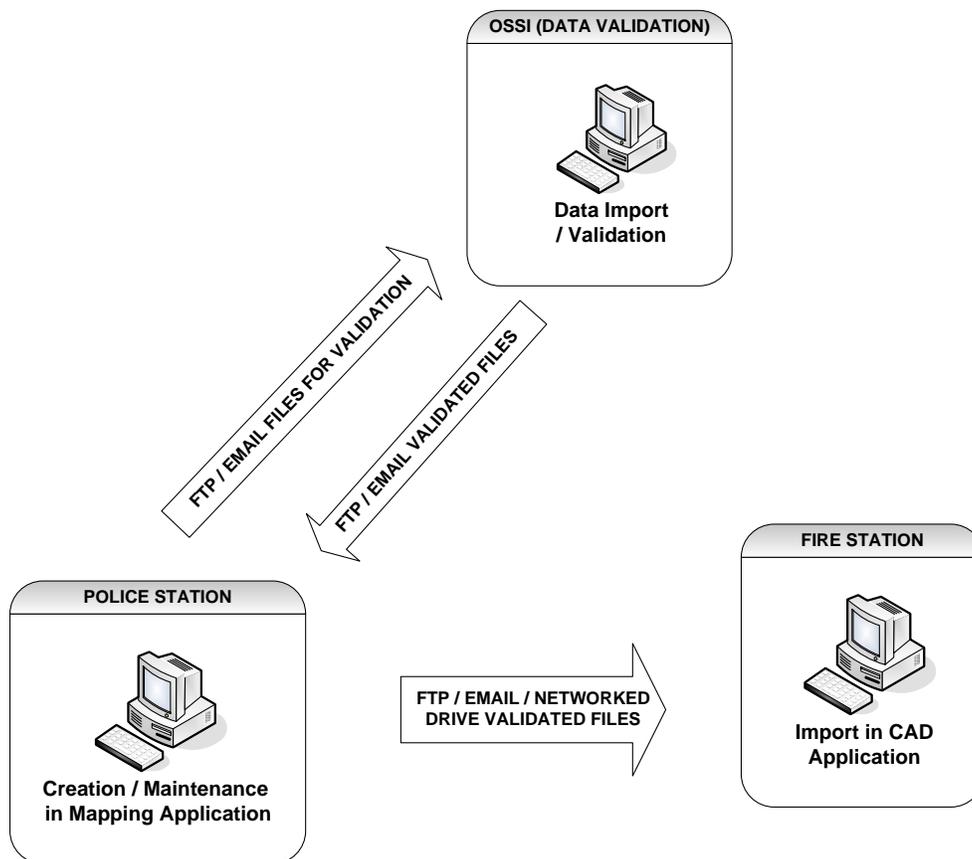
There are currently four (4) distinct streets data sets being managed / stored independently for the City. Duplication of core data sets creates many issues including increased cost of data maintenance, duplication of effort, increased probability of data anomalies / errors, among others. It is our **recommendation that the City move to one common street map layer based on the VBMP roads data set**.

The streets layers being stored / maintained in the City currently include:

1. DPW CADD-based Streets – These streets are maintained in the DPW / Utilities office currently.
2. VBMP Streets – Virginia Base Map Program Streets – These streets were developed by VGIN and are accurately referenced to the VBMP imagery. They, additionally, contain VDOT attribution. The VBMP Streets geometry was created by digitizing from the 2002 VBMP Imagery program. The positional accuracy meets or exceeds the 1"=200' scale mapping standards in the Fredericksburg area. VBMP Streets are attributed with statewide standard business data. This enables the City to share data with adjacent localities and to use other statewide data layers built on the VBMP Streets. The VBMP Streets program is in process of getting local business data for the streets including road name and address ranges. **We recommend that this business data be transferred from the EMS data set to the VBMP geometry**. Once complete, this will be the source of the common streets data set for the City.
3. EMS Streets - Police Station / Fire Station Streets – These streets are managed by EMS mapping professionals and are currently being used for EMS operations such as dispatching (CADD). The EMS road geometry has

served well as a source of road data for the CADD application. However, maintenance is tedious at best. It is done intermittently as staff time permits. The EMS data set not accurate to a specific geometric standard. Data position errors are propagated as new streets are added based on the old road positions. This makes it difficult to use this data set with other data sets in GIS or CADD systems. The EMS Streets data set does contain the most complete and accurate model for road business data including the road name and address ranges. This information is VERY valuable to many current and future City applications including CADD and GIS. **We recommend that this business data be transferred from the EMS data set to the VBMP geometry.** This will insure that the data required for the CADD application is transferred to the GIS. It will also insure that the City fully leverages the investment of time and resources made in the EMS streets data. The current approach for managing streets used in EMS operations is detailed in the diagram below.

Current Workflow



4. Tax Map Streets – Streets on paper-copy of tax maps – These maps are maintained by DPW / Graphics staff to support the Commissioner of Revenue and other departments.

Proposed Road Data Development Steps

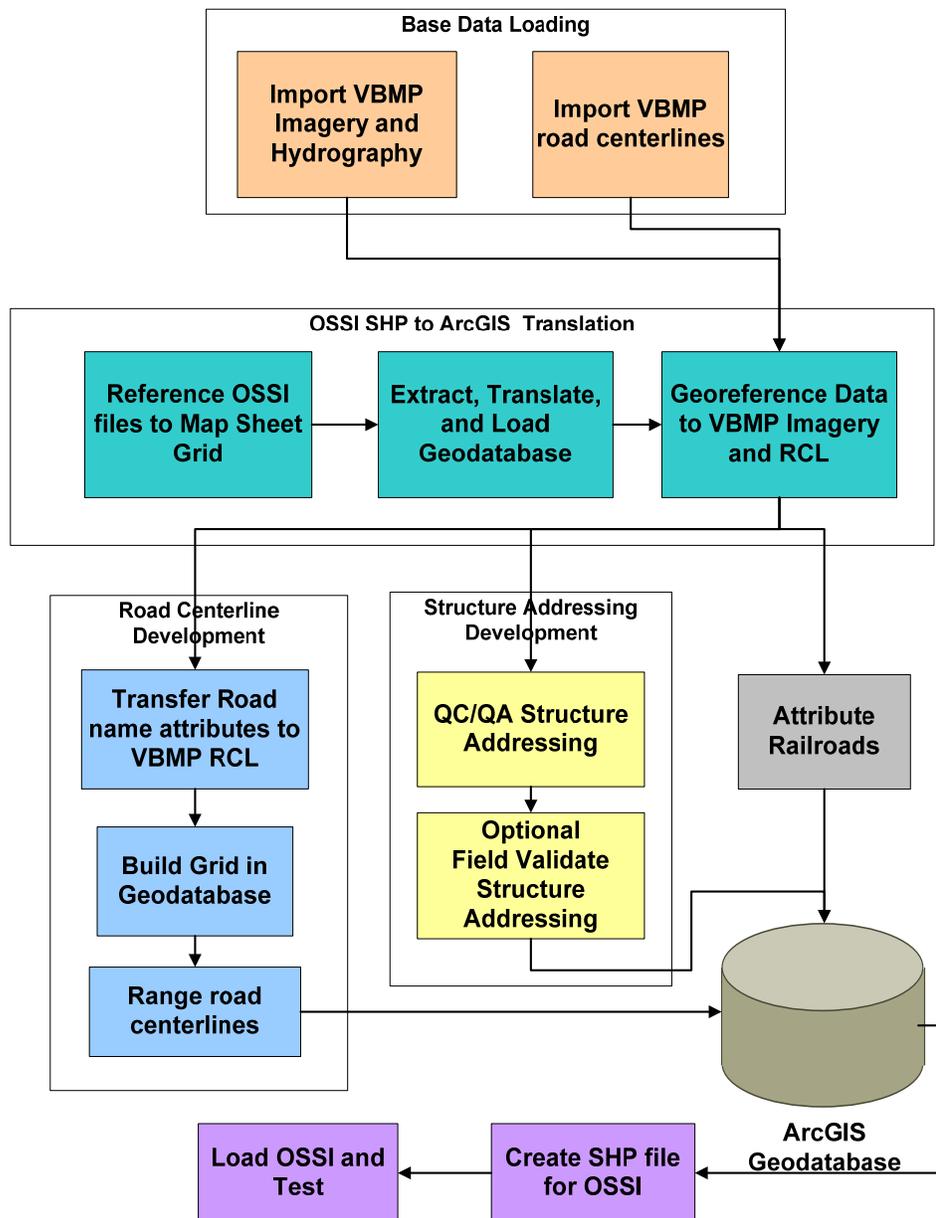
We recommend that the City follow the steps below to transform the existing data into a GIS map layer to support streets, addressing and structure maintenance.

ArcGIS Geodatabase Development

In this task, the ArcGIS personal geodatabase model that incorporates the data tables, fields, and relationships necessary to support the E-911 mapping and addressing maintenance would be developed. This model should be based on the VBMP standard addressing model which incorporates the National Emergency Number (NENA) standard for addressing. The geodatabase will be the repository for addressing information that supports addressing maintenance and distribution.

Addressing Data Development

Our recommended approach to addressing data development is shown in the process flowchart below. The proposed approach incorporates the latest VBMP geometric data with the roads and range information from OSSI. New roads built since March of 2002 will be incorporated into the addressing data as part of the VBMP update process.



Addressing Data Development Approach

Base Data Loading

The first step is to load the base data into the geodatabase. The base data we recommend using is the latest VBMP road geometric data and latest orthophotography for the City. The base data provides the common underlying spatial reference. We recommend using the base data to spatially adjust and fit other data layers together. This will enable GIS data users to correctly overlay the streets, structures and imagery.

OSSI to ArcGIS Translation

This step will organize, extract, translate and load the OSSI data into the ArcGIS personal geodatabase. This enables the use of addressing information in the Geodatabase environment. The existing road geometry and attribute information will be extracted from the OSSI system using the SHP export feature of the OSSI software. This step assumes that the City has followed their layering and naming standards.

The next task is to georeference the translated data layers to the VBMP imagery and road centerlines. Georeferencing the data will enable users to overlay the translated data with the imagery and VBMP road centerlines.

Road Centerline Development

This step will develop the road centerline data in the ArcGIS environment. It will use the VBMP road centerline data as the source for road centerline geometry. It will use the OSSI road centerline and attribute information translated in the step above as the source for road names, address ranges, and road changes since the last update.

The first task is to spatially reference the VBMP and translated RCL geometry and transfer the name attributes. This will be done through an automated spatial overlay process and then manually QC checked against the source addressing map data to insure that all road names were properly assigned. Once transferred, automated ESRI tools should be used to ensure connectivity of centerlines, ensure the arcs are oriented correctly in the addressing directionality, and ensure all streets are broken at intersections.

The second task is to create the addressing grid that will be used to range the road centerlines. An addressing grid should be created using the City ordinance and a copy of the existing addressing maps as reference. The addressing grid will be created in the ArcGIS environment.

The next task is to assign the address ranges to the road centerlines. We will intersect the road centerlines with the addressing grid and assign address ranges to the road centerlines. Address ranges will include: low right, high right, low left, high left. This will result in road centerlines with road name and address range attribution.

Process Road Updates

The road centerline data provided by the VBMP project is current through the last time data was sent to VGIN for the non-conforming review process. Changes to the data set since that time will need to be incorporated into the new RCL set. This can be done using the Procedures Guide provided with the VBMP Roads project. This guide was provided to City at the VBMP workshop held 11/10/2005.

Emergency Service Zone (ESZ) Development

The OSSI system contains ESZ polygon information. This is used to segment the road network by the emergency service zones. The ESZ geometry and attribute information will be extracted from the OSSI system using the SHP export feature of the OSSI software. This step assumes that the City has followed their layering and naming standards.

The next task is to georeference the translated data layers to the VBMP imagery and road centerlines. Georeferencing the data will enable users to overlay the translated data with the imagery and VBMP road centerlines.

ESN and Road Centerline Integration

The road centerlines and ESN information are used to maintain the MSAG and ALI information. New streets and changes in response district boundaries necessitate changes in the MSAG. Using the GIS, these changes can be easily identified and provided to the Telco. Spatial relationships should be developed within the Geodatabase environment to ensure that streets are broken at postal boundaries, ESN boundaries, and municipal boundaries. The Geodatabase environment assures topologically correct features, therefore connectivity. The result of this step will be road centerline and ESN data that can be used as a base for the City GIS and as input to the E-911 CAD, mapping, and MSAG maintenance.

Proposed GIS Road Maintenance

Maintenance Overview

There are two main components of road maintenance. They are geometric changes and attribute (business data) changes. We propose that both of these road maintenance components be maintained in a common GIS data repository. This enables the efficient maintenance and sharing of a consistent road network. **We recommend that the City begin by adopting the VBMP road geometry as the starting point for their GIS streets layer.** The State will provide the City a comprehensive set of road geometry and standard attribute information at no charge.

Geometry Maintenance

For most localities the road geometry maintenance is done as one of the last steps in the subdivision and site plan approval process. Road geometry is entered into the GIS by using one of three methods:

1. Fitting the new road geometry to the imagery and existing road data. This is the most common approach. It provides timely entry of streets and enables streets to be entered before they are cleared and/or built.
2. GPS locating road centerline. This is done by driving or walking the road. This method provides an accurate and representation of the road. It generally is done once the road is cleared.

3. Using coordinate geometry (COGO). This is the least frequently done approach.

Once the road geometry is in the GIS it can be coded as a paper road until the road building process is at a sufficient stage to enable the use of the road by emergency vehicles.

Attribute (Business Data) Maintenance

Road attribute changes are made once the geometry is in place. **We recommend the City adopt the statewide standard road attributes and naming conventions. These are included as part of the VBMP Roads data set currently available to the City.** This will minimize the cost of data exchange with the State and insure that changes are standard and consistent.

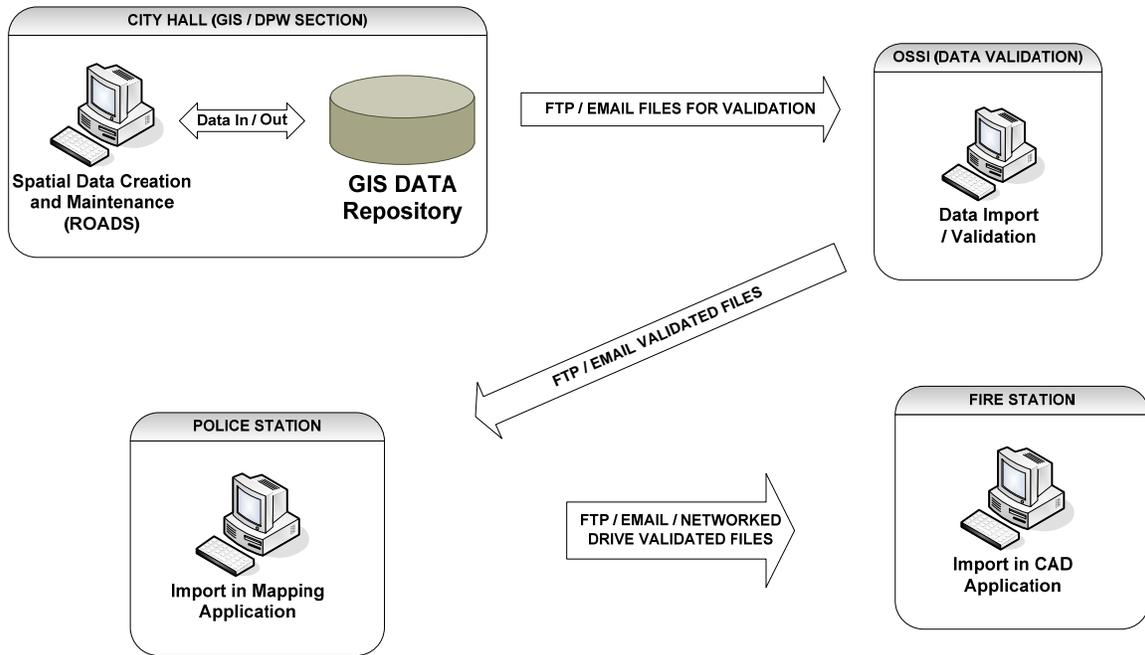
New streets can be attributed with their name and address range based on data provided as part of the approval process. The City will need to incorporate a standard address range plan for the City based on a linear distance down the road and existing addressing data. We recommend incrementing the addressing standard of one number every 5.28 feet. This results in 1000 addresses per mile and provides for future development in-fill. The standard address range information can be used by GIS application programs to automatically calculate and assign structure addresses as described in the Structure Addressing Section below.

GIS Streets Maintenance Diagram

The proposed approach to GIS Streets Maintenance is detailed in the diagram below. It is **recommended that OSSI still validate the streets information and addressing attributes.** It is crucial for mapping and dispatch to have valid GIS data for their operations. Until the GIS capabilities in the City advance to the point where they are comfortable validating streets / addresses internally for the City, this is the proposed approach.

It is, however, **recommended that the City engage OSSI to determine what data anomalies OSSI finds in the City's data.** The City should track, confirm and resolve these issues if at all possible. This will be an efficient mechanism for normalizing City addresses and geometry, and important for removing the reliance on OSSI. The GIS/DPW section will continue to provide ESRI Shapefiles to OSSI. OSSI will continue to provide ESRI shapefiles to EMS mapping professionals.

Proposed Workflow



This proposed approach has **many advantages** including:

- Consolidation of effort / removal of duplicative effort
- Maintenance of OSSI validation for required EMS uptime
- Normalization / cleansing of City streets through OSSI feedback protocols

Structure Addressing

This section focuses on the development and maintenance of structure addresses. Structure location, with address attributes, is an important data layer for many GIS applications including: emergency response, tax assessment, planning, and zoning.

Structure Addressing Development

We recommend the development of the structure layer once the road centerlines, parcel, and planimetric information have been completed. This will insure consistency in addressing and reduce the cost of development by utilizing existing data resources for address determination.

The City already has addresses established over time using several addressing schemes. The structure addressing is currently shown on a paper copy of the parcel maps maintained for the Office of the Commissioner of the Revenue.

Load Structure footprints

Structure footprints created from the imagery will be used as the basis for locating structures. These are already part of the GIS data set, are spatially referenced to the imagery, and should contain appropriate structure addressing attribution.

Overlay Parcel and Assign Address

The parcel data layer should include the situs and billing address information as part of the attribute information. This will be used as the primary source for address numbering. Structure footprints are overlaid on the parcel data. The address number attribution is then assigned to the structure footprint using the underlying parcel situs address. This will result in the bulk assignment of structure addresses.

Structure Address Cleanup

The bulk address assignment will result in most structures being assigned the correct address. The next step is to cleanup the structure data set. Cleanup will need to occur in cases where:

- A structure is on one or more parcels
- Two or more structures are on one parcel
- No address was included in the parcel source data
- The structure does not fall within a parcel

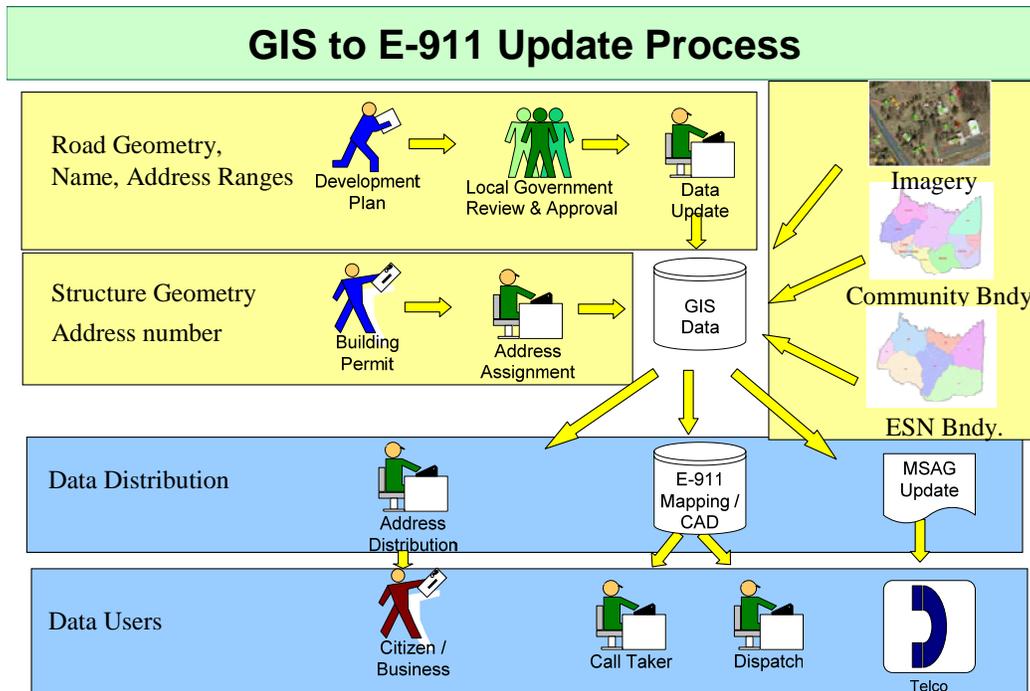
The correct address will need to be determined based on tax data records, utility billing records and as a last resort, field verification.

Structure Addressing Maintenance

Structure addresses are the most common way to locate structures in an emergency. The structure addresses are based on the road name and address range information developed above. Structure addresses are assigned based on their access point relative to the road. The access point location is at the intersection of the driveway and the road. The road range information is used to calculate a new address.

The following is a general process for structure address assignment and distribution.

1. A building permit is submitted. If this is a small lot subdivision, the addresses can be pre-assigned based on the center of the lot. Otherwise, the building permit must include the access point location.
2. The structure and access point are added to the GIS. The City staff enter the structure and access point location based on the building permit, GPS'd coordinates, or via COGO.
3. The GIS calculates the new structure address. This is based on the address model and road ranges.
4. New structure addressing distribution. The new structure and access point are distributed to the citizens and public safety departments.



GIS Support of E-911 CAD

We recommend that data used by emergency response operations be derived from the GIS. This will insure that all City functional areas are operating on consistent information. This is critical in emergency situations when any needed data layer from any functional area can be easily and quickly used. Using GIS derived data also reduces the overall cost of data maintenance by entering the data once and using it many times.

A second critical element to emergency response data is that it always remain available to emergency dispatch, even if the City networks and servers are down. To accommodate this need, we recommend that the data be maintained using the GIS and replicated on the E-911 system. Given the physical location of the GIS and E-911 systems and the networking infrastructure, we recommend that a standard process and frequency be setup to copy the required data from the GIS to the E-911 system.

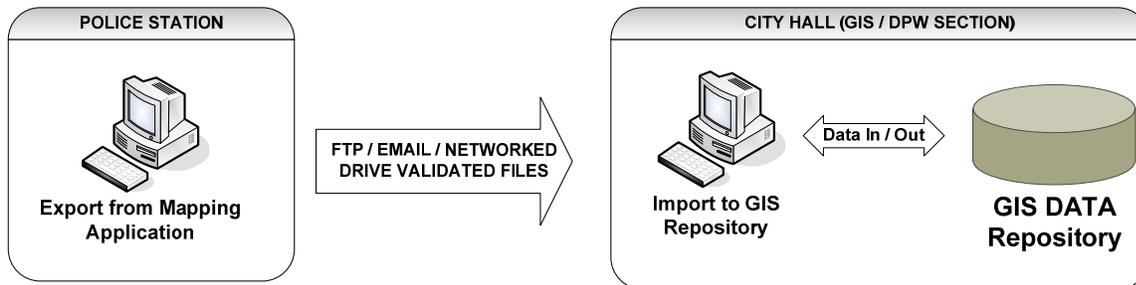
Various methods exist for transferring the ESRI shapefiles from EMS to GIS data servers, and vice versa. Networked drives can be shared out; files can be FTP'd or files can be emailed, assuming they are not too large. **This is a decision to be made ultimately by the City.** Any of these options are valid and our project team can work with the City to find the best solution. It is **recommended that the EMS mapping professionals create a back up copy of the current, live data set** prior to replacing files from OSSI in case problems arise. If the OSSI delivery fails for any reason, EMS staff can revert back to the previous, working, version.

EMS-Generated / Maintained Layers²

The EMS units within the City have created, and currently maintain, several GIS layers important to the rest of the City and their constituents (e.g., public). These include, but are not limited to:

- Fire, Rescue, and Police zones
- Parking / Tow Zones

Procedures and schedules need to be established to replicate EMS-maintained layers from EMS-based mapping stations to the centralized GIS repository. It is recommended that these occur less often than Streets data replication. These data do not change often.



Proposed Data Maintenance Schedule

LAYER	FREQUENCY
ROADS	WEEKLY
STRUCTURES	WEEKLY
EMS ZONES	QUARTERLY OR AS NEEDED
PARKING / TOWING ZONES	MONTHLY

Staff availability for GIS map updates and actual data update frequency requirements will ultimately determine this schedule.

Optional Data Recommendations

Included below are some additional data recommendations for consideration. They are based on our experience of working with similar localities.

² Please refer to Report Supplement #2 for further details, as proposed to the Virginia Information Technology Agency (VITA) for funding.

Require Submission of Geographically-Controlled Plats in a Digital Form

One of the most time consuming GIS data maintenance tasks is the editing of the parcel map layer as plats, plans, and “as-builts” showing parcel splits and subdivisions are approved and recorded in the Circuit Court Clerk’s Office. These documents are currently submitted and recorded in paper form and, therefore, need to be entered into the GIS digitally. Since these plat and plans are generally created in digital form, some jurisdictions in Virginia have seen the value in requesting the submission of digital plats, particularly for major subdivisions.

For example, the City of Lynchburg has instituted a City ordinance that requires the submission of a digital version of all approved major subdivisions (defined as five or more parcels). Loudoun County does not require digital submission, but requests a CAD file (.DXF format) at the approved stage and gets one about 95% of the time. Prince William County does not require digital submission in the planning or recordation phases. In their GIS Department, they have a voluntary process for receiving digital plans. Currently that County is contacting the Engineering/Surveying companies noted on the recorded plats and requesting digital versions to speed up their process for creating GPIN’s and adding the new cadastral information to their GIS data layers. This is a 100% voluntary program, but the digital files (.dwg or .dxf) do expedite their parcel map updates.

We recommend that the City review the relevant Lynchburg City ordinance(s) to determine whether or not it makes sense to require the digital submission of plats and “as-builts” in Fredericksburg.

Evaluate Cost Recovery Options for GIS Data Distribution

GIS data needs to be maintained to remain accurate and useful. There will be a cost to the City to maintain GIS data layers, especially the aerial photography and photogrammetrically-derived layers (Building footprints, topography, edge of pavement, etc.). To help offset this ongoing investment, some local governments in Virginia charge commercial and/or private users for copies of GIS data sets. The terms and conditions of use, and use fees, vary among jurisdictions, and are driven primarily by their “public service” philosophy. Some jurisdictions offer free use of GIS data because it “was paid for by taxpayers, so why charge them again”. Other jurisdictions consider the obvious commercial value of GIS data sets and have decided to charge businesses, but not private individuals, for use. In these cases, fees for commercial use are variable and are viewed by some as a way to cover their costs for reproduction and distribution of the data (i.e. no charge for the data, just media, shipping, and handling). Other jurisdictions try to cover these costs, and also a bit more to help contribute toward the ongoing data maintenance costs.

We recommend that the City discuss their philosophy toward GIS data – is it a “public service” or is this a valuable “extra” service (particularly for commercial use) that justifies some type of cost recovery. As a frame of reference, here is what

GIS Needs Assessment for the City of Fredericksburg, VA

some jurisdictions are doing. Your neighbor, Stafford County, charges for reproduction of digital map data. See this form for pricing and disclaimer: <http://gis.stafford.va.us/Costwav.pdf>

Loudoun County's agreement with their air photo vendor requires that people buy orthophotos from them: http://inetdocs.loudoun.gov/omagi/docs/productsservice_/aerialphotograp/aerialphotograp.htm

Spotsylvania may be a good model for you. They have an information page about their orthophotos on the Web here: http://www.spotsylvania.va.us/departments/infoserv/gis/index.cfm?doc_id=362

They reference use agreements according to the type of user (i.e. commercial, local government, etc.): <http://www.vgin.virginia.gov/VBMP/VBMP.html>

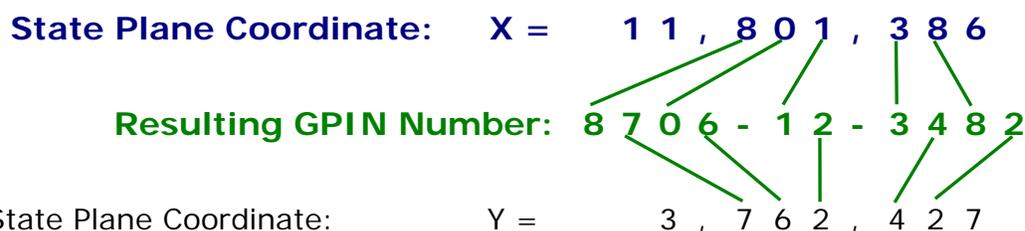
The actual user agreement is from VGIN, and provides a good legal template that could be adapted to meet the City's needs: <http://www.vgin.virginia.gov/VBMP/CommDocs/0926-VBMP-License-Agreement-Commercial-Users-V2.doc>

If, after some internal discussions and research by the GIS Steering Committee and City Attorney, the City would like to develop a formal GIS Data Use Plan (including user terms, conditions, agreements, and fees), Timmons Group would be happy to assist with this as a separate, follow-on task to this project.

Create Parcel GPINs

We recommend that Geographic Parcel Identification Numbers (GPINs) be created and stored as part of each parcel's attribute information. The GPINs can be used internally by the GIS and provide the City with flexibility in using either the current tax map sheet numbering system and/or the GPIN, or switch entirely to the GPIN at some point in the future.

We recommend using the following process for establishing the GPIN. The coordinate pair of the apparent centroid of each parcel, derived from NAD 83 State Plane, Virginia North Zone project specifications, will serve as the basis for the new GPIN number developed under the project specifications. The proposed GPIN number will be a combination of the State Plane Coordinate System Northing (Y-value) and Easting (X-value) coordinates and a 2-character elevation suffix. The diagram below indicates a typical GPIN construction currently in use in Hanover, Warren, Prince William, and other Virginia Localities:



This GPIN numbering scheme will provide for a unique parcel identifier for each 10-foot square in the City. Moreover, this number system is map sheet independent, which is important when considering changes in future map scale layouts.

To account for above ground interests within an individual parcel (condominiums, business suites, or multi-story units, for example), we recommend a 2-digit "Z" value to uniquely accommodate all units of ownership in the City. This 2 digit number would be set to "00" when no vertical ownership is present, and would range from 01 to 99 to provide for multiple vertical ownership. The resulting GPIN number would thus take the following form: XYXY-XY-XYXY-ZZ.

A number of benefits are derived by developing consistency in the structure of a tax parcel layer to facilitate data exchange:

- It allows rapid exchange of parcel data in a timely fashion to address cross border (Mutual Aid) emergency dispatch and evacuation.
- It enables regional land use and zoning studies for better coordination of development, transportation infrastructure, and green space planning.
- Allows assessment of potential or actual impacts before or after natural or man-made disasters.
- Provides for better coordination of taxation for lots crossing boundary lines (City, county, neighborhood) where the lot is taxed in one of the two localities.

The goal of the GPIN recommendation is to achieve a continuous statewide layer of land ownership showing current property lines and a minimum set of tax parcel attribute data that can be used to achieve the above objectives. These recommendations include development of a consistent statewide Geographic Parcel Identifier or GPIN based on the geographic coordinates of a lot's center. There are several primary benefits of a GPIN:

- Frees organizations from being tied to an arbitrary map sheet layout that is prone to change.
- Facilitates joining data from multiple cities/counties by providing a standard formatted unique primary key across the state.
- Can be used to link to any jurisdiction's assessment records.
- Provides a means of determining the lot's location by virtue of the geographic coordinate contained within the ID.

According to the Code of Virginia, the legal description for a property boundary is the property deed. A tax parcel layer should be viewed as a graphical representation the property's location, not the legal description. We recommend that the City include a disclaimer to this effect on GIS parcel map data that is distributed outside City Departments. As a next step, the City's GIS Steering Committee and Commissioner of the Revenue should discuss the benefits of establishing GPIN's for GIS parcels.

Information Technology (IT) Assessment and Recommendations

A critical success factor to any technical implementation effort is a sound IT infrastructure. This infrastructure includes the servers on which data resides, the devices that allow data to flow from one device to another, and the mechanisms to back-up and restore data. A well written application cannot function correctly on insufficient hardware. Users cannot utilize a well written application if they cannot access it in an efficient manner.

The City of Fredericksburg has made a significant investment in its information technology infrastructure. With the deployment of appropriate network and data management practices, the network traffic added through the introduction of the planned GIS should have minimal impact on the City's overall network performance. From our discussions with the City's IT staff, it appears as though only some of the GIS power users and data editors will reside in City Hall. There are various ways to handle this situation. The best option would be to leverage ESRI disconnected editing which would allow for data to be "Checked Out" from the master ArcSDE instance at City Hall, edited locally, then "Checked In" to City Hall once edits are completed.

As a component of the analysis, Timmons Group examined Fredericksburg's existing IT infrastructure. This was limited to the core LAN / WAN components and applications and was not as in-depth as what would be performed during a full Systems Analysis and Design effort. The major elements that are addressed below include:

- Computer Hardware
- Storage Architecture
- Data Management
- Network Connectivity
- Data Interoperability
- System Maintenance
- Back-up and Recovery
- Core Software Applications

Computer Hardware

Hardware Configurations

The City generally maintains an adequate number of desktop workstations that meet the minimum requirements for the specified GIS desktop viewing systems. The minimum requirements are: Pentium class computers with 256 Mb of RAM, as this will be required to operate a standard windows-based internet browser software package that will permit the user to access GIS data across the City's LAN.

GIS maintenance systems require the local installation of GIS maintenance software and temporary storage of some GIS data sets. To ensure acceptable performance from these systems, an adequate amount of hard-disk space (20GB) and RAM (256Mb) is required for each desktop workstation.

The following table details the recommended GIS workstation installations:

GIS Hardware	Quantity	Departments
Advanced Desktop GIS System (ArcView Station)	7	Planning & Zoning Department City Shop Building Public Works Building and Development Public Safety (Fire, Police, Sheriff)
GIS Data Maintenance System	4	(2) Graphics or New GIS Department, (1) Utility Records Department, and (1) Transit
GIS Data Server	1	Information Technology

Peripheral Equipment

The following table details the required GIS peripheral installations:

GIS Peripheral	Quantity	Departments
Color Printer	unlimited	All user departments – In place
Large Format Color Plotter / Scanner Combination (i.e. HP Designjet 815mfp)	1	Graphics or new GIS Department
Upgrade existing HP Designjet 800 ps	1	Utility Records Department

Many of the City's existing printers will be suitable for most departments' GIS output requirements – provided they are color printers. Special print jobs requiring prints larger than 8 ½" x 14" can produced by the large format color plotters.

Storage Architecture

Currently, the majority of the storage occurs on each server / workstation. This creates many inefficiencies including redundant data, poor file management, difficult back-up and recovery procedures and increased risk of data loss. Additionally, the management of complicated back-ups and file management potentially require a large proportion of the network administrator's time.

It is recommended that the City investigate purchasing a consolidated storage device. Mass storage devices (e.g., NAS / SAN) provide the scalability / redundancy / performance required by current GIS programs and data. These devices, unlike server-based storage, do not become obsolete when the server's CPU becomes outdated. Typically, companies / agencies purchase a server to meet a specific need (e.g., SQL server DB and an application). This server is configured to meet the computing needs and estimated storage requirements of that application at that time. If the needs begin to outpace the server (e.g., all drive bays are filled and space becomes an issue) the server is decommissioned and a new one purchased. This requires new hardware, installation efforts, application downtime, operating system licenses, data / application migration. SAN / NAS devices allow for the offloading of storage to another device and allow servers (applications / web / etc.) time to perform the tasks at hand.

Until recently, these devices were too costly for most local governments to afford. They are now very affordable especially when viewed in context with the rest of the organization. There are several good SAN / NAS vendors (e.g., EMC / Network Appliance / IBM) that offer solutions. Timmons Group can assist with specifications for the appropriate storage system if the City decides to move forward with this recommendation.

Data Management

It is important to store all spatial data in a consistent and consolidated manner. Timmons Group would suggest implementing ESRI ArcSDE.

ESRI's ArcSDE will provide the storage and management platform on which all of the City's spatial data should reside. All the benefits associated with a true Relational Database Management (RDBMS) system will be available to GIS users and managers. These include transaction control, long-transactions, back-up and recovery, scalability, increased performance, integrated programming interface (SQL) and security. It is expected that all spatial data, both raster and vector, would be managed by ArcSDE and the RDBMS.

By using ArcSDE, the City will be able to consolidate all data sets into a single repository. Data editors will be able to leverage the advanced tools of ESRI ArcGIS 9x in context with data versioning. Versioning will allow for better control over edits including edits from multiple, simultaneous, users. It is suggested the City use Windows 2000 or 2003 and SQL server 2000 to take full advantage of existing skill sets in-house.

For ease of management, once the ArcSDE database is in place, it is recommended that the City establish categories of users. These will mostly likely be created as Owners, Editors and Read-only accounts. Using database roles can make the management of these user categories, and associated users, easier.

It is further recommended that each user be assigned a specific login to the database. There are many reasons for doing this. It provides more granular control over data access rights and permissions. It also gives database administrators better information when debugging issues. ArcSDE, currently, maintains 2 log files in the ArcSDE schema. Each user in the database that accesses GIS layers will be given a set of these tables. If all users log into the database using the same account, these log files tend to grow very large and result in sluggish performance.

Network Connectivity

Fredericksburg City's existing network configuration is sufficient to provide the necessary GIS data access capabilities for all levels of GIS users within the proposed implementation. The ESRI GIS solutions proposed for implementation is capable of integrating with the City's existing networking infrastructure, as they are fully integrated Microsoft Windows 2000/XP Systems environments.

Data Interoperability

The City has several legacy applications that should be integrated with the GIS. One of the most important is the BRIGHT CAMA system running on the AS400. Timmons Group has integrated BRIGHT data with GIS in other localities either through direct connection into the database or through automated scripting (Microsoft DTS packaging).

It is generally recommended that all server-class machines be connected to each other, and to mass storage devices, through dual Gigabit interfaces. It is also recommended that these interfaces be truncated, or bonded, together. This provides multiple benefits. While all interfaces are up and functioning the server receives aggregated throughput. If one interface fails, the server will continue to stay connected to the LAN, however, the throughput will be reduced to the capacity of the remaining interface. Servers need to be connected on a fast, reliable, backplane.

It is also recommended that all users be connected through switched devices as opposed to hubs. These switches should be, at a minimum, 100mb. Switches of this class should be used to support all client (PC) devices. Gigabit switches should be purchased to connect all server-class devices together and to mass storage devices. If any users are connected through either hub devices or 10mb switches, we recommend upgrading those devices to 100mb switches. This is especially important for heavy GIS users.

System Maintenance

The GIS server and desktop hardware are currently being well maintained by the City IT staff. We think that the City IT staff should continue to maintain this infrastructure into the future.

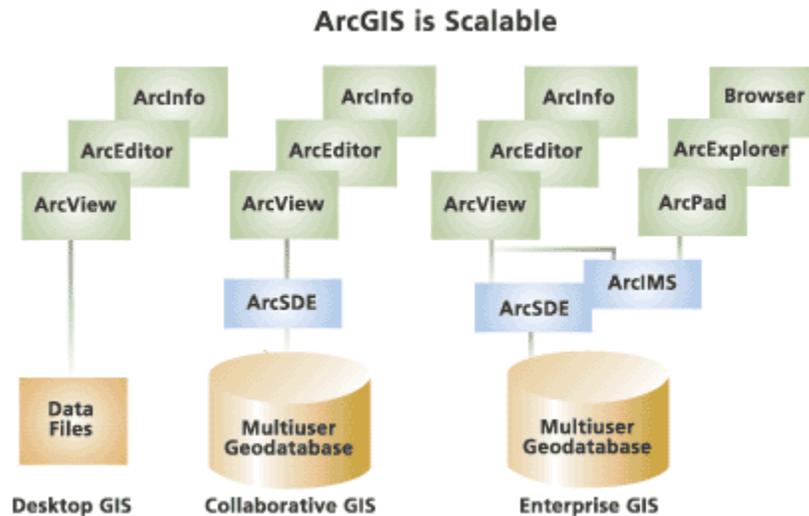
Backup and Recovery

Currently, the City utilizes an Enterprise Backup and Recovery tool made by Veritas. Veritas provides advanced functionality, and most importantly, plug-ins to SQL Server and Exchange / mail servers. This allows for hot backups and recoveries and greatly reduces the chance for data corruption and loss.

The City could further protect their IT and data investments and simplify the back-up and recovery process by leveraging a consolidated storage device (e.g., SAN / NAS). The need to access shared drives across many servers goes away. Most SAN / NAS devices also come with “snapshot tools” to facilitate rapid data recovery. These tools take point-in-time snapshots of all data on the storage device and archive it on disk. Multiple snapshots can be taken (daily / hourly) etc. as space permits. These are fully user-defined and configurable. If data are inadvertently lost, administrators can access these snapshots and drag the files lost back to the current data set. Each snapshot does not require the full storage footprint of the existing data. Algorithms are used to optimize the storage and management of these snapshots.

Core Software Applications

ESRI’s ArcGIS suite of software is designed as a scalable system that can be sized (scaled) to fit any size organization, from an individual desktop to a government wide distributed network of people. It provides the framework for development of GIS data and applications that use industry standard databases and programming languages. The diagram below details the product offerings, some of which are detailed for implementation below.



Our GIS implementation approach enables us to maximize the City's existing investments in technology systems (data, hardware and software) through the deployment of an ArcGIS solution that utilizes commercial off-the-shelf relational database management software (COTS RDBMS). As described above, the ArcGIS family of products enables each user to access the same spatial data using the client application most suited to their needs, thus enabling the organization to better manage their software and training costs while simplifying the task of keeping the data accurate and current. The ArcGIS platform selected for implementation in Fredericksburg is comprised of a variety of software clients / modules as described below:

Database Management Configuration

Fredericksburg's GIS database should be designed around ESRI's ArcGIS geodatabase technology. The ArcGIS geodatabase should be developed on Microsoft SQL Server 2000 database, a multi-user (edit) relational database management system. Data should be developed based on the ArcGIS Urban Data Model schema. The schema can be adjusted to meet the specific City database requirements. A license of ESRI ArcSDE 9.1 should be purchased and installed on the GIS server.

Data Maintenance Software

Our recommended solution for maintenance implementation includes one seat of ESRI's desktop data management system, ArcGIS ArcInfo or ArcEditor 9.1, without extensions for each power user / data creator. It is possible to obtain a "concurrent" use license for each seat of ArcGIS to allow for license sharing. This will allow multiple users to have access to the software but only for the total number of concurrent licenses purchased. This will enable sharing of the software among multiple City staff. The database should be stored on the City centralized servers. This provides a secure, reliable in environment and backup capability.

We recommend the City use NovaLIS' Parcel Editor, Sidwell's Parcel Builder, or SDS' Parcel Mapper, or comparable software for maintaining the GIS parcel map and attribute file (Parcel Maintenance Software). Any of these software packages use the ESRI ArcGIS platform, and provide tools for maintaining parcel, building, road, addressing, and easement information in an integrated GIS environment. These products are based on industry standard database products that can be linked to the BRIGHT system data on the AS/400.

Data Query and Map Composition Applications

We recommend that the City employ a combination of ArcView 9.1 and the freely available ArcExplorer tool in the initial phases of the project. The ArcView software should be deployed using the concurrent licensing software model. This will enable sharing of the software among multiple City staff.

Due to the cost and significant learning curve of ArcView software, it is recommended that it be used by advanced GIS users only for GIS tasks related to map editing, data maintenance, and advanced queries not supported by the Web-based GIS applications to be deployed. Therefore, it is anticipated that seven (7) advanced desktop GIS workstations will be adequate to meet the initial needs of the City. ArcExplorer and the Web-browser-based GIS applications will allow an unlimited number of City staff to query data in the GIS, to do routine analyses, and to compose and print custom maps without the need for more advanced GIS software.

Web-based GIS Applications

Technological improvements in GIS software and widespread broadband access have made providing access to GIS data through the Internet and Intranet a reality for local governments. The City's newest aerial photography (March 2005) could be put on the web for immediate access and to help introduce and promote the pending GIS to City staff and citizens. Web access to digital imagery several benefits to City operations:

1. The City staff can use and integrate data from the City GIS and external sources, like VEDP, to analyze and present business solutions. Data from a variety of sources can be used as if it were part of the City GIS.
2. Select information (graphics and business data) from the City GIS can be shared and viewed by other users in an interactive user environment. Citizens can access information 24x7 through the Internet thus expanding your service hours while reducing walk-in traffic.
3. The cost to use GIS tools for standard query and analysis applications is reduced through the end user use of web browser software instead desktop GIS software.
4. The City GIS can be stored and maintained off-site thus reducing the cost of hardware and software licensing and maintenance. The City would pay for these as annual services.

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This ability to serve GIS applications on the Internet is made possible through a standard Internet browser (Explorer or Netscape) and broadband access to the Internet. Most computer users are familiar with web browser software. This reduces the learning curve and makes access to standard queries easy to do.

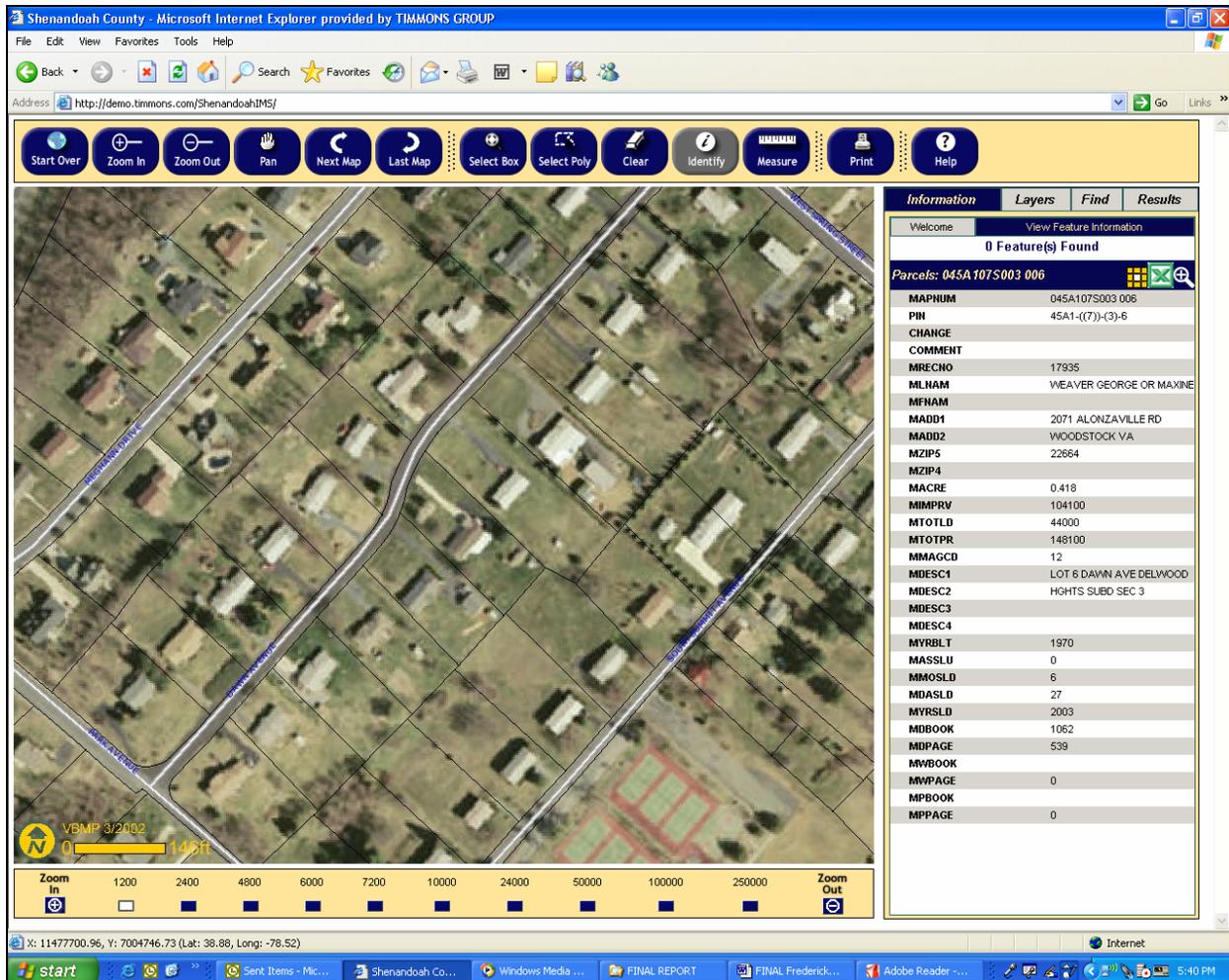


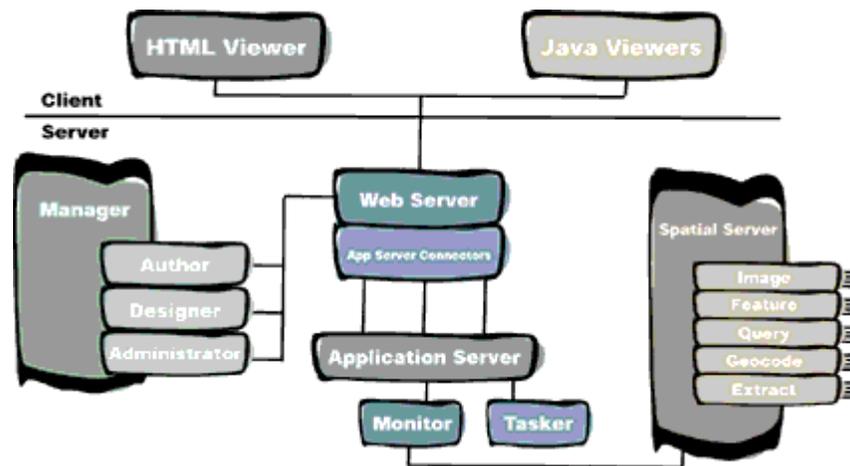
Figure Caption: Example of Web-browser based GIS interface developed by Timmons Group for Shenandoah County, VA. Timmons Group hosts and maintains the data and software for the County.

Furthermore, a number of powerful, easy-to-use mapping tools can be deployed in a web mapping environment. One such tool that we recommend for the City is a “My Neighborhood” map location tool much like that offered by MapQuest, except that any combination of the City’s map layers could be quickly searched and located on a map, and presented to the user with descriptive details. For example, a new resident could enter their address and have a list of City services presented to them, such as local schools, polling locations, and nearest bus stops. This mapping tool could also be used to locate a popular destination (e.g. tourist, stores, city offices) or any address of interest. This capability could also be used to assist

passengers with navigating the best route through the FRED system, and to their destinations (e.g. work, stores, recreational activities).

The widespread availability of the Internet and Intranet has made distribution of GIS access via the web a viable alternative for the incidental and casual users. Several components are necessary to make web-based GIS possible. These are shown on the diagram below. Serving GIS on the web is done in a distributed environment and consists of both client-side (end user's desktop) and server-side (City IT or hosted) components. Typically, the client requests information from an Internet or Intranet server. Then the server processes the request and sends the information back to the client viewer.

Depending on the size of the GIS and the expected traffic the ArcIMS Applications and Spatial servers can reside on one or more physical computers. The Web server can be dedicated to serving GIS requests or shared with other non-GIS web server applications.



These components can be on-site at the City or off-site at a GIS web hosting facility. Web hosting can be acquired through a service contract. This saves the cost of software licensing and hardware maintenance. In some cases GIS web hosting services will also provide GIS data maintenance. This reduces the City staff data maintenance time and expense and alleviates the concern of exposing web services to the public and City production GIS data stored in ArcSDE.

Software Deployment

The GIS software and applications can be deployed using centralized license management software that comes with ArcGIS software. This licensing management software can be used for the ArcGIS ArcInfo and ArcView software. This will result in a smaller number of licenses needed as they can be shared among users across the network. The license management software should be loaded on the ArcSDE Server. Licenses are checked out / in as the users enter the application. Users have the ability to switch between ArcGIS ArcInfo and

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ArcView as needed providing for more efficient use of higher-cost licenses (i.e., ArcGIS ArcInfo).

Software Installations

The following table details the recommended GIS software installations. Additional licenses can be quickly added should the demand increase.

GIS Software	Quantity	Departments
ArcView 9.1 – Query Software – Shared license deployment	7	Planning & Zoning Department City Shop Building Public Works Building and Development Public Safety (Fire, Police, Sheriff)
ArcGIS ArcInfo 9.1 – GIS Maintenance for maintenance and advanced users	4 seats	(2) Graphics Department or New GIS Department, (1) Utility Records Department, and (1) Transit
Parcel Maintenance Tools	1 seat	Graphics / GIS
Internet Browsing Software for basic analysis and reporting / printing	Unlimited	incidental and casual users and public
ArcSDE – Data Management Software	1 seat	Information Technology
Microsoft SQL Server – RDBMS Software	1 seat	Information Technology

GIS Implementation Plan

We recommend a phased approach for implementation of the City's new GIS. A phased approach will enable the efficient acquisition, deployment, and management of the various aspects of a new GIS solution. Phase II can be started before phase I is complete, should the City staff's schedule and finances permit. This would result in a quicker deployment of the GIS tools and training. Recommended components for each primary initial phase of the GIS are summarized below, along with an estimated cost to deploy.

Phase I³

This phase focuses on developing and updating the core GIS infrastructure and data sets listed below that are required for the GIS.

I. GIS Staffing

- a. Select a GIS Coordinator
- b. Hire 1-2 GIS Analyst(s)

II. GIS Training

- a. Desktop GIS Software (ArcView) Training for Primary Users in City Departments (7)
- b. Advanced Desktop GIS Software (ArcGIS) training for GIS Department / Sub-Department staff (2)
- c. Parcel Maintenance Software Training (2)
- d. Web GIS User Training for all relevant City Staff

III. GIS Software

- a. ArcView (7)
- b. ArcGIS (4)
- c. Parcel Maintenance Software, such as NovaLIS' Parcel Editor, Sidwell's Parcel Builder, or SDS' Parcel Mapper, or comparable (1)

IV. GIS Related Computer Hardware

- a. New or Upgraded Computer Workstation for Primary GIS Users (Quantity depends on which staff are designated as a primary GIS users)
- b. Large Format Color Printer / Scanner (1)

V. GIS Map Data Creation and Conversion Services

- a. Develop a Local Government Data Model for Fredericksburg
- b. Road Centerline and Addressing Development
- c. Convert paper tax maps to create parcel layer
- d. Convert City boundary map layer
- e. Create subdivision / neighborhood boundary map layers
- f. Photogrammetrically -derive hydrography map layer
- g. Photogrammetrically -derive 2' topographic contours
- h. Photogrammetrically -derive railroad map layer
- i. Photogrammetrically-derive bridges

³ Please see Report Supplement #4 for a revised GIS implementation Plan and Budget for Phase 1 that assumes the availability of a smaller budget.

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- j. Convert Zoning map layer
- k. Convert Fire hydrant location map
- l. Obtain GIS data sets from RADCO (bus stops, bus routes, etc.)

VI. Other GIS Services

- a. Development of a Local Government Internet Mapping Portal to support both internal (employees and allies) and external (public) clients
- b. Web hosting of City's GIS base map layers
- c. Integration of GIS with Bright System for automated update of parcel attribute information
- d. Consulting services to assist City with development of a Commercial GIS Data Use and Distribution Plan
- e. Consulting services to define the requirements for a new GIS-based permit tracking system for the Department of Building and Development Services

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Budget Item	Low Estimate	High Estimate	Comments
I. GIS Staffing	\$85,000	\$125,000	
a. Hire a GIS Coordinator	\$50,000	\$75,000	We have a brief job description
b. Hire 1 GIS Analyst	\$35,000	\$50,000	We have a brief job description
II. GIS Training	\$15,600	\$22,500	SUBTOTAL
a. Desktop GIS Software (ArcView) Training for Primary Users in City Departments (7)	\$4,500	\$6,300	2 days
b. Advanced Desktop GIS Software (ArcGIS) training for GIS Department / Sub-Department staff (2)	\$5,400	\$6,300	3 days
c. Parcel Maintenance Software Training (2)	\$4,500	\$7,500	3-5 days
d. Web GIS User Training for all relevant City Staff	\$1,200	\$2,400	1-2 days of training in City - Multiple 2 hour sessions per day.
III. GIS Software	\$36,426	\$38,926	SUBTOTAL
a. ArcView Concurrent User Licenses (7)	\$19,726	\$19,726	\$2,818 each. This is non eVA pricing. First Year software maintenance is included.
b. ArcGIS Concurrent User Licenses (2)	\$14,200	\$14,200	\$7,100 each. This is non eVA pricing. First Year software maintenance is included.
c. Parcel Maintenance Software (1)	\$2,500	\$5,000	Assumes NovaLIS' Parcel Editor, Sidwell's Parcel Builder, or SDS' Parcel Mapper, or comparable
IV. GIS Related Computer Hardware	\$15,000	\$21,000	SUBTOTAL
a. New or Upgraded Computer Workstation for Primary GIS Users (quantity depends on which staff are designated as a primary GIS users)			The City may already have sufficient equipment that meets the recommended specifications. Budget estimate per workstation is \$1,500 - \$2,000
b. Large Format Color Printer / Scanner (1)	\$15,000	\$21,000	Depends on configuration and warranty
V. GIS Data Model Development, Map Data Creation and Conversion Services	\$154,000	\$215,000	
a. Develop a Local Government Data Model for Fredericksburg	\$6,400	\$7,500	Using the ESRI model and Timmons Group experiences with other localities, to house all converted / developed data.

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Budget Item	Low Estimate	High Estimate	Comments
b. Road Centerline and Addressing Development	\$22,000	\$26,000	Includes: Analyze existing City roads data; Load Base Data; OSSI to ArcGIS Translation; Road Centerline Development; Process Road Updates; ESZ Development; and ESZ/ RCL Integration
c. Convert paper tax maps to create parcel layer			
i. Digitize Property records maps	\$38,300	\$57,400	Low end represents Georeferencing/best fit; High end assumes some additional COGO work will be required
ii. Conversion of Map Specific Annotation	\$9,600	\$15,300	Low end assumes parcel number annotation; high end includes address annotation
d. Convert City boundary map layer	\$1,700	\$2,500	Assumes bearings/distances available and in singular assumed directional datum (magnetic declination or true North)

Budget Item	Low Estimate	High Estimate	Comments
e. Create subdivision / neighborhood boundary map layers	\$600	\$1,300	Assumes coincidence with parcel boundaries
f. Creation of Priority Planimetric Map Features			
i. Data processing, Management, and QC services required for Photogrammetrically derived map features	\$57,500	\$75,000	
ii. Photogrammetrically derive hydrography map layer	\$4,500	\$6,000	
iii. Photogrammetrically derive 2' topographic contours	\$2,400	\$3,500	
iv. Photogrammetrically derive railroad map layer	\$1,000	\$2,000	

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Budget Item	Low Estimate	High Estimate	Comments
v. Photogrammetrically derive bridges	\$1,000	\$2,000	
g. Convert Zoning map layer	\$3,800	\$5,700	
h. Convert Fire hydrant location map	\$1,000	\$2,000	
i. Obtain, and convert, GIS data sets from RADCO (bus stops, bus routes, etc.)	\$4,200	\$8,800	
VI. Applications Development / Hosting	\$30,400	\$46,900	SUBTOTAL
a. Development of a Local Government Internet Mapping Portal to support both internal (employees and allies) and external (public) clients.	\$20,000	\$30,000	
b. Web hosting of City's GIS base map layers	\$7,200	\$12,500	First Year. Includes monthly data updates to the site(s).
c. Integration of GIS with Bright System for automated update of parcel attribute information			
i. Desktop integration	\$2,000	\$2,400	
ii. Web application Integration	\$1,200	\$2,000	

Budget Item	Low Estimate	High Estimate	Comments
VII. Other GIS Services	\$30,000	\$45,000	SUBTOTAL
a. Consulting services to assist City with development of a Commercial GIS Data Use and Distribution Plan	\$10,000	\$15,000	
b. Consulting services to define the requirements for a new GIS-based permit tracking system for the Department of Building and Development Services	\$20,000	\$30,000	
Budget Recommendation for GIS Implementation - Phase I	\$281,426	\$389,326	Note: Does not include staffing costs

Phase II

This phase of the GIS implementation is focused on maintenance of primary GIS layers, creation/conversion of secondary GIS layers, and the development of secondary GIS applications for the desktop and Web.

I. GIS Staffing

- a. Evaluate need for additional GIS support staff in City Departments (e.g. Transportation Planner for FRED)

II. GIS Training

- a. Evaluate need for additional desktop GIS software training for existing and new primary users in City
- b. Consider additional training needs for incidental and casual GIS Users (e.g. refresher Web GIS User Training for all relevant City Staff – “brown bag” seminars)
- c. GIS Database Administration Training – GeoDatabase and ArcSDE (1)
- d. Evaluate the need for training on the use of Global Positioning Systems (GPS) to locate critical features in the field (e.g. pole, manholes, hydrants)
- e. Training for new GIS-based permit tracking system for the Department of Building and Development Services

III. GIS Software

- a. Evaluate need for additional ArcView GIS software licenses
- b. Evaluate need for additional ArcGIS software licenses
- c. GIS database administration software for GIS data server – ArcSDE (1)
- d. Procure new GIS-based permit tracking system for the Department of Building and Development Services

IV. GIS Related Computer Hardware

- a. Evaluate need for new or upgraded computer workstations for current and existing primary GIS Users (Quantity depends on which staff are designated as a primary GIS users)
- b. Consider hardware needed for GIS-based permit tracking system
- c. Evaluate the need for mass storage device for GIS Data (i.e. NAS / SAN)
- d. Evaluate the need for Global Positioning Systems (GPS) to locate critical features in the field (e.g. pole, manholes, hydrants)

V. GIS Map Data Creation and Conversion Services

- a. Maintenance of Primary GIS base map layers (Internal)
- b. Photogrammetrically-derive building footprints
- c. Create rights-of-way / easement map layer
- d. Create publicly-owned property map layer
- e. Create land use plan map layers
- f. Create map of business districts
- g. Create map of special tax districts
- h. Convert voter precinct and polling place maps

- i. Create map of City facilities (schools, libraries, parks, etc.)
- j. Create map of school zones
- k. Create map of school bus routes
- l. Create map of environmentally sensitive areas
- m. Create map of City Pathways (biking, walking)
- n. Create map of HazMat locations and related database
- o. Create GIS database of tourist destinations
- p. Create GIS database of the City's businesses
- q. Obtain map of revised floodplains from FEMA

VI. Other GIS Services

- a. Web hosting of City's GIS base map layers – including new VBMP orthophotos to be flown in Spring 2006
- b. Evaluate need for enhancements to primary GIS applications
- c. Creation and hosting of Secondary GIS applications (Economic Development Portal, tourism mapping, FRED bus routing, address routing, with driving instructions)
- d. Implementation of a GIS-based community development solution for permitting and inspections
- e. Integration of land record documents indexed and scanned in Circuit Court Clerks Office with GIS and the Commissioner of the Revenue's Office
- f. Consulting services to define the need for document management and integration with GIS and GIS-integrated systems (e.g. permits and inspections for the Department of Building and Development Services)

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Budget Item	Low Estimate	High Estimate	Comments
I. GIS Staffing	\$0	\$0	
			At end of Year 1, evaluate need for additional GIS support staff in City Departments (e.g. Transportation Planner for FRED)
II. GIS Training	\$2,400	\$4,800	SUBTOTAL
a. Desktop GIS Software (ArcView) Training for Primary Users in City Departments			At end of Year 1, evaluate the need (assume 2 days @ \$1,200 / day)
b. Advanced Desktop GIS Software (ArcGIS) training for GIS Department / Sub-Department staff			At end of Year 1, evaluate the need (assume 3 days @ \$1,200 / day)
c. GIS Database Administration Training – GeoDatabase and ArcSDE (1)	\$1,200	\$2,400	1-2 days
d. Web GIS User Training for all relevant City Staff	\$1,200	\$2,400	1-2 days of training in City - Multiple 2 hour sessions per day.
e. Training on the use of Global Positioning Systems (GPS) to locate critical features in the field (e.g. pole, manholes, hydrants)			If applicable, allow 1-2 days (\$1,200 - \$2,400)
III. GIS Software	\$16,260	\$18,500	SUBTOTAL
a. ArcView Concurrent User Licenses			At end of Year 1, evaluate need for additional ArcView GIS software licenses
b. ArcGIS Concurrent User Licenses			At end of Year 1, evaluate need for additional ArcGIS software licenses
c. ArcSDE – Data Management Software	\$8,260	\$10,000	Requires annual maintenance fee for subsequent years
d. Annual Software Maintenance	\$8,000	\$8,500	This is for 7 copies of ArcView, 2 copies of ArcGIS, and 1 copy of parcel maintenance software purchased Year 1
IV. GIS Related Computer Hardware	\$0	\$0	SUBTOTAL

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Budget Item	Low Estimate	High Estimate	Comments
a. New or Upgraded Computer Workstation for Primary GIS Users (quantity depends on which staff are designated as a primary GIS users)			The City may already have sufficient equipment that meets the recommended specifications. Budget estimate per workstation is \$1,500 - \$2,000
b. Mass storage device for GIS Data (i.e. NAS / SAN)			At end of Year 1, evaluate the need
c. Hardware needed for GIS-based permit tracking system and/or work order / asset management system			At end of Year 1, evaluate the need
d. Global Positioning Systems (GPS) to locate critical features in the field (e.g. pole, manholes, hydrants)			At end of Year 1, evaluate the need
V. GIS Data Model Development, Map Data Creation and Conversion Services	\$50,000	\$101,600	
a. Maintenance of Primary GIS base map layers			City Staff (Internal Cost)
b. Structure Addressing Development	\$12,000	\$16,000	To be done after conversion of parcels and road centerlines. Includes: Load structure Roofprints; Overlay on Parcels and Assign Addressing; and Structure Address Cleanup
c. Photogrammetrically-derive building footprints	\$9,000	\$12,000	Price assumes required, preliminary data processing done in Year 1
d. Create rights-of-way / easement map layer	\$4,000	\$20,000	Tax maps do not include all of the easements. Public ROW layer would be a derivative of the Parcel layer development.
e. Create publicly-owned property map layer	\$800	\$1,500	
f. Create land use plan map layers	\$2,500	\$3,600	
g. Create map of business districts	\$1,600	\$2,200	
h. Create map of special tax districts	\$1,600	\$2,200	
i. Convert voter precinct and polling place maps	\$1,000	\$4,000	Price depends on the current data status and format.
j. Create map of City facilities (schools, libraries, parks, etc.)	\$2,500	\$4,000	for a cartographic paper map product
k. Create map of school zones	\$2,000	\$3,000	Price depends on the current data status and format.

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Budget Item	Low Estimate	High Estimate	Comments
l. Create map of school bus routes	\$1,500	\$4,500	Price depends on the current data status and format.
m. Create map of environmentally sensitive areas	\$2,000	\$5,000	Price depends on the current data status and format.
n. Create map of City Pathways (biking, walking)	\$1,500	\$3,500	Price depends on the current data status and format.
o. Create map of HazMat locations and related database	\$3,000	\$7,000	Price depends on the current data status and format.
p. Create GIS database of tourist destinations	\$1,500	\$4,500	Price depends on the current data status and format.
q. Create GIS database of the City's businesses	\$1,500	\$3,600	Price depends on the current data status and format.
r. Obtain map of revised floodplains from FEMA	\$2,000	\$5,000	Varies depending upon complexity and availability - accuracy will not likely be to FEMA standards
VI. Applications Development / Hosting	\$42,200	\$62,500	SUBTOTAL
a. Enhancements to Local Government Internet Mapping Portal to support both internal (employees and allies) and external (public) clients.	\$7,000	\$10,000	At end of Year 1, evaluate enhancements to priority web GIS applications (online data access, automated mapping and printing, address location)
b. Creation and hosting of Secondary GIS applications			
ii. Economic Development Portal	\$14,000	\$20,000	
iii. Tourism Mapping Application	\$14,000	\$20,000	
c. Web hosting of City's GIS base map layers	\$7,200	\$12,500	Second Year. Includes monthly data updates to the site(s).
VII. Other GIS Services	\$110,000	\$145,000	SUBTOTAL
a. Consulting services to define the need for document management and integration with GIS and GIS-integrated systems (e.g. permits and inspections for the Department of Building and Development Services)	\$10,000	\$15,000	
b. Consulting services to define the requirements for the integration of land record documents indexed and scanned in Circuit Court Clerks Office with GIS and the Commissioner of the Revenue's Office	\$10,000	\$15,000	

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Budget Item	Low Estimate	High Estimate	Comments
c. Implementation of a GIS-based community development solution for permitting and inspections	\$90,000	\$115,000	Includes first year hosting and software modules for permitting, code enforcement, planning, Web portal, and GIS. Includes services for consulting, training, and estimated data migration.
Budget Recommendation for GIS Implementation - Phase II	\$220,860	\$332,400	Note: Does not include staffing costs

Phase III

This phase of the GIS implementation is focused on maintenance of existing GIS layers, creation/conversion of tertiary GIS layers, and the development of tertiary GIS applications for the desktop and Web.

I. GIS Staffing

- a. Evaluate the need for an additional GIS Analyst in the GIS Department / Sub-Department
- b. Evaluate the need for additional part-time and/or full-time GIS support staff in other City Departments (e.g. public safety, engineering, building and development services)

II. GIS Training

- a. Evaluate the need for additional GIS software training for existing and new primary users in City
- b. Consider additional training needs for incidental and casual GIS Users (e.g. refresher Web GIS User Training for all relevant City Staff – “brown bag” seminars)
- c. Evaluate the training needs for GIS-based systems (i.e. GPS, permitting and inspections)
- d. Training for new GIS-compatible, enterprise document management software

III. GIS Software

- a. Evaluate need for additional ArcView GIS software licenses
- b. Evaluate need for additional ArcGIS software licenses
- c. Procure GIS-compatible, enterprise document management software

IV. GIS Related Computer Hardware

- a. Evaluate need for new or upgraded computer workstations for current and existing primary GIS Users (Quantity depends on which staff are designated as a primary GIS users)
- b. Evaluate the need for mass storage device for GIS Data (i.e. NAS / SAN)
- c. Evaluate the need for additional GIS hardware peripherals (GPS, scanners, printers)

V. GIS Map Data Creation and Conversion Services

- a. Maintenance of Primary GIS base map layers (Internal)
- b. Maintenance of Secondary GIS layers (Internal)
- c. Creation of Historic District Map
- d. Create map of Civic and Homeowner Association Boundaries
- e. Create geo-coded demographic database
- f. Create database of rental properties

VI. Other GIS Services

- a. Web hosting of City’s GIS base map layers
- b. Evaluate need for enhancements to existing GIS applications

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- c. Creation and hosting of Tertiary GIS applications (school bus routing, crime mapping, economic development and tourism)
- d. Implementation services for new GIS-compatible, enterprise document management system
- e. Consulting services for the design and deployment of a GIS-based Web system for tracking, querying, locating, and displaying the status of building permits and inspections
- f. Consulting services for the design of a GIS-based web system for automated acceptance, tracking, and reporting on the status of citizen requests for service (e.g. street light repair, street flooding, snow removal, debris cleanup, code violation complaints, etc.)

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Budget Item	Low Estimate	High Estimate	Comments
I. GIS Staffing	\$0	\$0	
			At end of Year 2, Evaluate the need for an additional GIS Analyst in the GIS Department / Sub-Department
			At end of Year 2, Evaluate the need for additional part-time and/or full-time GIS support staff in other City Departments (e.g. public safety, engineering, building and development services)
II. GIS Training	\$3,600	\$6,000	SUBTOTAL
a. Desktop GIS Software (ArcView) Training for Primary Users in City Departments			At end of Year 2, evaluate the need (assume 2 days @ \$1,200 / day)
b. Advanced Desktop GIS Software (ArcGIS) training for GIS Department / Sub-Department staff			At end of Year 2, evaluate the need (assume 3 days @ \$1,200 / day)
c. GIS Database Administration Training – GeoDatabase and ArcSDE			At end of Year 2, evaluate the need (assume 1-2 days @ \$1,200 / day)
d. Web GIS User Training for all relevant City Staff			At end of Year 2, evaluate the need (1-2 days @ \$1,200 / day)
e. Training on the use of Global Positioning Systems (GPS) to locate critical features in the field (e.g. pole, manholes, hydrants)			If applicable, allow 1-2 days (\$1,200 - \$2,400)
g. Training for new GIS-based permit tracking system for the Department of Building and Development Services			At end of Year 2, evaluate the need (assume 3-5 days @ \$1,200 / day)
h. Training for new GIS-compatible, enterprise document management software	\$3,600	\$6,000	3-5 days

Budget Item	Low Estimate	High Estimate	Comments
III. GIS Software	\$36,000	\$61,500	SUBTOTAL
a. ArcView Concurrent User Licenses			At end of Year 2, evaluate need for additional ArcView GIS software licenses
b. ArcGIS Concurrent User Licenses			At end of Year 2, evaluate need for additional ArcGIS software licenses
c. GIS-compatible, enterprise document management software	\$25,000	\$50,000	Implementation services not included.

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d. Annual Software Maintenance	\$11,000	\$11,500	This is for 7 copies of ArcView, 2 copies of ArcGIS, 1 copy of parcel maintenance software, and SDE purchased Years 1 & 2.
IV. GIS Related Computer Hardware	\$10,000	\$25,000	SUBTOTAL
a. New or Upgraded Computer Workstation for Primary GIS Users (quantity depends on which staff are designated as a primary GIS users)			The City may already have sufficient equipment that meets the recommended specifications. Budget estimate per workstation is \$1,500 - \$2,000
b. Scanners for new GIS-compatible, enterprise document management software	\$10,000	\$25,000	Depends on configuration and warranty
c. Mass storage device for GIS Data (i.e. NAS / SAN)			At end of Year 2, evaluate the need
d. Global Positioning Systems (GPS) to locate critical features in the field (e.g. pole, manholes, hydrants)			At end of Year 2, evaluate the need

Budget Item	Low Estimate	High Estimate	Comments
V. GIS Data Model Development, Map Data Creation and Conversion Services	\$8,000	\$13,500	
a. Maintenance of Primary GIS base map layers			City Staff (Internal Cost)
b. Maintenance of Secondary GIS layers			City Staff (Internal Cost)
c. Creation of Historic District Map	\$6,000	\$10,000	Depends on # of copies required
d. Create map of Civic and Homeowner Association Boundaries	\$800	\$1,500	
e. Create geo-coded demographic database	\$1,200	\$2,000	
f. Create database of rental properties			Can't estimate price without more details. Depends on if source data exists - need to elaborate
VI. Applications Development / Hosting	\$32,200	\$68,500	SUBTOTAL
a. Enhancements to Local Government Internet Mapping Portal to support both internal (employees and allies) and external (public) clients.	\$4,000	\$8,000	At end of Year 2, evaluate enhancements to priority web GIS applications (online data access, automated mapping and printing, address location)
b. Creation and hosting of Tertiary GIS applications			
i. School bus routing	\$7,000	\$20,000	Requires good road centerline layer
ii. Crime mapping	\$7,000	\$14,000	
iii. Economic development and tourism	\$7,000	\$14,000	
c. Web hosting of City's GIS base map layers	\$7,200	\$12,500	Third Year. Includes monthly data updates to the site(s).

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Budget Item	Low Estimate	High Estimate	Comments
VII. Other GIS Services	\$50,000	\$65,000	SUBTOTAL
a. Consulting services for the design and deployment of a GIS-based Web system for tracking, querying, locating, and displaying the status of building permits and inspections	\$15,000	\$20,000	
b. Consulting services for the design of a GIS-based web system for automated acceptance, tracking, and reporting on the status of citizen requests for service (e.g. street light repair, street flooding, snow removal, debris cleanup, code violation complaints, etc.)	\$15,000	\$20,000	
c. Implementation services for new GIS-compatible, enterprise document management system	\$20,000	\$25,000	
Budget Recommendation for GIS Implementation - Phase III	\$139,800	\$239,500	Note: Does not include staffing costs

Appendices and Supplements

Appendices

- A. GIS User Questionnaire
- B. Summary Spreadsheet of Map Data Layers and Priority GIS Applications as Reported by City Staff
- C. Glossary

Supplements

- 1. Details of the 2006 Virginia Bas Map Program (VBMP) Digital Orthophotography Project
- 2. Proposal to the Virginia Information Technology Agency (VITA) for E-911 Digital Addressing Services (Phase I was funded)
- 3. Proposal for ArcGIS Parcel Conversion Services
- 4. Revised GIS Implementation Plan and Budget for Phase I based on the availability of a smaller budget.

Glossary

AutoCAD - A popular computer aided drafting program developed by Autodesk. AutoCAD files typically have the extensions DWG and DXF.

Base Map - A map depicting background reference information such as landforms, roads, landmarks, and political boundaries, onto which other, thematic information is placed. A base map is used for locational reference and often includes a geodetic control network as part of its structure.

COGO - Acronym for coordinate geometry. A method for calculating coordinate points from surveyed bearings, distances, and angles.

Data Conversion – The process of translating data from one format to another (e.g. paper to digital)

ESRI – Acronym for Environmental Systems Research Institute, the world's leading provider of GIS software such as (ArcExplorer, ArcGIS, ArcView, ArcIMS, ArcEditor, ArcInfo, ArcSDE, Geodatabase). For more information, see: www.esri.com

Geocode - A code representing the location of an object, such as an address, a census tract, a postal code, or x,y coordinates.

Geographic Information System (GIS) - A computer system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to positions on the Earth's surface. Typically, a Geographical Information System (or Spatial Information System) is used for handling maps of one kind or another. These might be represented as several different layers where each layer holds data about a particular kind of feature. Each feature is linked to a position on the graphical image of a map.

GPIN – Acronym for Geographical Parcel Identification Number. A unique number which is composed of the land property's state plane coordinates (X, Y).

Georeference - To establish the relationship between page co-ordinates on a planar map and known real-world co-ordinates.

Global Positioning System (GPS) - A satellite based navigational system allowing the determination of any point on the earth's surface with a high degree of accuracy given a suitable GPS receiver.

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Hydrography – The representation of the location and direction of flow of water bodies. In GIS, it usually refers to map layers depicting various water features.

Map Accuracy – The closeness of observations, computations or estimates to the true value as accepted as being true. Accuracy relates to the exactness of the result, and is distinguished from precision which relates to the exactness of the operation by which the result was obtained.

Map Feature / Layer - A usable subdivision of a GIS database, generally containing objects of certain classes, for example: rivers, roads or geology.

Map Feature / Layer Attribute - A trait, quality or property describing a geographical feature

Map Scale – The ratio of the distance measured on a map to that measured on the ground between the same two points. Often, the difference between large and small map scales is confused. The larger the ratio, the smaller the map scale. Therefore, a map of the world would have a very small scale, whereas a map of a town will have a large scale.

Orthophotography – A geometrically-modified copy of an aerial photograph of the earth's surface with distortions due to tilt and relief removed.

Parcel Maintenance – The process of keeping the representation of a tract or plot of land current in a GIS.

Photogrammetry- The science of making reliable measurements of physical objects and the environment by measuring and plotting electromagnetic radiation data from aerial photographs and remote-sensing systems against land features identified in ground control surveys, generally in order to produce planimetric, topographic, and contour maps.

Pixel - The term is an abbreviation for picture element. The smallest unit of information in an image or raster map. Usually square or rectangular, pixel is often used synonymously with cell.

Planimetric Map – A map that displays only the x,y locations of features and represents only horizontal distances.

Rectification - The process of converting an oblique or tilted image to an image that is vertical, relative to the ground. The conversion process requires re-sampling of values.

Shapefile (.shp format) - A vector data storage format for storing the location, shape, and attributes of geographic features. A shapefile is stored in a set of related files and contains one feature class.

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Spatial – Related to or existing within space.

Street / Road Centerline (RCL) – A line digitized along the center of a road / street that at a large enough scale would be represented by a polygon.

VBMP – Acronym for the Virginia Base Mapping Program. For details, see: <http://www.vgin.virginia.gov/VBMP/VBMP.html>

VGIN – Acronym for the Virginia Geographic Information Network. For details, see: <http://www.vgin.virginia.gov/>