CITY OF
WEST SACRAMENTO

# *Geographic Information Systems (GIS)*
# *Needs Assessment, System Design, and Implementation Plan*

*Submitted By:*

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# Guide to This Document

This GIS Needs Assessment and Three-Year Implementation Plan is an exhaustive look at everything that needs to be considered for further implementing geographic technologies in the City of West Sacramento. It is understood that most people do not have the time to read the entirety of this document. Therefore, this guide has been created as a quick reference for the various people that will need to read this document. Find the category or categories into which you fit and turn directly to those sections to get optimal impact from the document.

| **Guide to the Icons in the Document**<br>Interspersed throughout this document are icons used to designate specific information and draw attention to key topics or points. | |
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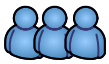
|  | Included in the needs assessments to designate a section about Personnel and Duties. |
| | Included in the needs assessments to designate a section about Hardware and Software. |
| | Included in the needs assessments to designate a section about GIS Needs and Duties. |
| | Designates a recommendation or key concept specific to a GIS need |
| | Included in the needs assessments to designate a Case Study |
| | Designates GIS Data Layers or data that can be converted to GIS Data |
| | Designates a section about GIS Applications to meet specific GIS goals |
| | Designates a specific GIS Application to meet specific GIS goals |
| | Identifies or designates Multi-tier GIS Users |

## Management (Elected Officials, City Manager)

**Step 1 – Read the executive summary beginning on page i**

Step 2 – Read Chapter 1 beginning on page 1-1 for a detailed look at the needs of each department
Step 3 – Read Chapter 9
Step 4 – Review the Table of Contents and read sections of interest

## Department Heads

**Step 1 – Read the executive summary beginning on page i**

Step 2 – Read your department's section of Chapter 1 - Refer to the Table of Contents to find the page number for your department
Step 3 – Read Chapter 9
Step 4 – Read Chapter 2 detailing the recommended organizational structure for the City of West Sacramento
Step 5 – Review the Table of Contents and read sections of interest

## Departmental Staff

**Step 1 – Read the executive summary beginning on page i**

Step 2 – Read your department's section of Chapter 1 – Refer to the Table of Contents to find the page number for your department
Step 3 – Review the Table of Contents and read sections of interest

## Technical Staff (GIS Users)

**Step 1 – Read the executive summary beginning on page i**

Step 2 – Read the entire document and highlight areas that require action
Step 3 – Refer to the document throughout the life of the project and update annually

# Introduction and Executive Summary

## Introduction

Geographic Technologies Group, Inc. (GTG) was retained by the City of West Sacramento to perform a City-wide Geographic Information System (GIS) Needs Assessment, System Design, and Implementation Plan. A summary of the key recommendations and conclusions made by GTG for the City of West Sacramento is provided. GTG is recommending a three-year phased implementation of GIS. A "Three-Year Phased GIS Implementation Plan" was developed through information gathering, questionnaires and interviews conducted with the departments of the City of West Sacramento. After extensive on-site interviews, meetings, and telephone conversations, the following results were determined:

## Executive Summary

### Conclusions:

- The City of West Sacramento has been utilizing GIS in a moderate capacity for several years in various departments; it now needs to move to a more integrated, scalable, enterprise-wide implementation

- Some of the critical elements needed for a successful GIS are:
    - Enabling existing databases using a tiered GIS front-end
    - Creation of new GIS data layers and updates to existing GIS data layers
    - Conversion of existing GIS data to a standard citywide format
    - Consolidation, centralization, and management of GIS data layers for use by all departments
    - Creation of user-friendly tools to access GIS efficiently and effectively
    - Implementation of GIS applications integrated with Springbrook, Permits Plus, VisionAIR and other enterprise systems
    - Coordination of GIS efforts across the enterprise to improve effectiveness, reduce duplicate efforts, and realize optimal return on investment

- Current GIS efforts are diverse and include: creation of map products, spatial analyses, database queries, records management, and ad hoc information retrieval

- The City of West Sacramento has invested in software and associated databases (ArcGIS, ArcIMS, Springbrook, VisionAIR, etc.). Utilizing GIS as a window into these databases will improve City of West Sacramento operations

- A survey of all networking, hardware and software resources throughout the City of West Sacramento indicates that computer resources and network infrastructure are good. Some personal computers may need to be upgraded to accommodate high-end GIS applications and additional software installations and updates will be required. Additionally, database resources will need to be expanded and optimized as the City's GIS continues to grow

## Summary of Recommendations:

The following is a list of key implementation issues and recommendations:

- This document should be relied on to direct the implementation of the technology, especially for the first year. However, this document should be looked upon as a living document that will evolve to incorporate the invariable changes that occur in local government. Additionally, new and emerging technologies will need to be considered as the phases of implementation progress. It is therefore imperative to regularly update the master implementation plan. It is recommended that the City of West Sacramento update the plan on an annual basis at a minimum

- The City of West Sacramento should utilize a hybrid GIS organizational structure. The GIS Specialist in the Information Technology Division will serve as the primary GIS resource for the City. The GIS Specialist will coordinate many of the City's GIS implementation efforts, with support and assistance from the Information Technology Manager and other department/division heads. Key GIS staff for data creation, collection, and analysis are distributed throughout certain City of West Sacramento departments; though these staff members are not directly responsible for the City's GIS, they play a key role in the City's implementation of GIS and its complementary technologies. For the present and near future, the GIS Specialist should assist departments until demand outpaces his or her ability to adequately meet their needs

- It is recommended that the City of West Sacramento continue to utilize Environmental Systems Research Institute (ESRI) and Autodesk's AutoCAD products for its GIS. Optimal data formats are ArcGIS Shapefiles, Geodatabases, ArcSDE layers, and AutoCAD Drawings (DWG)

- Train at least one existing staff member in the Engineering Division to serve as that division's GIS liaison

- Retrain all staff members in the Drafting Services Section (Engineering Division) to continue serving GIS data maintenance roles

- Train at least one existing staff member in the Fire Department to serve as that department's GIS liaison

- Train at least one existing staff member in the Parks & Recreation Department to serve as that department's GIS liaison

- Train at least one existing staff member in the Planning Division to serve as that division's GIS liaison

- Retrain at least one existing staff member in the Police Department to serve as that department's GIS liaison

- Train at least one existing staff member in the Public Works Department to serve as that department's GIS liaison

- Retrain at least one existing staff member in the Redevelopment Agency to serve as that department's GIS liaison

- Schedule and adhere to monthly (or quarterly) technical meetings of the GIS Users Group and GIS Steering Committee

- Based on the implementation plan, develop rules/protocols to decide administrative issues such as:
  - Data development priorities
  - Application development priorities
  - Data standards and documentation
  - Maintenance responsibilities
  - Public data access
  - Cost recovery or data sales

- Maintain a dynamically updated repository for all GIS data (initially stored as a hybrid of shapefiles, CAD drawings, and SQL Server tables; eventually stored in SQL Server and accessed via ArcSDE) that is accessible to all users with appropriate security

- Work in conjunction with Yolo County and the Yolo County GIS Cooperative to continue data development and data sharing efforts

- Create, consolidate, and convert needed data layers; this process is critical and should be a focus in the first year of this initiative (address points, utility features, etc.).

- Enhance and expand functionality of the City's GIS Intranet application

- Implement data maintenance applications within appropriate departments

- Acquire and utilize an easy-to-use data browser that will enable all necessary staff to utilize GIS to answer daily questions

- Implement mobile GIS technologies that will provide field staff with access to both static and dynamic data layers

- Conduct annual reviews of GIS activities and user satisfaction survey (modify implementation based on review and survey results)

- Develop training and educational mechanisms to involve all levels of employees

- Develop educational programs for citizens of the community. These can be used to demonstrate the utility of the GIS

- Distribute a City of West Sacramento GIS newsletter (hardcopy and/or Intranet) as a means of sharing successes and educating the organization about the uses of GIS

- Share data with the public through Internet based GIS applications

A successful GIS is measured not by the amount of money spent, the volume of data, or the GIS software utilized, but by the applications made available and the usage of these applications by staff and the public. Key applications have been identified and prioritized and are as follows:

- Intranet Data Browser – ArcIMS-based; most commonly used GIS functionality made available to entire organization

- ArcGIS 9 for advanced spatial analysis, data editing, and data maintenance
- Police and Fire Incident Analysis – Allows mapping of all incidents for crime analysis, arson investigations, balancing districts, and optimal facility location
- Internet GIS – Public access of GIS data via the Internet
- Work Order Processing – Organization-wide GIS based work orders. Maps assist field crews and insure needed information is returned from the field
- Touch Screen Public Access – Extremely easy to use touch screen GIS application for use by the public
- GIS Data Browsers for use in Fire Department, and Police Department
- Emergency Notification – Emergency and public service applications that will place calls to phone numbers based on a spatial query
- Automated mapping application for creation of vicinity maps, exhibit maps, and other publicly distributed maps
- Planning Support System – Allows for "What If?" planning modeling and analysis

## Summary of Implementation Costs

The following cost estimate includes costs associated with a three-year phased implementation, based on baseline budgetary projections. This three-year phased implementation plan, if implemented, will provide the City of West Sacramento with a thorough and sophisticated enterprise-wide GIS, on par with enterprise-wide GIS implementations in mid-sized cities in the United States. Additional costs for GIS-Specific Efforts and Support and Maintenance are not included in these cost estimates—those costs can be viewed in the detailed cost schedules in *Chapter 9: Three Year Phased GIS Implementation Plan*.

**The Three-Year GIS implementation costs are as follows:**

**Year One - Applications Development and Initial Database Design Phase**

Year One will be focused on continuing development and acquisition several enterprise-wide GIS applications as well as continuing data development efforts; the City will also begin to develop the foundation for a geodatabase by commencing on logical and physical database design, which will be used for an enterprise geodatabase. The primary goal for the Year One is to build on the current year's efforts and gain several "quick successes" in terms of application implementation, data development and integration, data maintenance procedures, and training. Year One will be pivotal in terms of providing GIS access across the enterprise through an Intranet GIS data browser. Tasks and procedures for Year One are summarized below.

At the end of Year One the City of West Sacramento will have accomplished the following goals:

- Upgraded hardware and software to support City-wide GIS usage
- Enhanced its Intranet GIS data browser with more data and functionality
- Upgraded to a standardized GIS platform across City departments, based primarily on ArcView
- Completed monthly/quartely meetings to continue prioritization of GIS data design and development objectives
- Implemented a GIS data browser with PIN mapping for Police personnel
- Completed a Logical and Physical Database Design
- Created new GIS layers to serve a variety of City of West Sacramento departments
- Implemented a Public Access PC with mapping functionality for the Community Development Department
- Provided training to key staff throughout the City
- Enabled GIS for the enterprise across all departments

*Year One Resources: $95,825*

**Year Two - Continuing Application Development, Database Development, and Public Access Phase**

Year Two will be focused on continuing development/acquisition of GIS applications, database development and integration of recently developed (and acquired) geo-spatial data; in addition, Year Two will include public access to geo-spatial data through the Redevelopment Agency's Community Asset Tracking System (CATS) as well as through a more general City Internet GIS data browser (that may work on the same platform as CATS). By Year Two, most, if not all, relevant City personnel will have access to base map data through a Tier 3 application. The City will have the opportunity to develop a geodatabase by leveraging the database design from Year One; however, it should be noted that the City's GIS data management and maintenance may also evolve to encompass other data management structures that are complementary to a geodatabase. Year Two will also include ongoing software and hardware installation and configuration, as well as training and education for both technical and non-technical staff.

At the end of Year Two the City of West Sacramento will have accomplished the following goals:

- Continued the creation/update of additional departmental GIS layers

- Continued coordination with Yolo County, the Yolo County GIS Cooperative, and the Sacramento Area Council of Governments on the integration and standardization of shared data layers
- Implemented a GIS-based emergency notification system
- Implemented an Internet GIS Data Browser to provide public access to the City's spatial information
- Implemented hand-held GIS units for use by departmental field staff
- Implemented a Public Access PC with mapping functionality for the Police Department
- Implemented GIS-based wastewater and storm water modeling tools
- Provided additional training to key staff throughout the City

*Year Two Resources: $50,525*

**Year Three - Data Access and Sharing Phase**

Year Three will revolve around continued data sharing throughout the organization and maintenance of the City's existing investment. At this point in the implementation, departments should be utilizing the GIS for sophisticated analysis. It should have become another resource that employees rely on, much like a word processor or spreadsheet program. During Year Three the public will have become familiar with many of the City's GIS offerings, including Internet GIS data browsing, public access kiosks, and publicly distributed maps and cartographic products. The City will have marked success in its GIS implementation and it will be primed to move forward with increasingly sophisticated technology, resources, and knowledge.

At the end of Year Three, the City of West Sacramento will have accomplished the following goals:

- Centralized all data into an enterprise-wide data store (potentially a geodatabase)
- Enabled GIS for use by all City departments
- Completed a three year compilation of needed data layers
- Enhanced its Internet GIS Data Browser with more complex functionality
- Established a solid foundation for additional development and refinement of the City of West Sacramento GIS

Year Three Resources: $36,525

# Chapter 1 – Departmental GIS Needs Assessments

The City of West Sacramento has identified and utilized technology as a means for improving its business processes, infrastructure, services, information and decision-making. The City has recognized the value and importance of an enterprise GIS, thereby taking the necessary action to ensure that its implementation of GIS is efficient, effective, and viable.

As the acquisition, management, and dissemination of information continue to become increasingly valuable functions within local governments, so too has GIS proven to be increasingly valuable. The City of West Sacramento is no exception to this observation, as it too has benefited from its preliminary implementation of GIS. GIS and GIS-based technologies have contributed to improve the City of West Sacramento's business processes, infrastructure, services, information, and decision-making.

Positive, yet pragmatic, vision, mission, and goals will prove to be critical as the City proceeds with its GIS implementation. The benefits of GIS, especially an optimal return on investment and improved efficiency and effectiveness, can only be realized if GIS is adopted and integrated on a citywide basis.

## City of West Sacramento GIS Vision

The GIS Vision of the City of West Sacramento is to manage, maintain and effectively utilize accurate, reliable, and consistent geo-spatial data. The City of West Sacramento's GIS Vision further consists of six functional areas:

<u>I. Coordination</u>

1. Enterprise-Wide GIS Management
2. Leadership & Management Support
3. Identification, Development, and Maintenance of Knowledge and Skills for Spatial Data Handling
4. Public Service Needs Analysis and Assessment
5. Strategic and Tactical Support for Projects and Programs

<u>II. Data Standards</u>

1. Accurate, Reliable and Consistent Geo-Spatial Data
   a) Implementation of Enterprise-Wide Metadata Standards, Procedures, and Protocols
2. Documentation, Archiving, and Indexing of Geo-Spatial Data Standards

<u>III. GIS Functionality</u>

1. Effective Use of GIS
2. Multi-tiered GIS Functionality
   a) Power Users
   b) Analytical Users
   c) Browser Users
3. Internal (City) and External (Public) Access

<u>IV. Data Creation, Conversion, and Maintenance</u>

1. Geo-Spatial Data Handling to Acquire, Process, Store, and Distribute GIS Data
2. Scalable, Centralized Data Storage with Enterprise-Wide Accessibility
3. Documentation and Archiving of Geo-Spatial Data Processing Methodologies and Workflows

4. Conversion, Integration, and Standardization of Disparate Data from Multiple Sources and Applications

V. GIS Infrastructure

1. Materials
   a) Technology
   b) Hardware
   c) Software
   d) People
   e) Networks
2. Knowledge
   a) Training
   b) Documentation
   c) GIS Users Group
3. Process
   a) Methodologies
   b) Procedures
   c) Protocols

VI. Public Service and Customer Relations

1. Improve Efficiency, Increase Productivity, and Enhance Public Service
2. Expand and Improve Public Access to GIS

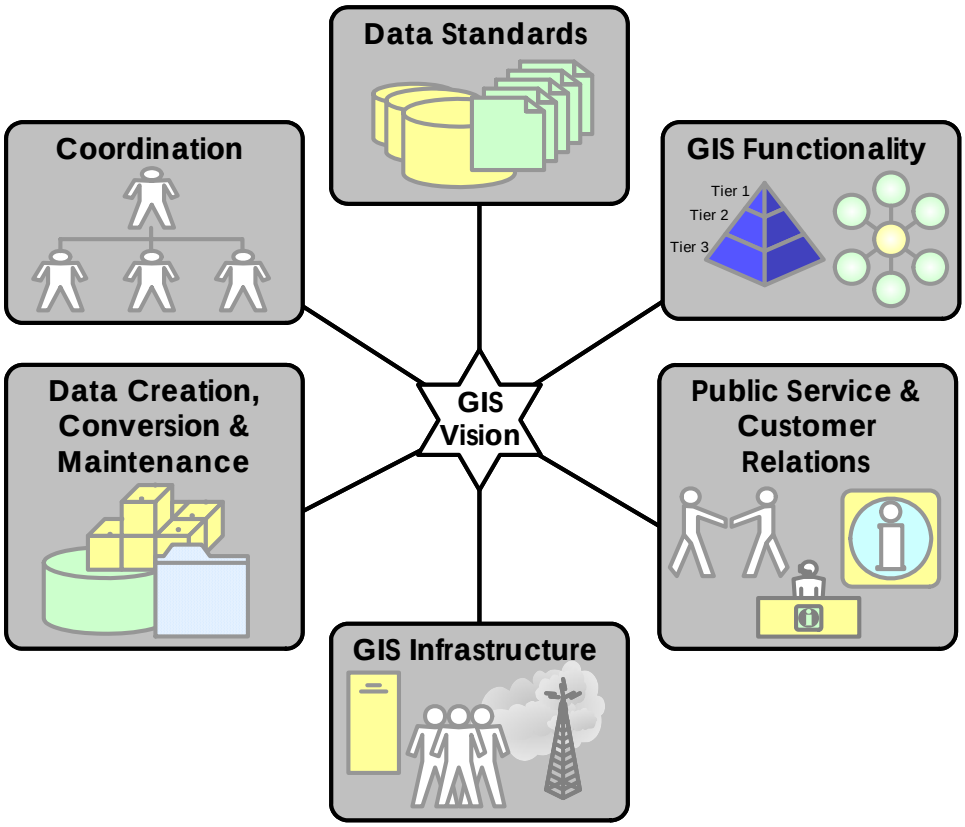



***Figure EW-1.1: City of West Sacramento GIS Vision***

## City of West Sacramento GIS Mission

The City of West Sacramento GIS Mission is to provide proactive support and assistance, in terms of both technology and staff, to acquire, convert, integrate, maintain, document, analyze, coordinate, and distribute geographic information for a variety of City needs. The City's GIS mission, in a greater context, is to utilize GIS and GIS-based technologies to improve analysis, and subsequent decisions, aimed at improving internal and public services and products.

## City of West Sacramento GIS Goals

Execution of a comprehensive and effective GIS implementation plan will allow the City of West Sacramento to meet its short-term and long-term GIS goals.

There are four primary steps that comprise an effective enterprise GIS implementation:

1. Needs Assessment
2. System Design
3. Development and Integration
4. System Implementation

Building on its previous GIS implementation plan, the City is poised to improve its existing GIS by developing goals based on these steps, thereby establishing a foundation for a successful GIS implementation. It is an exciting time for the City of West Sacramento, as it is poised to eventually become a model of GIS implementation in the local government context.

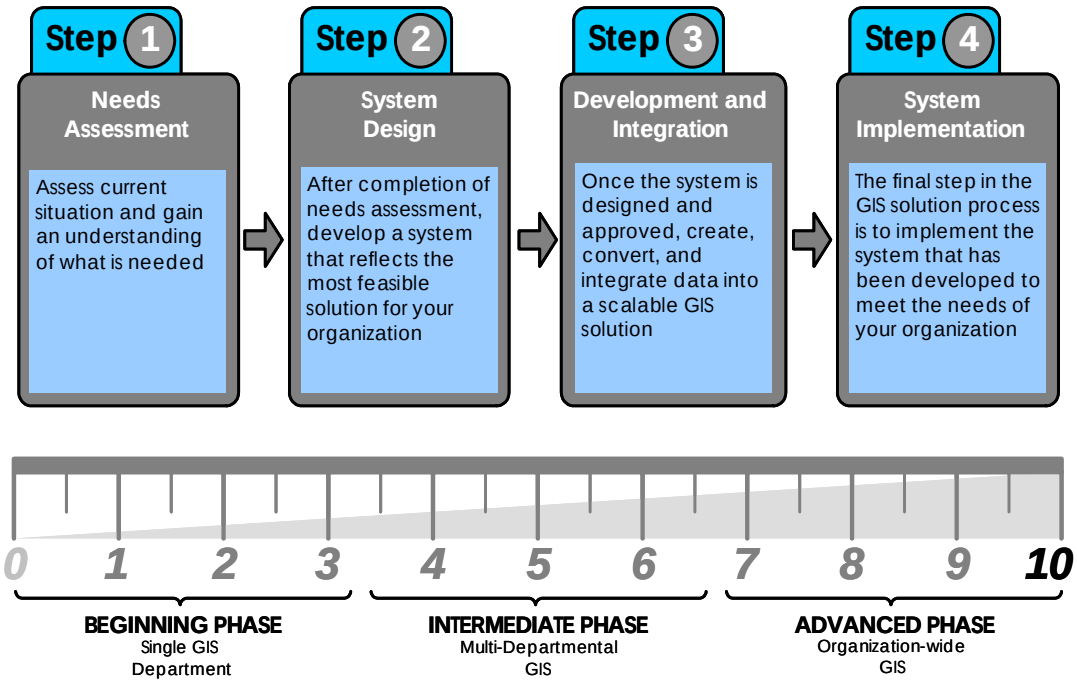



***Figure EW-1.2: Four Primary Steps for an Effective Enterprise GIS Implementation***

### Enterprise-Wide Goals

The City of West Sacramento has ten primary goals for the enterprise-wide implementation of GIS:

1. Attract, Retain, and Develop a Core-Group of Specialized GIS Professionals
2. Commit and Allocate Adequate Resources to Maintain GIS Infrastructure

3. Use GIS and Complementary Technologies to Continuously Improve Efficiency, Increase Productivity, and Improve Effectiveness, thereby Enhancing Public Service
4. Provide Leadership to Design, Develop, and Support an Enterprise-Wide GIS
5. Convert and Integrate All Available Data into a Standard Format in a Centralized Data Store Accessible to All Relevant Departments
6. Expand Accessibility to GIS by Implementing Integrated Web-Based Solutions
7. Continuously Provide Management Support to Foster the Diffusion of GIS to an Array of End-Users
8. Create and Maintain Complete and Accurate Metadata for All GIS Data Layers
9. Provide Training and Education Materials for All Levels of GIS Users
10. Coordinate and Collaborate on Enterprise-Wide GIS Efforts with Regional Organizations and Entities

**Departmental/Division Goals and Objectives**

Listed below are some of the primary goals and objectives for each of the City's departments/divisions. More detailed information can be found in each department/division section in this chapter.

City Attorney's Office

1. Utilize city GIS resources as needed

City Manager's Office

1. Support enterprise-wide implementation of GIS
2. Participate in GIS Steering Committee

Information Technology Division

1. Organizational GIS Support (Multi-tiered)
2. Continue to provide enterprise-wide GIS hardware support
3. Support enterprise-wide GIS implementation pertaining to software
4. Continue to provide enterprise-wide GIS software support
5. Coordinate the migration of all City geo-spatial data to a centrally managed, distributed data store
6. Continue to provide enterprise-wide GIS network administration and support
7. Provide and facilitate enterprise-wide GIS training
8. Coordinate GIS collaboration with regional organizations, including Yolo County and SACOG

Community Development

Building Division

1. Implement a GIS application that provides access multi-departmental GIS Data Layers
2. Work with GIS Specialist to spatially enable permits database
3. Work with GIS Specialist and Information Technology Division to integrate mapping interface with existing online permit search application
4. Utilize GIS to map and analyze building and sewer inspection locations, occupancy, permit fees, inspection and code violations, and more

Engineering Division

1. Utilize GIS to map and analyze transportation, utility, and facilities infrastructure
2. Implement a GIS-based transportation infrastructure management solution

3. Implement hand-held computers to provide field staff with access to geo-spatial data
4. Conduct GIS-based transportation modeling and analysis, including traffic accident and traffic flow analyses
5. Implement an application that provide staff with access to automated neighborhood and vicinity mapping (in conjunction with Planning Division)
6. Work in conjunction with the GIS Specialist and Information Technology Division to provide a public Internet GIS data browser that includes access to transportation, utility, and facilities infrastructure data

Drafting Services Section

1. Coordinate GIS data production and maintenance efforts with GIS Specialist
2. Work with GIS Specialist to standardize, centralize, and consolidate geo-spatial data to an enterprise data store
3. Continue to produce and map the City's base map data
4. Continue to produce and map the City's infrastructure data
5. Work with GIS Specialist to convert selected datasets from CADD format to a geo-spatial format
6. Implement and enforce digital submission standards for external maps

Facilities Development and Maintenance Division

1. Utilize GIS for mapping and spatial analysis of facilities and maintenance data
2. Implement hand-held computers to provide field staff with access to geo-spatial data
3. Work in conjunction with the GIS Specialist and Information Technology Division to provide a public Internet GIS data browser that includes access to City facilities and proposed development locations

Planning Division

1. Implement various GIS applications to support mapping and spatial analysis of land use and zoning data
2. Implement an application that provide staff with access to automated neighborhood and vicinity mapping (in conjunction with Planning Division)
3. Implement GIS-based planning support systems to conduct scenario modeling and analysis
4. Work in conjunction with the GIS Specialist and Information Technology Division to provide a public Internet GIS data browser that includes access to City facilities and proposed development locations
5. Implement a public access kiosk to provide front counter support

Finance Department

1. Convert and consolidate all relevant databases maintained by Finance Department to GIS data layers using applicable address information
2. Work with the GIS Specialist to migrate and integrate all GIS data into a centrally managed, distributed data store

Fire Department

1. Continue to expand and enhance GIS capabilities to reduce response times and coordinate resources
2. Establish streamlined access to accurate parcel, centerline, and address data in and beyond city limits

3. Identify and produce new GIS data layers for fire and emergency management, including Entrapment Areas, Automatic Aid Areas, and more
4. Implement mobile GIS technologies for use by field staff for resource and response management
5. Implement a web-based mapping application that allows citizens to view risk information and fire department infrastructure (e.g., fire stations, hydrants, etc.)

Grants & Community Investment Department

1. Utilize GIS for mapping and spatial analysis including viewing and analyzing City demographic information, proposed real estate project location analysis, identifying vacant and underutilized land, Community Development Block Grant (CDBG) administration and analysis, Environmental Assessment (EA) and Cost Benefit Analysis (CBA) for projects, programs, and CDBGs, and more
2. Work with GIS Specialist to produce cartographic products for grant proposals
3. Work in conjunction with the GIS Specialist and Information Technology Division to provide a public Internet GIS data browser that includes access to housing and land information

Human Resources

1. Support enterprise-wide GIS implementation

Parks and Recreation Department

1. Utilize GIS to improve facility and program management
2. Mapping and spatial analysis of parks and recreation data
3. Field access to geo-spatial data
4. Work with the GIS Specialist to implement a GIS interface to irrigation control system
5. Implement a GIS-based work order management system (long-term)
6. Work in conjunction with the GIS Specialist and Information Technology Division to provide a public Internet GIS data browser that integrates existing online activity registration application with mapping capabilities

Police Department

1. Utilize GIS to facilitate crime, incident, and traffic accident analysis, hot spot mapping, court case and logistical support, and more
2. Provide field spatial data access for officers through mobile GIS technologies
3. Implement GIS-enabled applications for use with department RMS
4. Implement a web-based mapping application that provides citizens with access to criminal activity and reports

Public Works Department

1. Utilize GIS to improve management and regulation of City infrastructure
2. Provide spatial data access for field crews through mobile GIS technologies
3. Convert and consolidate department databases from disparate formats and databases to GIS data layers
4. Work with Drafting Services Section to convert legacy knowledge ("brain trust") to digital GIS data layers

Redevelopment Agency

1. Utilize Mapping and spatial analysis for support of economic development and Redevelopment projects, including proposed project location analysis, identifying vacant and underutilized land, Community Development Block Grant (CDBG)

administration and analysis, Environmental Assessment for CDBGs, focus area identification and evaluation, citizen education and advocacy

2. Work in conjunction with the GIS Specialist and Information Technology Division to provide a public Internet GIS data browser that provides access to site specific real estate, property, financial, demographic, infrastructure, and other City information creating increased awareness of the benefits of business investment in West Sacramento

# City Manager's Office

The City Manager is the Chief Administrative Officer of the City. The Manager is selected by the City Council on the basis of training and ability alone without regard to his or her political preferences.

The City Manager is hired to serve the Council and the community and to bring to the City the benefits of training and experience in administering local government projects and programs on behalf of the governing body. The manager prepares a budget for the Council's consideration; recruits, hires, and supervises the government's staff; serves as the Council's chief advisor; and carries out the Council's policies. Council members depend on the City Manager to provide complete and objective information, benefits and detriments of the alternatives, and long-term consequences. The City Manager makes policy recommendations to the Council, and the Council may or may not adopt them, opting sometimes to modify the recommendations. The City Manager is bound to the decisions the Council makes.

Personnel in the City Manager's Office include:

- City Manager
- Assistant City Manager
- Cable
- City Attorney
- City Clerk
- Community Relations
- General Administration
- Human Resources
- Information Technology
- Risk Management

Recent interviews with City Manager's Office personnel identified some important themes with regard to GIS implementation. It was determined that GIS should be applied in a simple yet effective way. It should be integrated as fully as possible into the workflow of each department.

As discussed with City management, GIS assists and will continue to assist the City of West Sacramento in achieving its mission. By following the recommendations in this implementation plan, the City of West Sacramento will utilize GIS in innovative ways, enabling the City to be part of the top tier of city GIS implementations in the state of California. Citizens will have Internet access to GIS data and the ability to initiate and track complaints through web-based applications as well as improved infrastructure and services based on more effective citywide use of GIS. A centralized data management and distribution model will provide staff with real-time access to detailed data that will enable them to do their jobs more efficiently and improve decision-making at various levels. In addition, GIS will continue to add value to existing systems, by allowing staff to view data in a user-friendly geographic context.

The City of West Sacramento has the core competencies and interdisciplinary skills to use robust geo-spatial tools. An enterprise-wide implementation of GIS technology facilitates support, offering an opportunity to organize and distribute existing and future digital data created during this initiative. Organizing and centralizing data/databases from each department will eliminate data redundancy, thereby improving data integration and data

quality. Improved data management will also assist with automation of analytical processes by providing rapid access to reliable, consistent, and valid data.

Each department must maintain itself informed of new and exciting developments in the geo-spatial sciences, given that emerging technologies and methodologies may assist in reducing liability, reducing operating costs, improving efficiency, and improving productivity.

The following needs are identified as essential to this GIS initiative, including:

- The need for support from City Management
- The need for automated mapping and analysis applications
- The need to integrate and centralize existing data/databases for easy access and distribution of citywide information
- The need to make this an enterprise-wide effort instead of departmental
- The need to show cost/benefit for implementing GIS among the city departments
- The need to design and develop user-friendly web-based GIS applications and tools
- The need to provide formal GIS training for staff
- The need to educate elected officials as to the benefits of GIS

The real and demonstrated application of GIS technology will guarantee success. The first year of implementation must demonstrate quantifiable and visible successes with GIS.

City Management stated that the following items were important to the project:

- Easy-to-use GIS tools
- Access to accurate and complete data
- Base mapping (including street centerlines, address points, tax parcels)
- Identification of problem areas/complaint tracking
- Access to infrastructure data for strategic planning
- Access to crime statistics
- Access to traffic and accident statistics
- Access to census information and other community profile data
- Fire station location analyses
- Business location analysis
- Business site selection analysis
- Code compliance analysis and mapping
- Asset mapping
- City demographics mapping and analysis
- Sphere of Influence mapping
- Utilization of Reverse 911 technology for emergency and citizen notification
- Organizational structure assessment and recommendations
- Intergovernmental agreements with Yolo County and regional organizations
- Providing business information and tools for decision-making, finance, GASB 34
- GIS should be a unifying technology that ties various technologies together in one common interface
- Formal GIS training for existing staff

Also, the technology should be:

- Manageable
- Usable
- Easily maintained
- Cost effective
- Scalable

It is expected that City Management will continue to support enterprise-wide GIS implementation. The City of West Sacramento is poised to leverage existing investments in technology and personnel to improve citywide decision-making, services, and products through the use of GIS. Continued leadership and strategic guidance will be necessary to ensure that the City's GIS implementation is fulfilled in the long term.

# Information Technology Division

## Personnel and Duties

The Information Technology Division is part of the City Manager's Office. The Division employs six staff members, including:

- Information Technology Manager (1)
- GIS Specialist (1)
- IT Specialists (2)
- Application Support Specialists (2)

In addition, the Division employs three I.T. college interns and is currently seeking a GIS intern. Depending on GIS project requirements and other information technology workloads/projects, one of these interns may be moved to work directly with the Division's GIS Specialist.

The Information Technology Division is a division of the City Manager's Department. The Division maintains the City's information technology and communication systems throughout the City. The Division assists all departments with their automated information processing needs, including computer and telecommunication equipment purchases and maintenance.

The Information Technology Division plays a key role in assisting the City achieves its information technology vision. The Division provides reliable and quality information management services as well as ongoing information technology leadership and direction for the organization. The Information Technology Division's mission is to enable the service delivery of its customers through the integration of industry tested and secure citywide technology resources.

The Division recently hired a GIS Specialist to lead and coordinate the City's GIS implementation. The GIS Specialist will be responsible for providing enterprise-wide support to all City departments/divisions. The GIS Specialist's organizational position within the Information Technology is optimal, as GIS and Information Technology are inherently interconnected. The GIS Specialist will work closely with other Division personnel to ensure that all GIS infrastructure, including data, hardware and software, network, and customer support issues are addressed. In addition, the GIS Specialist will work closely with the Engineering Division's Drafting Services Section. This role, along with the accompanying relationships associated with it, are crucial for the successful implementation of GIS at an enterprise level (see Appendix II: Seven Keys to a Successful GIS for more information on the importance of having a GIS Specialist).

As the GIS Specialist inherently will work closely with other Information Technology personnel, it should be noted that mention of the GIS Specialist infers support from colleagues in the Information Technology Division.

The Division has a wide array of core services, including:

- Network and Communications Services - Enable the availability and relevancy of data and voice communications.
- Technology Customer Support - Provide direct customer support and training for technology equipment and applications.

- Citywide Data Management - Manage the City's data so that critical business processes remain operational and reside in a secure networked environment.
- Technology Strategic Planning - Ensure optimal resource utilization and technology investment across the organization.
- Technology Solutions Consulting - Create and implement new technology solutions that maximize the delivery of City Services.
- Internet and Intranet Services - Integrate key City services into the City Internet and Intranet services to enhance customer service.
- Geographic Information Services (GIS) Services - Manage the City GIS and associated services to achieve the goals of the GIS Strategic Plan.
- City-wide Infrastructure Enhancements - Support the enhancement of our City infrastructure to enable new technology services to be deployed that facilitate the attainment of the City Vision 2020 Strategic Framework Work Program 2003.

The GIS Specialist is a Level 1 GIS user; however, other users within the Division will utilize GIS for less complex analyses and mapping, such as that of Level 2 and Level 3 GIS Users (see Chapter 2: GIS Organizational Structure and Staffing for more information on Level 1, Level 2 & Level 3 GIS Users).

The Information Technology Division will play a key role in the development and implementation of the City's enterprise GIS.

Organizational GIS Support

The GIS Specialist, in conjunction with the Information Technology Division, will implement three levels of departmental support, depending upon the current level of GIS use and internal capabilities per department. They include:

**Level 1** – GIS Specialist provides minimal support for department/division/office GIS activities, system and application support. The GIS Specialist is used primarily for strategic and procedural support. The City of West Sacramento's currently does not have any departments/divisions at Level 1; however personnel in the Engineering Division's Drafting Services Section will quickly become Level 1 users. Divisions and sections within the Community Development, Public Works, and Utilities departments should aspire to be at Level 1 in the future.

**Level 2** – GIS Specialist provides partial support for department/division/office GIS activities. A Level 2 department/division/office will do most of its own data maintenance, but the GIS Specialist will provide advanced support; the GIS Specialist will also be responsible for advanced spatial analysis as well as application development.

**Level 3** – GIS Specialist provides all support for department/division/office GIS activities. The GIS Specialist is responsible for data maintenance, complex data analysis, and cartographic products. Most of the non-technical departments will require continued support from the GIS Specialist.

The GIS Specialist should provide training and technical support for all enterprise-wide GIS applications. All GIS software training should be coordinated through the GIS Specialist to ensure maximum efficiency and effectiveness at a minimum cost.

Not every department/division/office at the City of West Sacramento that wants to utilize GIS is able to hire or convert staff to effectively handle the tasks of data analysis and data maintenance. The GIS Specialist will assist these departments/divisions/offices with their GIS

needs. However, as usage of GIS in the aforementioned entities grows, the GIS Specialist must encourage and facilitate the acquisition of appropriate resources to handle data maintenance responsibilities for these departments/divisions/offices.

## Hardware & Software

The Information Technology Division currently manages approximately 340 personal computers (organization-wide); in addition, the Division manages and maintains a server farm with several enterprise servers, including a SQL server and a GIS data server. All personal computers have the Windows XP operating system. All desktop computers have a 100 MB network connection.

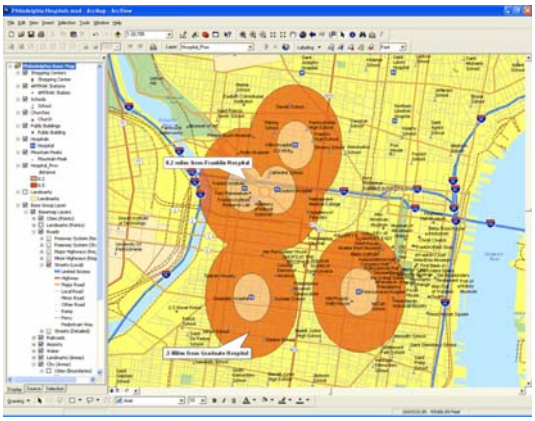
The Information Technology Division manages, maintains, and provides support for various applications used by the City's various departments, including:

1. MS Office
2. Springbrook (Utility Billing)
3. Bi-Tech (Finance/Human Resources)
4. VisionAIR (RMS)
5. FirePoint (Accela)
6. Accela (Building/Engineering Permit Tracking)
7. CrossRoads (Traffic Accident Tracking)
8. Liberty Systems (Document Imaging)

In addition to the aforementioned software, the Division maintains several GIS applications, including ESRI's ArcView and ArcIMS, as well as AutoCAD Map 3D. The new GIS Specialist is responsible for management and maintenance of this software, with support from other staff from the Division. ArcView is recommended as the primary GIS application to be used by the Division; Internet and Intranet applications will require ArcIMS, which the GIS Specialist will be responsible for configuring, updating, and upgrading..

ArcView

ArcView will be used extensively to view and map the City's GIS data; ArcView can also be used to perform spatial analyses. The GIS Specialist can use ArcView to generate cartographic products for use by administrative and field staff.



***ESRI's ArcView***

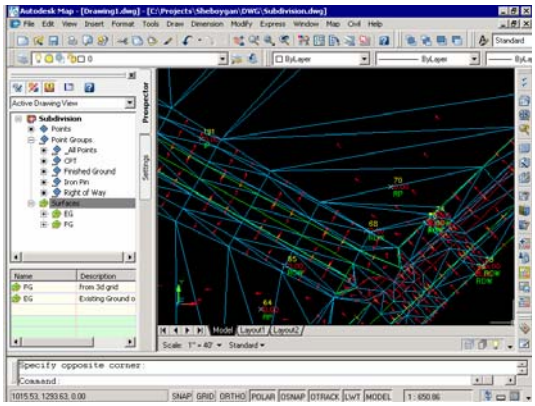
ArcIMS

ArcIMS will be used as the map server platform for the City's Intranet GIS data browser. This application has come to be quite valuable for City departments, and it is expected that utilization of it will continue to increase as the Division proceeds to enhance and customize this application.

***ESRI's ArcIMS***

AutoCAD Map

AutoCAD Map provides an interface for visualization of CADD drawings and GIS data such as Shapefiles. AutoCAD Map can be used to view a variety of CADD drawings currently maintained by the Drafting Services Section. The GIS Specialist plans to use AutoCAD map in conjunction with ArcGIS 9 (and FME) to convert CADD drawings to geo-spatial data such as Shapefiles.



***Autodesk AutoCAD Map 3D***

## GIS Needs and Duties

The Information Technology Division, primarily the GIS Specialist, will be working to provide GIS support to the City's departments. As aforementioned, the GIS Specialist will be a focal point for general technical support as the City expands and increases its utilization of GIS across the enterprise. Information Technology staff will need to work with the GIS Specialist to establish, configure, and support various types of information technology infrastructure, including software, hardware, databases, networks, user accounts, and documentation.

The GIS Specialist will continue to serve as the in-house GIS expert, putting into action many of the recommendations of the City's GIS Implementation Plan. One of the key issues that the GIS Specialist will need to address is the short and long-term impact of enterprise-wide GIS implementation—support needs for each of the City's departments will quickly increase and continue to increase as personnel become exposed to the technology and its benefits. The GIS Specialist will need to identify and devise strategies for ensuring that support is adequate in all aspects of the City's GIS effort; these strategies may entail procurement of new software, outsourcing of projects, additional staffing (primarily interns), and protocols and standards.

This needs assessment provides general recommendations for GIS efforts within the Information Technology Division. Comprehensive recommendations for each department/division are provided in other sections of this chapter; the GIS Specialist will need to work based on the recommendations provided, as a whole, throughout this chapter.

Based on this needs assessment, the Information Technology Division can contribute to the enterprise-wide GIS Implementation by contributing to the following efforts:

- Enterprise GIS coordination
- GIS user support
- GIS software support
- Training
- Network administration

☑ Enterprise GIS Coordination

As aforementioned, the GIS Specialist will provide consistent guidance and coordination in support of GIS and its related components. In general terms, the Division will be responsible for providing technical support and guidance with the GIS Specialist. Enterprise GIS coordination encompasses a variety of tasks, processes, and procedures, all of which have a cross-functional context within the scope of GIS implementation planning—the GIS Specialist will have frequent contact with staff from other departments as well as external entities.

The following are GIS coordination needs to be provided both internally and externally:

City of West Sacramento

- Installation, maintenance, and upgrade of hardware and its operating systems
- Provision of training for users in the organization
- Establishment of database standards
- Plans and procedures for effective integration or transfer of GIS data from various sources into usable databases
- Establishment of mapping standards
- Maintenance of data security and integrity
- Primary contact for user problems and vendor support
- Complex spatial analysis
- High-level cartography
- Project management
- Inter-departmental collaboration on GIS projects and initiatives

External

- Collaboration with other local agencies
- Frequent attendance and participation in local and regional GIS groups
- Distribution and acquisition of geo-spatial data
- Participation with state and federal agencies on GIS initiatives

☑ GIS User Support

The Information Technology Division should provide ad hoc GIS user support as needed. The GIS Specialist should work with Division staff to determine optimal strategies for the long-term implementation of GIS. In addition, the GIS Specialist should implement and administer formal GIS support protocols to ensure that GIS user support is properly documented and administered.

☑ GIS Software Support

The Information Technology Division should continue to provide GIS software support. It is recommended that the GIS Specialist work in conjunction with Division staff on GIS software installation and support. The GIS Specialist will be responsible for identifying, evaluating, and acquiring new GIS applications that may be beneficial for the City's GIS implementation.

Additional staff members from the Division may need to be trained on some GIS software, in order to provide redundancy in technical knowledge as well as backup support should circumstances require support beyond that which can be provided solely by the GIS Specialist.

### Training

City employees will require training on new GIS applications as they are implemented. The GIS Specialist should work with the Division to setup and administer training. The GIS Specialist will be responsible for identifying appropriate classes and education materials for departmental staff. Preliminary recommendations are provided in the following table.

***GIS Applications Training Matrix***

| Class | Site | Trainer | Days | Year of Training | Participants | Cost |
|---|---|---|---|---|---|---|
| Introduction to ArcGIS I | On | ESRI Authorized Trainer | 2 | 1,2 | Various (including GIS Specialist and Engineering Technician from Drafting Services Section) | $7,500 |
| Introduction to ArcGIS II | On | ESRI | 3 | 1,2 | GIS Specialist; Police Crime Analyst; Engineering Technician (Drafting Services Section) | $7,500 |
| Building Geodatabases I | Off | ESRI | 3 | 1 | GIS Specialist | $1,875 |
| Building Geodatabases II | Off | ESRI | 2 | 1 | GIS Specialist | $1,350 |
| ArcSDE Administration for SQL Server | Off | ESRI | 5 | 1 | GIS Specialist | $2,925 |
| Introduction to ArcIMS | Off | ESRI | 3 | 1,2 | GIS Specialist | $1,450 |
| ArcIMS Administration | Off | ESRI | 2 | 2 | GIS Specialist, Information Technology | $1,775 |
| AutoCAD Map 3D | Off | Autodesk | 2 | 1 | GIS Specialist, Engineering Technician (Drafting Services Section) | $1,200 |
| Tier 3 Applications | On | Internal | 1 | 1,2,3 | Various | N/A |

***Recommended Number of Personnel (by Department) for ArcGIS I and II Training***

| Department/Division | ArcGIS I | ArcGIS II |
|---|---|---|
| Engineering Division (includes Drafting Services Section) | 4 | 2 |
| Planning Division | 1 | 1 |
| Police Department (Crime Analyst) | 1 | 1 |
| Public Works Department | 2 | 0 |
| **Total** | **8** | **4** |

### Network Administration

The Information Technology Division will continue to administer the City's network in support of GIS and its related components (see Figure IT-1.1). The GIS Specialist will need to continually evaluate network infrastructure and configuration to facilitate data transfer and systems integration. The GIS Specialist will also need to administer GIS user permissions for each GIS user—users must have different levels of read or write access to GIS data, depending on their responsibilities.

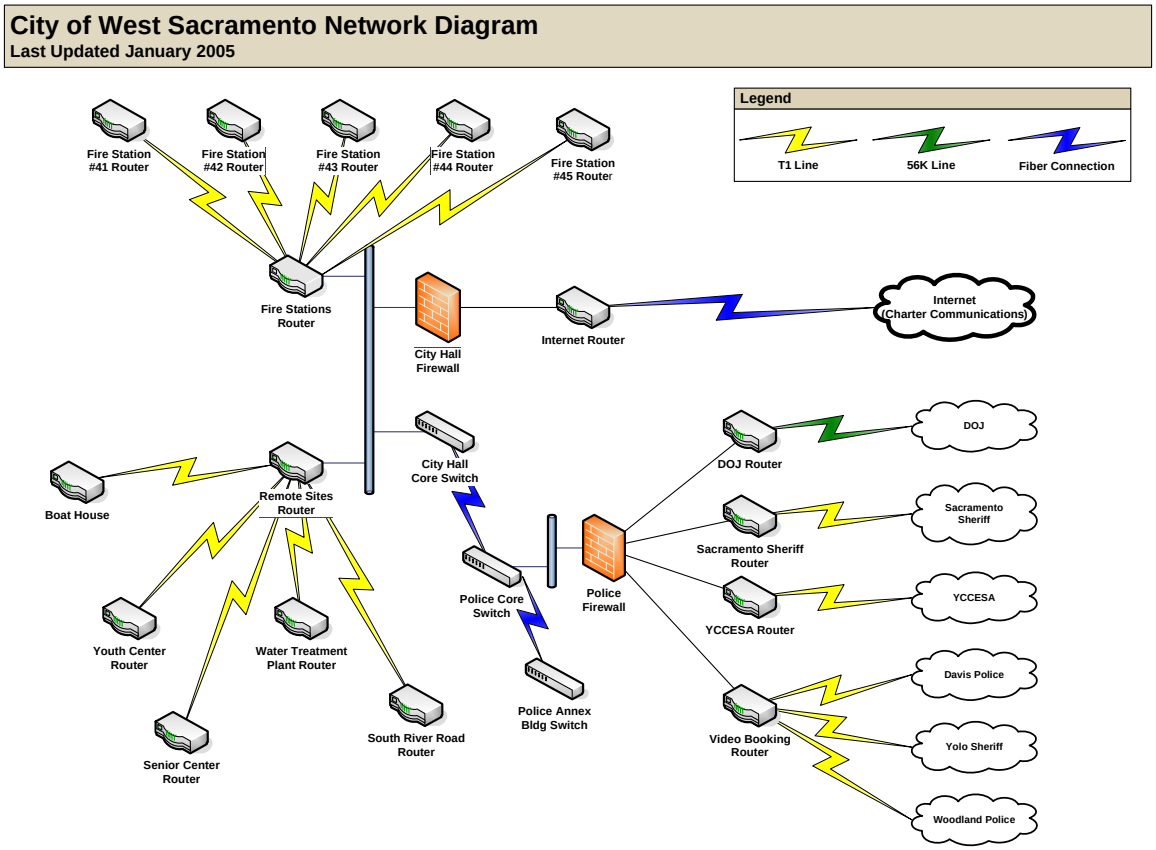



***Figure IT-1.1: City of West Sacramento Network Infrastructure***

## GIS Data Layers

Many CADD layers have been created and are maintained in Engineering. The GIS Specialist will need to work with the Engineering Division's Drafting Services Section to determine what layers will be migrated to a geo-spatial format, such as Shapefile and/or geodatabase. In addition, the GIS Specialist will need to perform an audit of this data to determine data quality, scale, coordinate system, and geographic extent to determine if any data editing, revision, or conversion is required.

The GIS Specialist will be responsible for establishing and maintaining the corporate GIS database. As new data layers are created, the GIS Specialist will need to ensure that each layer is at an acceptable accuracy level and that a data update methodology has been established. The GIS Specialist will work closely with each department to ensure that they have the appropriate training and skills to maintain their own GIS layers where appropriate.

The table below lists all layers, both existing and recommended, identified during the needs assessment process:

| *Data Layer* | *Creation Methodology* | *Recommended Update Division or Individual* | *Existing or Recommended?* |
|---|---|---|---|
| **Address Points** | Extract, cleanse, geocode, and map from Springbrook; georeference based on aerial photography and GPS field work | Automated; GIS Specialist; Drafting Services Section | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Aerial Photography** | Fly-over with control points | GIS Data Services Vendor | Recommended |
| **Backflow Devices** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Bad Bridges** | GPS data collection and integration with existing information | Fire Department; GIS Specialist | Recommended |
| **Bare Spots - Grass (Parks)** | GPS field work | GIS Specialist | Recommended |
| **Bicycle/Pedestrian Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Building Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Buildings with Site Plans** | Manually digitize polygons from plans and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Census Data** | Download from Census Bureau →http://www.census.gov/geo/www/census2k.html | GIS Specialist | Recommended |
| **Certificates of Compliance** | Extract, cleanse, geocode and map from Permits Plus database | Automated | Recommended |
| **City-owned Property** | Extract, cleanse, geocode, and map from Yolo County tax roll; other map sources as required | Automated | Recommended |
| **Commercial Addresses** | Extract, cleanse, geocode, and map from Springbrook | Automated | Recommended |
| **Community Facilities District** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Crime Data** | Extract, cleanse, and automatically map from Police VisionAIR database | Automated | Recommended |
| **Critical Facilities** | Manually digitize points from aerial photography and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Day Care Facilities** | GPS field work. | GIS Specialist; Redevelopment Agency | Recommended |
| **Drafting Water Sources** | GPS data collection; digitizing from existing maps | Fire Department; GIS Specialist | Recommended |
| **Easements** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Encroachment Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Enterprise Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Entrapment Areas** | Manually digitize polygons from aerial photography and other imagery | GIS Specialist | Recommended |
| **Facilities** | Digitize on screen; aggregate layers as needed | Drafting Services Section | Existing |
| **Fire Hydrant Permits** | Extract, cleanse, geocode and map from Permits Plus database (TBD) | Automated | Recommended |
| **Fire Hydrants** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Fire Incidents** | Extract, cleanse, geocode, and map from FirePoint or in-house database | Automated | Recommended |
| **Fire Inspections** | Extract, cleanse, geocode, and map from FirePoint or in-house | Automated | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| | database | | |
| **Fire Investigations** | Extract, cleanse, geocode, and map from FirePoint or in-house database | Automated | Recommended |
| **Flood Zones** | Acquire from FEMA (free to government entities) http://www.fema.gov/fhm/ | Drafting Services Section; GIS Specialist | Recommended |
| **GCI Special Plan and Special Study Areas** | Digitize from base map data; aggregate layers as needed | GIS Specialist | Recommended |
| **General Plan** | Digitize features from aerial photographs and existing data layer | Drafting Services Section | Recommended |
| **GPS Monument Map** | GPS field work | Drafting Services Section | Existing |
| **Hazardous Materials** | GPS data collection for location; extract from FirePoint or other database once data is entered | GIS Specialist; Fire HAZMAT Manager | Recommended |
| **Housing Condition Data** | Extract, geocode, and map from database | Automated | Recommended |
| **HUB Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Impervious Surfaces** | Digitize polygons from aerial photographs; derive polygons by raster analysis of remotely-sensed data | Drafting Services Section; GIS Specialist | Recommended |
| **Industrial Pretreatment** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Irrigation lines** | Digitize from as-builts; GPS field work (may be available from GreenTech system) | Drafting Services Section; GIS Specialist | Recommended |
| **Irrigation sprinkler heads** | GPS field work (may be available from GreenTech system) | Drafting Services Section; GIS Specialist | Recommended |
| **Labor Force** | TBD | GIS Specialist | Recommended |
| **Land Use** | Digitize polygons from aerial photographs and general plan maps; existing CADD data | Drafting Services Section | Existing |
| **Levees** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Licensed and Unlicensed Businesses** | Extract, cleanse, geocode, and map from in-house database | Automated | Recommended |
| **Liens** | Extract, cleanse, geocode and map from Springbrook | Automated | Recommended |
| **Lighting and Landscape Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Liquor Licenses** | Acquire from state ABC database; geocode and georeference using base layers | GIS Specialist; Drafting Services Section | Recommended |
| **Major Intersections** | Use street centerline layer as source | Drafting Services Section | Recommended |
| **Measure "K" Street Rehabilitation** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Mello-Roos Districts** | Digitize from base map data; aggregate layers as needed | GIS Specialist; Redevelopment Agency | Recommended |
| **Neighborhood Watch Areas** | Digitize from base map data; GPS field work (if needed) | GIS Specialist; Drafting Services Section | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Oak Trees (Heritage)** | GPS field work; validation may be possible using aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Parcels** | Acquire from Yolo County | Yolo County ( and GIS Data Services Vendor) | Recommended |
| **Park benches** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park Facilities** | Query from address point layer; attribute as needed; digitize from base map data; GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park lights** | Extract, cleanse, and map based on Excel spreadsheet maintained by Parks & Recreation Department | Drafting Services Section; GIS Specialist | Recommended |
| **Park signs** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park tables** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park trash receptacles** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park tree canopies** | Digitize from aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Parks** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Parolees** | Extract, geocode, and map from Parole download (available from California Department of Corrections) http://www.corr.ca.gov/ | Automated | Recommended |
| **Planning Division-specific Projects** | Extract, cleanse, geocode and map from Access database | GIS Specialist; Planning | Recommended |
| **Police Beats** | Digitize from base map data; other map sources as needed | GIS Specialist; Crime Analyst | Recommended |
| **Police Department Special Projects** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Police Station Location** | Manually digitize points from aerial photography and address sources | GIS Specialist; Drafting Services Section | Recommended |
| **Port** | Digitize features from aerial photographs and other maps | Drafting Services Section; GIS Specialist | Recommended |
| **Real Estate Sales** | Geocode and map from MLS database | Automated | Recommended |
| **Reclamation District Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Record of Survey Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Redevelopment Project Areas** | Digitize from base map data; aggregate layers as needed | GIS Specialist | Recommended |
| **Rehabilitation Projects** | Extract, cleanse, geocode and map from Access database | Automated | Recommended |
| **Schools** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Sewer Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Sewer Fees Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Sexual Offender Locations** | Extract, cleans, and automatically map from VisionAIR; Megan's Law Database | Crime Analyst & GIS Specialist | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Sidewalk Trip Hazards** | Based on citizen complaints; potentially GPS field work | Drafting Services Section | Recommended |
| **Signs** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Site Location Base Map** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Existing |
| **Social Service Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Speed Zones** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Recommended |
| **Sphere of Influence** | Acquire, geocode, and map locations; rectify utilizing base map data; derive spheres of influence through buffers | Drafting Services Section | Recommended |
| **Storm Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Storm Drain Fee Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Street Trees** | GPS field work; validation may be possible using aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Streets** | Derived from aerial photography; GIS Consortium | Drafting Services Section | Existing |
| **Street-Sweeping Routes** | Query route segments from existing street centerline layer | Drafting Services Section | Recommended |
| **Striping & Pavement Markings** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Recommended |
| **Tax Assessment Districts** | Aggregate parcels and assessor data; other sources, such aerial photography, as needed | GIS Specialist | Recommended |
| **Telecommunication Facilities** | Aggregate from telecommunications | GIS Specialist; Automated | Recommended |
| **Traffic Accidents** | Extract, cleanse, geocode, and map from Crossroads database | GIS Specialist; Engineer; (Crime Analyst) | Recommended |
| **Traffic Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Traffic Calming Devices** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Traffic Counts** | Extract, cleanse, geocode and map from Crossroads database | GIS Specialist | Recommended |
| **Traffic Signals** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Transit Routes** | Derive from street centerline layer; acquire from SACOG? | Drafting Services Section | Recommended |
| **Trees (Parks)** | Digitize from aerial photographs and existing maps | GIS Specialist | Recommended |
| **Truck Routes** | Derive from street centerline layer | Drafting Services Section | Recommended |
| **Under-utilized Buildings** | Query from parcel layer; other sources as needed | GIS Specialist; Redevelopment Agency | Recommended |
| **Vacant Properties** | Query from parcel layer; other sources as needed | GIS Specialist (eventually automated) | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Water Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Water Meters** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Water Quality Complaints** | Extract, cleanse, geocode, and map from complaints database (TBD) | Automated | Recommended |
| **Waterways** | Digitize polygons from aerial photographs and existing maps | Drafting Services Section; GIS Specialist | Recommended |
| **Work Orders** | Extract, cleanse, geocode, and map from work order database (TBD) | Automated | Recommended |
| **Zoning** | Based on existing maps; General Plan | Drafting Services Section | Existing |

Please refer to Chapter 4: Base Map Creation and Consideration for more information on base layers. Appendix IV: Master Data Layer List also provides this comprehensive listing of all recommended GIS data layers.

## GIS Applications

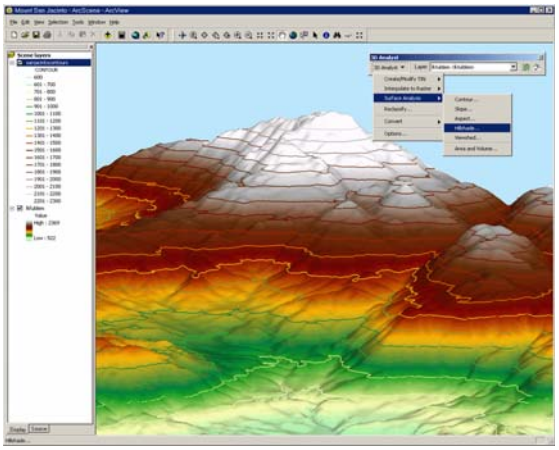
To meet the Division's GIS goals the following GIS software is recommended. A detailed description of each of the recommended applications, where applicable, is provided in the Enterprise-wide application section later in this chapter.

### ArcGIS 9

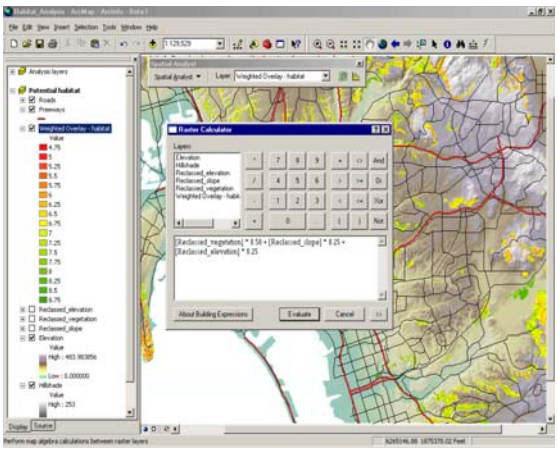
The full ArcGIS 9 suite (ArcInfo, ArcEditor, and ArcView) is recommended for use by Information Technology personnel. A description of ArcGIS applications is provided in the Enterprise-Wide Applications section of this chapter. One (1) license of ArcGIS is recommended for use by the GIS Specialist. The City may wish to utilize a license server in order for this license to be shared by users within the Division.

*ArcGIS Extensions*

Additional ArcGIS extensions, such as 3D Analyst, Network Analyst, and Spatial Analyst, are also recommended for use by the GIS Specialist. These extensions are not included with ArcGIS, and will need to be procured to provide additional analysis capabilities.



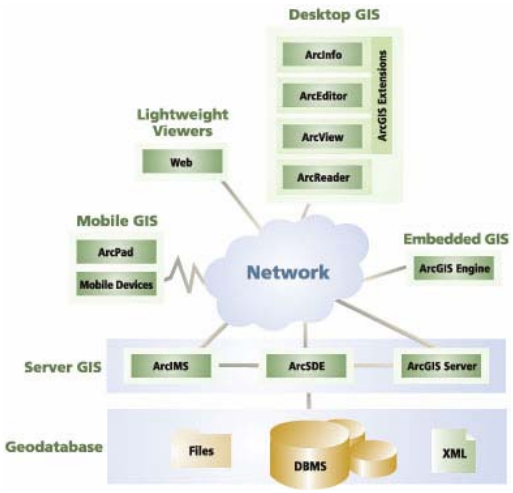
***ArcGIS 3D Analyst***



***ArcGIS Spatial Analyst***

## ArcSDE 9

The Division will need to assist with the deployment of ArcSDE. ArcSDE is a server software product used to access large multi-user geographic databases stored in relational database management systems (RDBMSs). At present the Department is using SQL Server as the RDBMS for ArcSDE. It is an integrated part of ArcGIS and a core element of any enterprise GIS solution. ArcSDE serves as a GIS gateway to spatial data stored in a RDBMS.




ArcSDE provides a suite of services that enhance data management performance, extend the range of data types that can be stored in a RDBMS, enable schema portability between RDBMSs, and offer configuration flexibility.

ArcSDE functionality includes:

- Serves spatial data to ArcGIS Desktop (ArcReader, ArcView, ArcEditor, and ArcInfo), to Internet clients through ArcIMS, and to applications developed with ArcGIS Engine and ArcGIS Server.
- Serve ESRI's file-based data using ArcSDE for Coverage's
- Manage geographic information in one of four commercial databases—IBM's DB2 Universal Database and Informix Dynamic Server, Oracle, and Microsoft SQL Server

It is recommended that once ArcSDE is acquired, that the Division maintain and manage an ArcSDE/SQL Server configuration with assistance from the GIS Specialist. As aforementioned, it is recommended that the Division utilize this configuration as the basis for an enterprise-wide geodatabase. All applicable departmental data will need to be migrated to the geodatabase format in order to facilitate data sharing between the City's various departments.

## ArcIMS

ArcIMS is a server-based product that provides a scalable framework for distributing GIS services and data over the Web. Currently ArcIMS is used as a platform to serve data for the City's LGweb data browser.

ArcIMS provides Web publishing of GIS maps, data, and metadata for access by many users both inside the organization and outside on the World Wide Web. ArcIMS enables Web sites to serve GIS data, interactive maps, metadata catalogs, and focused GIS applications. ArcIMS users access these services through their Web browsers using HTML or Java applications that are included with ArcIMS.

In addition, ArcIMS services can be accessed using many different clients including ArcGIS Desktop, custom applications created using ArcGIS Engine, ArcReader, ArcPad, ArcGIS Server, MapObjects—Java Edition, and a wide variety of mobile and wireless devices.

ArcIMS will serve as the foundation for the City's Internet GIS Data Browser, which will provide public access to the City's geo-spatial data.

## Intranet GIS Data Browser

An Intranet GIS Data Browser is recommended for implementation City-wide, on all networked City government computers. An Intranet GIS Data Browser is an easy-to-learn and easy-to-use web-based GIS application. It provides easy access to all City employees to display, query, and analyze spatial information about many aspects of the City. In contrast to an Internet GIS Data Browser, the Intranet GIS Data Browser may contain spatial layers or connect to databases that the City may not wish to share with the public. For more information on the recommended Intranet GIS Data Browser, please refer to the Enterprise-Wide Applications section of this Departmental GIS Needs Assessment Chapter.

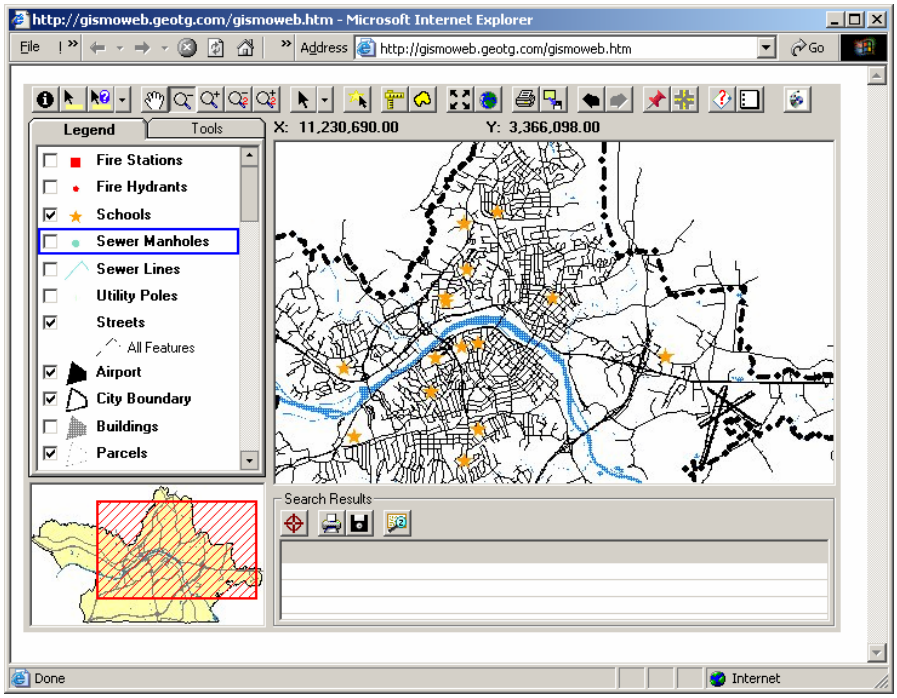



***Figure IT-1.2 Example of an Intranet GIS Data Browser***

## Internet GIS Data Browser

An ArcIMS-based Internet GIS data browser has been recommended to provide citizen's with access to the City's geo-spatial data. Leveraging the City's existing ArcIMS platform, the City will need to develop an enterprise-wide Internet GIS data browser to provide the public with access to geo-spatial property data. A description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

## Safe Feature Manipulation Engine (FME)

Safe Software produces a valuable spatial data conversion and data manipulation application called FME. The GIS Specialist identified several potential uses for FME, including CADD to Shapefiles conversion, automated data extraction and manipulation routines, and data migration/integration. Recommendations for GeoManager, a less robust data extraction and transformation application, are made for other City departments/divisions; the GeoManager application provides a less expensive solution that can be used in conjunction with FME or as an alternative tool to perform several automation/geocoding tasks. The decision for which extract/transform/load (ETL) application will be used will be left to the discretion of the GIS Specialist.

FME is an ETL tool for spatial data. It consists of three main components: a translator, a transformation editor and a viewer. FME Suite also includes developer tools and coordinate conversion support. FME integrates directly with ArcGIS and other GIS applications, such as GeoMedia and MapPoint.

*Translation*

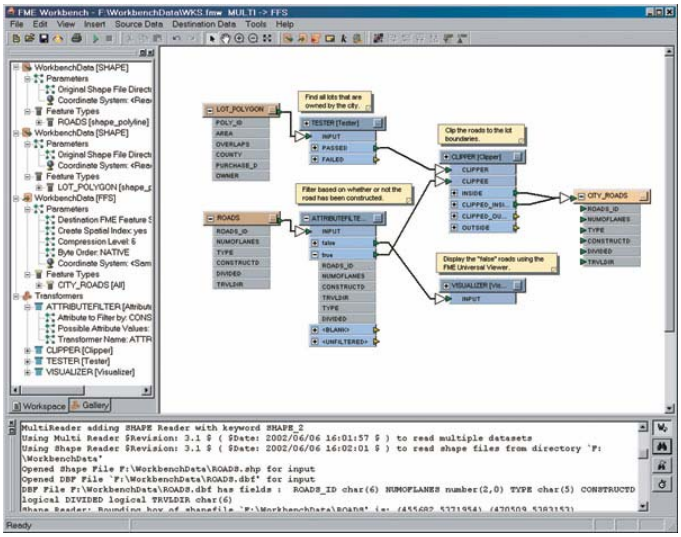
FME Universal Translator: Users can quickly and easily perform basic translations using the supplied defaults; advanced users can perform more sophisticated processing by creating and running their own mapping files.

*Transformation*

FME Workbench: Users control data translation and transformation tasks by graphically adjusting the way data flows from its source to the destination.

*Viewing*

FME Universal Viewer: Users can view multiple datasets before, after and even during a translation. Users can also examine features, identify attributes and values, and enhance the display using color, symbols and labeling.

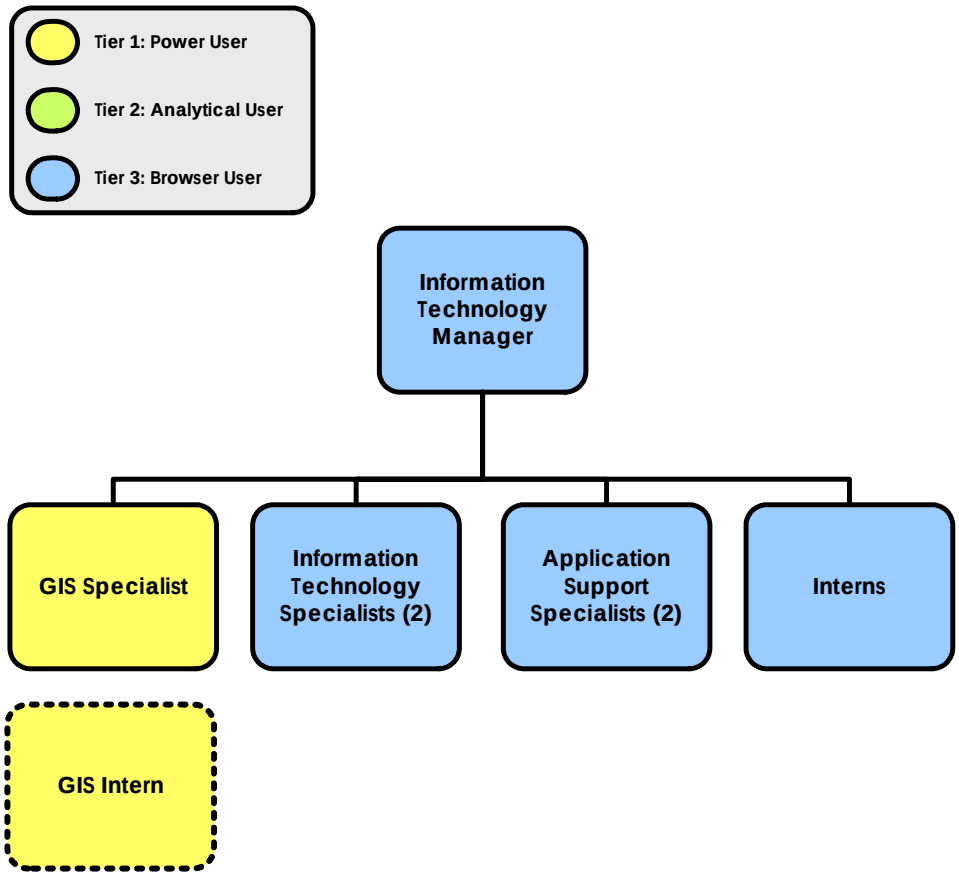


**FME's Workbench**

More information is available at http://www.safe.com

## Multi-Tier GIS Application Use within the Information Technology Division

The following chart describes the recommended GIS application use by the Information Technology Division. A Tier 1 user is a power GIS user who should have access to a fully functioning GIS toolset. A Tier 2 users focus is data analysis in addition to general browsing capabilities. A Tier 3 user requires only general browsing GIS data functions. The Information Technology Division will consist primarily of Tier 3 users, although some staff have technical knowledge and understanding of GIS such that they can be considered Tier 2 users; the GIS Specialist is a Tier 1 user.




***Information Technology Division Multi-Tier GIS Application Use***

# Community Development Department


| | |
|---|---|
| Building Division | 1-28 |
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# Building Division

## Personnel and Duties

The Building Division is part of the Community Development Department. The Division employs three staff members, including:

- Building Official (1)
- Building Permit Manager (1)
- Building Permit Technician (1)

The Building Division provides plan checking and building inspection services for all kinds of construction in the City. The City has continued the contract with Linhart Peterson Powers Associates (Lp2a) to perform Building Division duties, which includes building and fire code plan check and inspections. The Building Official works with the consultant as the contract supervisor and an additional plan checker. Two additional City employees, the Permit Manager and Permit Technician provide administrative and clerical support.

The Division currently does not utilize GIS. GIS users in the Building Division will be Level 3 GIS Users (see Chapter 2: GIS Organizational Structure and Staffing for more information on Level 3 GIS Users).

## Hardware and Software

The Building Division currently has 8 PCs.

All Building Division PCs have the Windows XP or Windows 2000 operating system (citywide standard).

The Building Division uses the following software applications:

1. MS Office
2. Permits Plus (Accela)

The Division currently does not utilize any GIS applications.

## GIS Needs and Duties

The Building Division works closely with other divisions in the Community Development Department, collecting and maintaining important information about building and sewer permits in Accela's Permits Plus database. Several departments will utilize GIS data layers derived from this database, thus maintaining the database accurate and up-to-date is imperative. Building Division personnel indicated that the ability to map and analyze permit data is also a key need within the Division.

The Division has worked closely with the Information Technology Division to produce an online application that allows the public to search for permits via the City's web site. This application has great potential to be integrated with an Internet GIS data browser, thereby providing citizens with the ability to view permit information via a mapping interface (see Public Access to Geo-Spatial Building data below).

Based on this needs assessment, the Building Division has the following GIS needs:

- Mapping and Spatial Analysis of Building Safety Data
- Public Access to Geo-Spatial Building Safety Data

Mapping and Spatial Analysis of Building Safety Data

The Building Division will need to work closely with the GIS Specialist to address short and long-term GIS goals and objectives. A key objective for Building Inspection personnel is the mapping and analysis of building and sewer permits—this objective can be accomplished by linking permit information with a City address point layer (or to a parcel layer). Another key analysis that will allow the Division to enhance its operations is the mapping and analysis of easements and flood zones; mapping these features will yield benefits for other departments as well, such as the Fire Department and the Public Works Department, both of which need this information in case of emergencies.

The Building Division can utilize GIS to assist in several tasks, including:

- Building and sewer inspection location analysis
- Occupancy data mapping and analysis
- Permit fee analysis and mapping
- Mapping easements in relation to inspection locations
- Inspection and code violation mapping and analysis
- Using maps to train personnel
- Code enforcement violations
- Statistical analysis for budgetary preparations

It is recommended that Building personnel utilize an Intranet GIS data browser to conduct basic spatial analysis and produce maps. This Intranet browser will be based on the enterprise-wide Intranet GIS data browser procured by the City (this is an ArcIMS implementation). More information on the Intranet GIS data browser is provided in the Enterprise-Wide Applications section of this chapter. For more advanced analysis and other tasks such as data creation, the Building Division should work with the GIS Specialist, who can use advanced GIS software such as ArcView or ArcInfo to conduct many of these tasks; the GIS Specialist may also be called upon to create cartographic products for the Division. The Division will continue to rely on the Drafting Services Section and the GIS Specialist for data creation and maintenance (see GIS Data Layers below for more information).

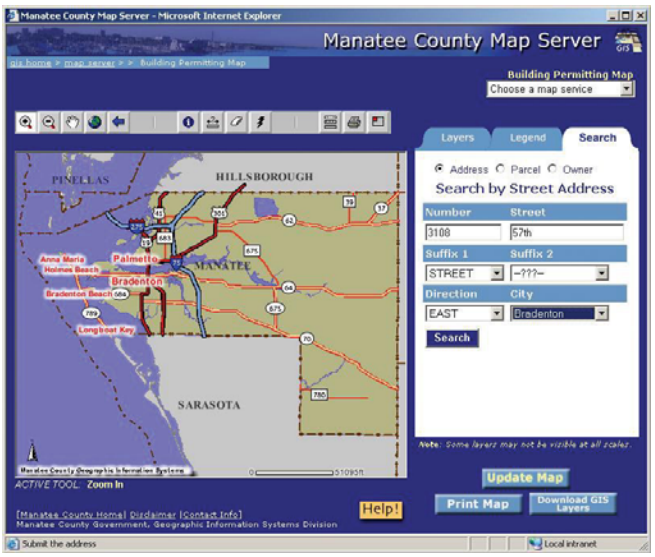
Case Study: Manatee County Building Department Uses GIS for Permitting Work Flow

Located on the central Gulf Coast of Florida, Manatee County government in Bradenton, Florida, serves a population of roughly 290,000 citizens. Like much of south and central Florida, the population in Manatee County has been steadily increasing. Since the 2000 census, an estimated 23,000 people have relocated to the county. Along with this increase in population comes an increase in construction of new buildings and infrastructure. The Manatee County Building Department is responsible for issuing the permits for this construction.

In the past, the Building Department's daily procedures involved tedious parcel-level research using multiple data sources. A good example is the use of cumbersome sets of static paper maps to delineate property boundaries, future land use, zoning, and flood prone areas. The data on these maps is only as current as the day it was produced. Reviewing a permit application using outdated data can lead to a whole host of problems, including legal issues.

*Background*

Well before the groundbreaking of any new construction, an extensive building permit application review is done. During this review, the location of the property, zoning, future land use, flood zones, overlay districts, impact fees, and watersheds are all considered before the issuance of a building permit. The application process can be straightforward if applicants have done their research. On the other hand, if applicants have not done research on the property on which they would like to build, the process can be drawn out and frustrating to both the applicant and the Building Department.




***Manatee County staff are presented with an initial map extent of the entire county and the ability to search for a more specific piece of property.***

*Project Start-Up*

The Manatee County GIS section, housed within the Information Services Department, was started in 1990 with a few workstations and ArcInfo licenses. The main responsibility of the section was to generate base mapping data and create a digital representation of the parcel fabric. As time went on and the true power of GIS was realized, the GIS section's responsibilities grew. In its current form, the GIS section supports any county department needing GIS services. This includes the Planning, Environmental Management, Agriculture and Natural Resources, Utilities, Transportation, and Building Departments.

The range of responsibilities of the GIS section made its goal explicitly clear: an enterprise GIS flexible enough to support the differing needs and skill levels of each department. The first enterprise-minded project tackled was to create a Web-based GIS tailored to the specific needs of the Building Department. The GIS would deliver fast, accurate, and current data within a single user-friendly application, which in turn would streamline the cumbersome permitting work flow. Staff from the GIS section met with staff from the Building Department to determine the users' needs and a scope of work. After several meetings, the scope became clear, and it was time for the GIS section to decide on the method of delivery.

Since the Building Department had a varying number of users with varying skill levels, the GIS section wanted to deploy a thin client application that was easy-to-use and accessible anywhere. After considering many options, ArcIMS was chosen because of its ability to serve browser-based GIS applications, relative ease of customization, and user friendliness. To handle the high volume of traffic anticipated, ArcIMS was installed on a Sunfire 280 server.

In Phase I of application development, the layout and functionality of the interface were created with many user testing and acceptance periods. Once the interface was accepted, Phase II began, which entailed map creation and symbology selection.

*Project Scope*

The initial two phases of the project consisted of providing the following items agreed upon during the user needs assessment:

- A linking of the ArcIMS map service to the building permitting database at the parcel level.
- Property appraiser information with the ability to query by parcel number, owner, secondary owner, business name, address, and secondary address. It was also imperative that queries would include condominiums and apartment complexes.
- Planning information with the ability to view parcel-level information on zoning, land use, future land use, overlay districts, and impact fee districts.
- Federal Emergency Management Agency Flood Insurance Rate Map information with the ability to view parcel-level information on flood zone designations.
- Environmental information with the ability to view parcel-level information on watersheds.
- Base map information including water features, streets, annotation, and aerial photography.
- Printable map with accompanying property data to attach to applications.

*Project Implementation*

The GIS section at Manatee County used a number of different tools in the creation of this application. The application uses ArcIMS 4.0.1, ArcSDE 8.3, Apache 2.0.48, Oracle9i, and Tomcat 4.0.12.

Making all this data available and searchable via a single application has made a previously tedious and time-consuming research effort quick and easy. As a result, the number of applications that can be researched and processed by the Building Department has increased dramatically.

By also making this application available to the public via the Internet, applicants are better prepared beforehand. This not only makes the application process move more efficiently, it in turn cuts down on public foot traffic in the Building Department as well.

**Case Study Courtesy of ESRI ArcNews Magazine*

☑ <u>Public Access to Geo-Spatial Building Safety Data</u>

As aforementioned, a great opportunity exists for the integration of the City's existing online building permit search with a GIS interface to provide the public with the ability to search for permits through input fields or via a mapping interface. Subject to creation (geocoding) of permit layers based on the Permits Plus database, the Division should work with the GIS Specialist and the Information Technology Division to create an application with similar search functionality that will allow users to click on a parcel (or address point) and view permit information.

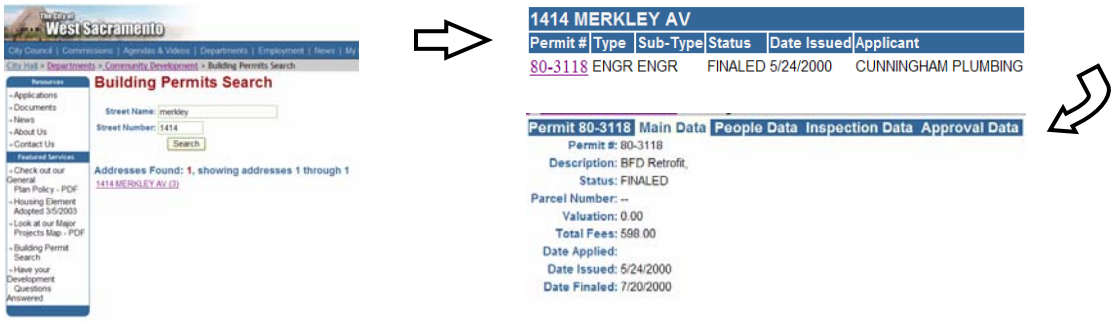



***Figure BD-1.1: Building Permit Search Application on the City's Web Site***

As part of the City's objective to provide an Internet GIS data browser, the Division should coordinate with the GIS Specialist to integrate relevant Building data as GIS data layers into the Internet-based application.

## GIS Data Layers

The Building Division will benefit from access to several other departmental GIS data layers. It is expected that once all departmental data is integrated, consolidated, and centrally stored, that staff will have access to **all** non-classified GIS data layers from other City departments.

Division personnel expressed that access to the following GIS data layers would be beneficial:

| *Data Layer* | *Creation Methodology* | *Recommended Update Division or Individual* | *Existing or Recommended?* |
|---|---|---|---|
| **Address Points** | Extract, cleanse, geocode, and map from Springbrook; georeference based on aerial photography and GPS field work | Automated; GIS Specialist; Drafting Services Section | Recommended |
| **Aerial Photography** | Fly-over with control points | GIS Data Services Vendor | Recommended |
| **Building Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Buildings with Site Plans** | Manually digitize polygons from plans and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Census Data** | Download from Census Bureau →http://www.census.gov/geo/www/census2k.html | GIS Specialist | Recommended |
| **Certificates of Compliance** | Extract, cleanse, geocode and map from Permits Plus database | Automated | Recommended |
| **City-owned Property** | Extract, cleanse, geocode, and map from Yolo County tax roll; other map sources as required | Automated | Recommended |
| **Commercial Addresses** | Extract, cleanse, geocode, and map from Springbrook | Automated | Recommended |
| **Crime Data** | Extract, cleanse, and automatically map from Police VisionAIR database | Automated | Recommended |
| **Easements** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Encroachment Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Enterprise Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Facilities** | Digitize on screen; aggregate layers as needed | Drafting Services Section | Existing |
| **General Plan** | Digitize features from aerial photographs and existing data layer | Drafting Services Section | Recommended |
| **Hazardous Materials** | GPS data collection for location; extract from FirePoint once data is entered | Drafting Services Section; GIS Specialist | Recommended |
| **Land Use** | Digitize polygons from aerial photographs and existing maps; existing CADD data | Drafting Services Section | Existing |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Licensed and Unlicensed Businesses** | Extract, cleanse, geocode, and map from in-house database | Automated | Recommended |
| **Major Intersections** | Use street centerline layer as source | Drafting Services Section | Recommended |
| **Oak Trees (Heritage)** | GPS field work; validation may be possible using aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Parcels** | Acquire from Yolo County | Yolo County ( and GIS Data Services Vendor) | Recommended |
| **Real Estate Sales** | Geocode and map from MLS database | Automated | Recommended |
| **Rehabilitation Projects** | Extract, cleanse, geocode and map from Access database | Automated | Recommended |
| **Schools** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Streets** | Derived from aerial photography; GIS Consortium | Drafting Services Section | Existing |
| **Under-utilized Buildings** | Query from parcel layer; other sources as needed | GIS Specialist; Redevelopment Agency | Recommended |
| **Vacant Properties** | Query from parcel layer; other sources as needed | GIS Specialist (eventually automated) | Recommended |
| **Water Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Waterways** | Digitize polygons from aerial photographs and existing maps | Drafting Services Section; GIS Specialist | Recommended |
| **Zoning** | Based on existing maps; General Plan | Drafting Services Section | Existing |

Additional layers may be required as the Department increases its GIS utilization and incorporates additional field data.

Division staff also identified a need to link digital documents, such as Adobe PDFs for permitted applications, with parcels and address points.

## GIS Applications

### Internet GIS Data Browser

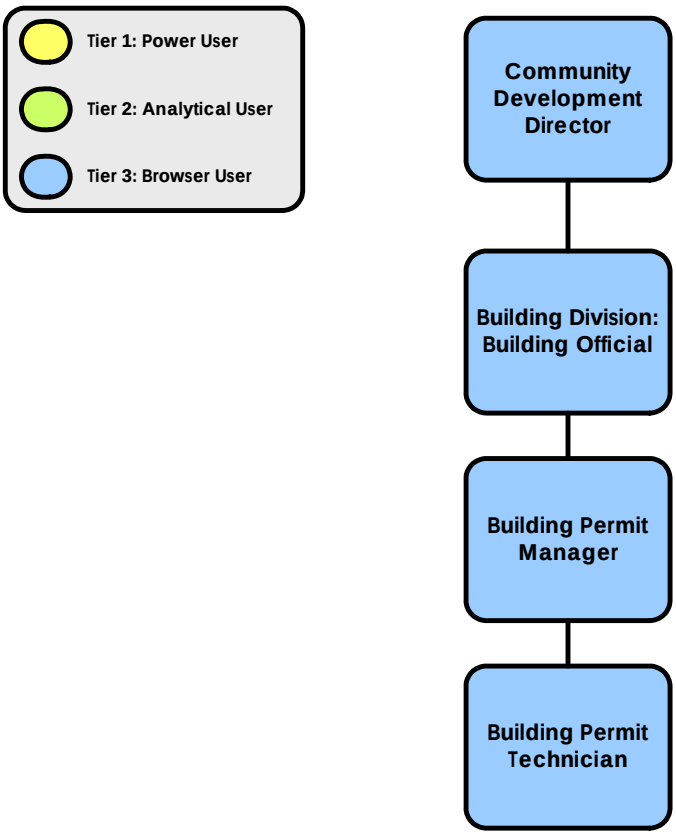
An Internet GIS data browser that includes building permit search functionality has been recommended to provide citizens with access to the City's geo-spatial data, including parcel and building permit information. Leveraging the City's existing ArcIMS platform, the City will need to develop an enterprise-wide Internet GIS data browser to provide the public with access to geo-spatial planning data. A description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### Intranet GIS Data Browser

An Intranet GIS data browser has been recommended for use by Building personnel. The Intranet GIS data browser should provide mapping and analysis capabilities for all personnel. This application will serve as the primary GIS application for the Building Division. A full description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

## Multi-Tier GIS Application Use within the Public Works Department

The following chart describes the recommended GIS application use by the Building Division. A Tier 1 user is a power GIS user who should have access to a fully functioning GIS toolset. A Tier 2 users focus is data analysis in addition to general browsing capabilities. A Tier 3 user requires only general browsing GIS data functions. The Building Division will consist of Tier 3 users.




***Building Division Multi-Tier GIS Application Use***

# Engineering Division

## Personnel and Duties

The Engineering Division employs twenty-six staff members, including:

- City Engineer (1)
- Senior Civil Engineers (2)
- Associate Civil Engineers (4)
- Transportation Engineer (1)
- Junior/Assistant Engineers (2)
- Engineering Assistants III (3)
- Engineering Assistants I/II (4)
- Engineering Technicians III (6)
- Engineering Technicians I/II (1)
- Construction Services Manager (1)
- Real Estate Specialist (1)

In addition to full time staff, the Division typically employs between two and five student interns and up to five contract employees that work on-site.

The Engineering Division is responsible for performing all professional and sub-professional engineering functions for the City. The Division is comprised of CIP Planning and Design, Development, Traffic, and Construction Services sections.

The Division is responsible for a significant number of programs, projects, and tasks, including:

- Administration of the City Capital Improvement Program (CIP)
- Capital Project Planning and Implementation, including Management, Design, Right-of-Way Acquisition and Bidding
- Infrastructure Master Plan Updates
- Encroachment Permitting
- Planning and Design of Public Road, Utility, and Public Facilities Projects
- Construction Contract Administration and Inspection
- Development Project Planning, Coordination and Review
- Subdivision Map and Development Improvement Plan Review
- Subdivision Map and Development Improvement Plan Review
- Permit Review and Land Use Entitlements – Engineering Issues Review
- Traffic Engineering – Planning, Design of Traffic Controls and Operations, Analysis of Traffic Operational Issues, and Residential Traffic Calming
- Liaison Activities with SACOG, YCTD, Reclamation Districts, CalTrans, DWR, Washington Unified School District, and SAFCA
- Citywide AutoCAD Mapping of Parcels, Street Centerline, Right-of-Way and Utilities

The Division uses GIS for mapping and some spatial analysis. The primary GIS users in the Division are personnel in the Drafting Services Section—a separate needs assessment is provided for this Section (please refer to the Drafting Services Section needs assessment in this chapter). This needs assessment addresses GIS use and needs for the other Engineering sections, including Development, Traffic, CIP, and Construction Services.

With the exception of the Drafting Services Section, the majority of GIS users in the Engineering Division will be Level 3 GIS Users; however, some GIS use within the Division will involve more complex mapping and analysis, such as that of Level 2 GIS Users (see Chapter

2: GIS Organizational Structure and Staffing for more information on Level 2 & Level 3 GIS Users).

## Hardware and Software

The Engineering Division currently has over 30 PCs.

All Engineering Division PCs have the Windows XP or Windows 2000 operating system (citywide standard).

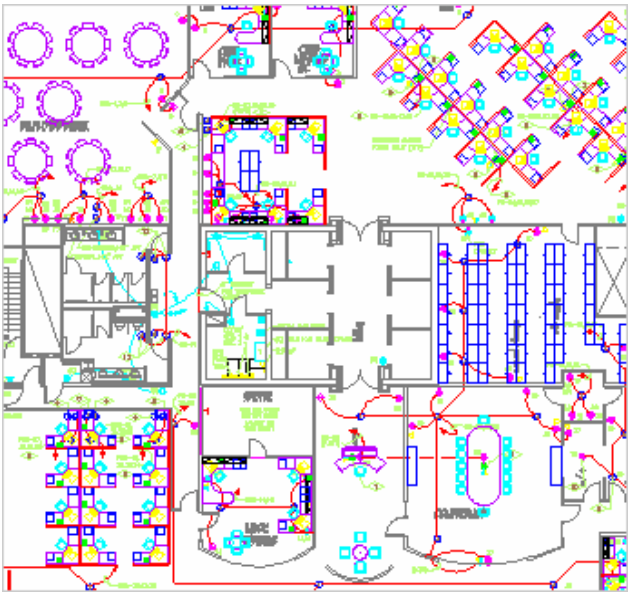
The Engineering Division uses the following software applications:

1. MS Office
2. MS Project
3. MS Visio
4. AutoCAD
5. Crossroads Collision
6. FHA Highway Capacity Software
7. CHEC InfraManager Pavement Management System (PMS)
8. Permits Plus (Accela)

The Division utilizes the aforementioned software in varying capacities. AutoCAD is used by various engineers within the Division.

AutoCAD

AutoCAD is used to view, map, maintain, and modify most of the Division's facility/infrastructure data. AutoCAD is also used for construction and building design.



***Autodesk AutoCAD***

## GIS Needs and Duties

The Engineering Division has the potential to gain various efficiencies by utilizing GIS. The Division's day-to-day (tactical) tasks as well as long-term (strategic) goals require holistic and integrated access to digital data in a variety of forms. The Engineering Division works closely with the Public Works Department—this department can be a major source for GIS data, given that it maintains much of the City's infrastructure. The GIS needs of the Division will need to be addressed with an understanding of this relationship, and the nature of data flow between the Public Works Department and the Engineering Division. The Division's objectives require comprehensive knowledge of various types of spatial data, including

planimetrics, utility and transportation infrastructure, and environmental data. The Engineering Division will need to work closely with the GIS Specialist and the Drafting Services Section to integrate GIS as much as possible with its workflows.

Based on this needs assessment, the Engineering Division has several GIS needs:

- Mapping and spatial analysis of transportation, utility, and facilities infrastructure
- GIS-based transportation infrastructure management
- Field access to geo-spatial data
- GIS-based transportation modeling and analysis
- Automated neighborhood and vicinity mapping
- Public access to Geo-Spatial infrastructure data
- Formal GIS training for Engineering Division staff

The Engineering Division's GIS needs are closely linked to the other divisions within the Community Development Department. The Drafting Services Section in the Engineering Division manages and maintains a majority of the data utilized by the Engineering Division. A key opportunity for all divisions within the Department lies in centralization of CADD/GIS data and distribution of this data via several tiers of GIS applications. It is expected that Engineering personnel will gradually garner greater involvement in infrastructure/facility GIS data production, maintenance, and management, as technical knowledge and resources within the Division increase.

It is recommended that the Division continue to work with the Drafting Services Section for CADD/GIS data management and maintenance. For mapping and spatial analysis GIS support, the Engineering Division should work with the GIS Specialist, who will use GIS software such as ArcEditor or ArcInfo to conduct additional mapping and analysis tasks; the GIS Specialist may also be called upon to create other cartographic products for the Engineering Division.

It is also recommended that the Division implement an ArcIMS-based Intranet GIS data browser to provide staff with access to mapping and spatial analysis functionality. This GIS data browser should include the ability for staff to view updated Division-specific information as well as the City's base GIS data layers.

Mapping and Spatial Analysis of Transportation, Utility, and Facilities Infrastructure

A key need identified by Engineering Division personnel is increased and improved use of GIS to map and analyze transportation, utility, and facilities data. A variety of Engineering projects and tasks require the ability to produce maps and derive information from spatial analyses, including permitting, development projects, transportation infrastructure (roads, signs, signals, etc.), traffic accidents, utility infrastructure (water and sewer lines, valves, manholes, etc.), and land use.

The Engineering Division identified that it could utilize GIS to assist in several tasks, including:

- Proposed construction and development location analysis
- Infrastructure mapping and analysis
- Automated land use mapping for traffic, water, and sewer modeling
- Tracking tentative maps and automating calculation of development impact fees
- Accurately mapping and maintaining Underground Services Alert (U.S.A) utility markings
- Linking as-built drawings to GIS data
- Project activity mapping
- Lot line adjustment/merger mapping

- Impact fees and permits mapping
- Assessor/parcel mapping and analysis
- Complaint tracking, mapping, and analysis
- Production of maps for public meetings and exhibitions
- Statistical analysis for budgetary preparations

Many of these mapping and analysis tasks can be automated by spatially enabling databases (such as Permits Plus) and producing regularly updates layers that can be used for mapping and spatial analysis via a GIS data browser; a key factor in this effort will be the coordination of database updates with other Community Development divisions as well as other City departments. For example, A GIS-based work order system has been recommended for use by Public Works personnel—it is expected that successful implementation of such a system will allow the Engineering Division to access updated information with regard to maintenance/repairs for infrastructure. Other database information, such as the Finance Department's utility billing data will be spatially enabled and accessible as a GIS data layer.

The Division's Development section currently has an existing set of digital submission standards. These standards should be leveraged for use with other digital data submitted than can be integrated with the City's GIS. In addition, the Division should work with the GIS Specialist to establish additional standards, if necessary, for digital map/data submission from developers—this effort should be carried out in conjunction with the Planning Division, which could benefit from use of the same or similar submission standards for digital data.

Case Study: Innovative Methods Speed Curb Ramp Survey

Although an accessible city has been the goal of many public works officials, city engineers, and urban planners who design cities, federal legislation now mandates that cities ensure that infrastructure, such as sidewalks, may be used by everyone. Traditional desktop GIS and the emerging field of mobile GIS are proving invaluable tools in meeting the requirements of the Americans with Disabilities Act (ADA). GIS is helping officials understand ADA compliance and identify improvements needed to achieve it.

Field-workers conducting the survey were deployed on bicycles equipped with iPAQs. After identifying and confirming each curb ramp location, the worker entered its location and added required information to the ArcPad form.

*Locating Curb Ramps*

In a proactive move by the city of Oakland, California, the Public Works Agency (PWA) ordered a comprehensive inventory of the city's curb ramps. ADA legislation gives specific guidelines regarding the design of curb ramps so they are accessible by persons with mobility or visual impairments. Although the city had a robust database of city streets and parcels, no data existed on curb ramps. Because curb ramps are frequently located underneath trees, this information could not be extracted from existing data layers or interpreted from the city's air photo database. PWA needed a complete intersection survey of the entire city.

*Pen and Paper Inventorying*

Previously, this type of infrastructure inventory would be done with pen and paper. Workers, sent into the field with clipboards, maps, and survey forms, would log each curb. After the initial survey, the collected data would be entered—record by record—into a GIS program. Only then could maps be generated and spatial analyses performed. This process is not only time consuming and expensive but also subject to error when paper notes are converted to

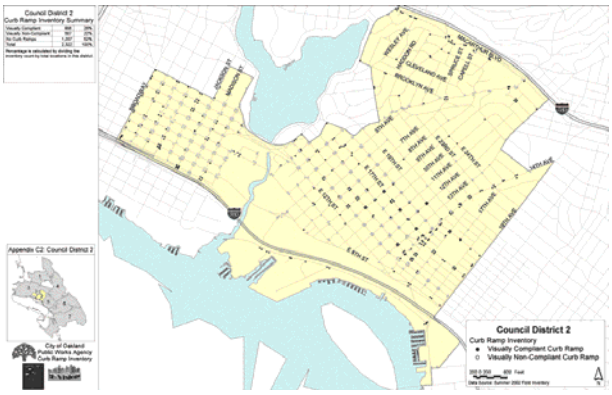
digital data. For Oakland, which encompasses 53.8 square miles and includes 835 miles of streets, the traditional paper-pen method would have meant months of data gathering and weeks of data entry. This would have made the project too expensive to be feasible.

*Developing a Solution*

Previous projects focused on supplying attribute data to preexisting polygon layers, typically parcel files. The Oakland project required the creation of a new point layer showing curb ramp locations.

The comprehensive inventory of Oakland's curb ramps produced a final data layer of approximately 20,000 points that showed the locations of ADA- and non-ADA-compliant curb ramps.

ArcPad has proven to be an important tool for creating user-friendly data capture forms for mobile GIS applications. With the recent release of ArcPad 6 and ArcPad Application Builder, forms can be quickly built and deployed. The ability to utilize Visual Basic Scripting (VBScript), new with ArcPad 6, allows for an extra level of data validation and data quality assurance. ArcPad in the Hewlett–Packard iPAQ handheld computer has proven to be a cost-effective platform for mobile GIS.




***Field-workers conducting the survey were deployed on bicycles equipped with iPAQs. After identifying and confirming each curb ramp location, the worker entered its location and added required information to the ArcPad form.***

Working with the city of Oakland a mapping and surveying consulting company helped determine the inventory needs and parameters for the project. This required defining what constituted a curb ramp and an obstruction to a ramp and what was necessary for a ramp to be ADA compliant. Training material was needed to ensure that the field surveyors understood the rating criteria. Also, a survey of this scope provided a unique opportunity for additional data to be gathered.

*Conducting the Survey*

The final surveying tool was built using the City's street centerline layer. However, to accommodate the limitations of the memory and processing speed of the iPAQs, the street layer was clipped to the city's planning areas. These clipped sections were distributed to field surveyors each day. This street layer was essentially a rubber sheet, which provided a reference layer that field-workers could use to place curb ramp points.

Field surveys are typically conducted from a vehicle or on foot. For efficiency, the field-workers were deployed on bicycles in teams of two and assigned to specific inventory areas each day. The iPAQs were mounted on each bicycle's handlebars. After identifying and confirming a location, a surveyor would enter its location as a point. A form containing the city's parameters for curb inventorying would then appear on the iPAQ, and the worker would fill in the required information. Each afternoon, data from the iPAQs was downloaded and integrated into a central database.

The final data layer of approximately 20,000 points fulfilled two purposes. Maps of the results were prepared in ArcView. The curb ramp data identified the location of ADA- and non-ADA-compliant curb ramps so the city knew how much work was needed for compliance. In

addition, this data also provides the basis for a capital improvement plan estimate that can be developed to fund future projects for ADA compliance for the city of Oakland.

**Case Study Courtesy of ESRI ArcNews Magazine*

GIS-Based Transportation Infrastructure Management

The Division's Traffic Section is tasked with administration, review, and management of the City's transportation infrastructure, including traffic signals, signing and striping, roadway geometry, traffic calming, speed surveys, and traffic volumes. GIS can be utilized to enhance many of the Section's efforts for management of the City's transportation infrastructure.

At present, the Division utilizes CHEC Systems InfraManager as its Pavement Management System (PMS). In the short-term, this application can be integrated with various GIS applications, including ArcGIS. It is recommended that the Traffic Section work with the GIS Specialist and the Information Technology Division to leverage the Division's existing investment in the InfraManager PMS by integrating it with ArcGIS; in addition, a third party data extraction application (such as Safe FME or GeoManager) can be used to extract and spatially enable the data maintained within the PMS. Data derived from the PMS will enable mapping and spatial analysis of pavement conditions, projects, and maintenance; in addition, other departments, such as the Public Works Department, will have access via a GIS data browser to the data extracted from the PMS.

As a long-term strategy, it is also recommended that the Division migrate from the current InfraManager system to Cartegraph's suite of transportation infrastructure management applications, including PAVEMENT*view*, BRIDGE*view*, MARKING*view*, SIGNAL*view*, and SIGN*view.* These applications integrate seamlessly with ArcGIS via the MAPdirector interface. This suite of products provides a powerful, user-friendly set of tools that will allow the Division to comprehensively manage all transportation infrastructure assets. More information on the Cartegraph suite of products is provided in the GIS Applications section below.

Field Access to Geo-Spatial Data

Personnel in the Construction Section, as well as staff throughout the Division, will benefit from field access to maps and GIS data. At present, field personnel in each division rely on hard copy maps provided on an ad-hoc basis by the Drafting Services Section. There are two methods for Construction personnel to access spatial information in the field:

I. Map Books
II. Mobile Computers

Map books are recommended as a basic means of providing field personnel with access to updated and accurate maps. Once designed and developed, these map books can provide both short and long-term access for a variety of staff (including part-time workers). Mobile computers, specifically hand-held computers, are recommended as more sophisticated means of providing field personnel with access to dynamic mapping and basic spatial analysis capabilities. Mobile computers are recommended for use in the long term, as field personnel become more familiar with GIS and the need for field-based GIS becomes more prevalent within the Section.

*I. Map Books*

The most cost effective solution for access to spatial information in the field is via map books. Map books can be generated for all Construction staff. Each page can display

a different section of the City or region. The location of pertinent features, such as signs, water, sanitary sewer, and storm water infrastructure, can be displayed on top of base map information, such as labeled streets, tax parcels, and aerial photography. Map books represent an effective means of referencing the location of all pertinent features. As features are changed or added, new map books can be generated to reflect these changes.

*II). Mobile Computers*

A more advanced method for accessing spatial data in the field is through the use of mobile computers, including notebook computers, tablet PCs and hand-held computers. A GIS data browser, such as ESRI's ArcPad, can be loaded on hand-held computers, allowing the same capabilities offered by map books, but also the ability to query attributes, such as streets, infrastructure, and facilities; link to GPS receivers, and more. These mobile computers, configured with ArcPad, can also be used by staff to update information while working in the field.

It is recommended that hand-held computers be purchased for field staff use. A GIS data browser, such as ArcPad, should be loaded onto each hand-held computer. Initially two (2) hand-held computers are recommended for Year 2; an additional two (2) hand-held computers are recommended for Year 3.

It is recommended that the Division have complete and accurate map books created in Year 1 of this three-year phased GIS implementation. Preliminary GIS access via mobile (hand-held) computers for the Construction Section is recommended for Year 2. Comprehensive GIS access (all users) via mobile (hand-held) computers for the Construction Section is recommended for Year 3.

☑ GIS-Based Transportation Modeling and Analysis

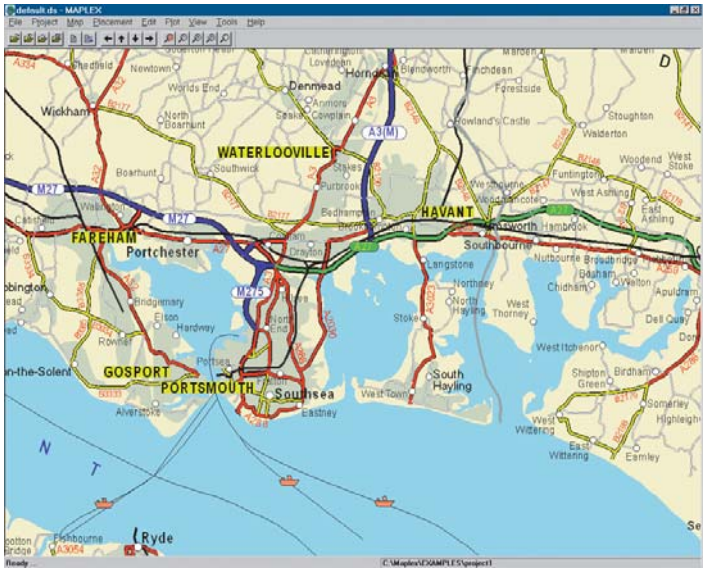
The Traffic Section indicated that it currently utilizes Crossroads Software's Traffic Collision Database. This application can be used to for collision diagrams; collision, citation and DUI record management; queries by location, primary collision factor, collision type, reporting district, highest degree of injury, and other factors; reports for intersection historical and high incidence and other collisions; data analysis of highest degree of injury, collision type & involved with, weather & lighting conditions, and much more. The application requires ESRI's ArcView for use of its GIS functionality.

It is recommended that personnel in the Traffic Section continue to utilize this Traffic Collision Database. The Section should work with the GIS Specialist to procure and implement ArcView for use in conjunction with the database. GIS data layers created from the database (through links to existing GIS data layers, such as streets, or as new geocoded point) should be shared with other departments, primarily the Police and Public Works departments. In addition, it is recommended that the Traffic Collision Database be regularly audited and compared with the Police Department's VisionAIR database, as these two databases maintain similar information.

☑ Automated Neighborhood and Vicinity Mapping

The Engineering Division will be able to better serve its public duties by utilizing an automated mapping application that enables staff members to quickly and efficiently create neighborhood and vicinity maps. At present, there is no automated means for generation of these maps.

It is recommended that a standalone application be developed to address these mapping needs. The application should be based on ESRI technology to facilitate integration with the City's existing/proposed platform and to enable streamlined access to the City's geo-spatial data. Subject to centralization of geo-spatial data in a geodatabase, it is recommended that the Engineering Division work with an outside consultant to custom-develop an ArcGIS-based application for the Division's specific needs. In addition to providing custom automated mapping capabilities, the application should support versioning of data, especially for use in proposed development plans; by using versioning, any approved changes to specific boundaries or land use features can be easily and effectively reconciled with the original data (i.e., central geodatabase). This application should be shared with the Planning Division, which has also received recommendation for an automated neighborhood and vicinity mapping application.




In order to ensure a high cartographic quality in publicly distributed maps, it is recommended that ESRI's Maplex software be integrated with the aforementioned automated mapping application. Maplex is sophisticated, high-end cartographic design software for creating quality labeling and annotation text for map generation. Utilizing an integrated approach that uses both ArcGIS and Maplex will yield cartographic quality products that can be created by both technical and non-technical staff.

***Figure ED-1.1: Maplex Cartographic Output***

An Intranet GIS data browser is an additional resource that can be used by Engineering Division staff to view and map GIS data. It is recommended that the Division utilize an Intranet GIS data browser to provide mapping and spatial analysis capabilities for non-technical staff (more information on this application is provided in the Enterprise-Wide Applications section of this chapter).

☑ <u>Public Access to Geo-Spatial Infrastructure Data</u>

The Engineering Division expressed the need to disseminate spatial information to the public by providing a mapping application that will enable citizens to map various types of City-maintained infrastructure and facilities, traffic and permit information, and impact fee zones via a mapping interface.

As part of the City's objective to provide an Internet GIS data browser, the Division should coordinate with the GIS Specialist to integrate divisional GIS data into the Internet-based application. In addition the Division should identify additional functionality that may be required in addition to the city's base enterprise offering.

More information on Internet GIS data browsers can be found in the Enterprise-Wide Applications section of this chapter.

Formal GIS Training for Engineering Division Staff

Several departments/divisions, including the Engineering Division, will benefit from formal training in GIS. It is recommended that the Engineering Division and the recommended GIS Specialist identify key division staff to receive formal training. More information on training opportunities can be found in Chapter 9: GIS Training and Education.

## GIS Data Layers

The Engineering Division will benefit from access to several other departmental GIS data layers. It is expected that once all departmental data is integrated, consolidated, and centrally stored, that staff will have access to **all** non-classified GIS data layers from other City departments.

Division personnel expressed that access to the following GIS data layers would be beneficial:

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Address Points** | Extract, cleanse, geocode, and map from Springbrook; georeference based on aerial photography and GPS field work | Automated; GIS Specialist; Drafting Services Section | Recommended |
| **Aerial Photography** | Fly-over with control points | GIS Data Services Vendor | Recommended |
| **Backflow Devices** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Bad Bridges** | GPS data collection and integration with existing information | Fire Department; GIS Specialist | Recommended |
| **Bicycle/Pedestrian Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Building Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Buildings with Site Plans** | Manually digitize polygons from plans and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Census Data** | Download from Census Bureau →http://www.census.gov/geo/www/census2k.html | GIS Specialist | Recommended |
| **Certificates of Compliance** | Extract, cleanse, geocode and map from Permits Plus database | Automated | Recommended |
| **City-owned Property** | Extract, cleanse, geocode, and map from Yolo County tax roll; other map sources as required | Automated | Recommended |
| **Commercial Addresses** | Extract, cleanse, geocode, and map from Springbrook | Automated | Recommended |
| **Community Facilities District** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Crime Data** | Extract, cleanse, and automatically map from Police VisionAIR database | Automated | Recommended |
| **Critical Facilities** | Manually digitize points from aerial photography and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Easements** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Encroachment Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Enterprise Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Entrapment Areas** | Manually digitize polygons from aerial photography and other imagery | GIS Specialist | Recommended |
| **Facilities** | Digitize on screen; aggregate layers as needed | Drafting Services Section | Existing |
| **Fire Hydrant Permits** | Extract, cleanse, geocode and map from Permits Plus database (TBD) | Automated | Recommended |
| **Fire Hydrants** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Flood Zones** | Acquire from FEMA (free to government entities) http://www.fema.gov/fhm/ | Drafting Services Section; GIS Specialist | Recommended |
| **General Plan** | Digitize features from aerial photographs and existing data layer | Drafting Services Section; GIS Specialist | Recommended |
| **GPS Monument Map** | GPS field work | Drafting Services Section | Existing |
| **Hazardous Materials** | GPS data collection for location; extract from FirePoint or other database once data is entered | GIS Specialist; YCCESA | Recommended |
| **Housing Condition Data** | Extract, geocode, and map from database | Automated | Recommended |
| **Impervious Surfaces** | Digitize polygons from aerial photographs; derive polygons by raster analysis of remotely-sensed data | Drafting Services Section; GIS Specialist | Recommended |
| **Industrial Pretreatment** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Irrigation lines** | Digitize from as-builts; GPS field work (may be available from GreenTech system) | Drafting Services Section; GIS Specialist | Recommended |
| **Irrigation sprinkler heads** | GPS field work (may be available from GreenTech system) | Drafting Services Section; GIS Specialist | Recommended |
| **Land Use** | Digitize polygons from aerial photographs and existing maps; existing CADD data | Drafting Services Section | Existing |
| **Levees** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Licensed and Unlicensed Businesses** | Extract, cleanse, geocode, and map from Springbrook | Automated | Recommended |
| **Liens** | Extract, cleanse, geocode and map from Springbrook | Automated | Recommended |
| **Lighting and Landscape Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Major Intersections** | Use street centerline layer as source | Drafting Services Section | Recommended |
| **Measure "K" Street Rehabilitation** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Oak Trees (Heritage)** | GPS field work; validation may be possible using aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Parcels** | Acquire from Yolo County | Yolo County ( and GIS Data Services Vendor) | Recommended |
| **Parks** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Police Station Location** | Manually digitize points from aerial photography and address sources | GIS Specialist; Drafting Services Section | Recommended |
| **Port** | Digitize features from aerial photographs and other maps | Drafting Services Section; GIS Specialist | Recommended |
| **Reclamation District Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Record of Survey Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Redevelopment Project Areas** | Digitize from base map data; aggregate layers as needed | GIS Specialist | Recommended |
| **Rehabilitation Projects** | Extract, cleanse, geocode and map from Access database | Automated | Recommended |
| **Schools** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Sewer Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Sewer Fees Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Sidewalk Trip Hazards** | Based on citizen complaints; GPS field work | Drafting Services Section | Recommended |
| **Signs** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Site Location Base Map** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Existing |
| **Speed Zones** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Recommended |
| **Storm Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Storm Drain Fee Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Streets** | Derived from aerial photography; GIS Consortium | Drafting Services Section | Existing |
| **Street-Sweeping Routes** | Query route segments from existing street centerline layer | Drafting Services Section | Recommended |
| **Striping & Pavement Markings** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Recommended |
| **Tax Assessment Districts** | Aggregate parcels and assessor data; other sources, such aerial photography, as needed | GIS Specialist | Recommended |
| **Telecommunication Facilities** | Aggregate from telecommunications | GIS Specialist; Automated | Recommended |
| **Traffic Accidents** | Extract, cleanse, geocode, and map from Crossroads database | GIS Specialist; Engineer; (Crime Analyst) | Recommended |
| **Traffic Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Traffic Calming Devices** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Traffic Counts** | Extract, cleanse, geocode and map from Crossroads database | GIS Specialist | Recommended |
| **Traffic Signals** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Transit Routes** | Derive from street centerline layer; acquire from SACOG? | Drafting Services Section | Recommended |
| **Trees (Parks)** | Digitize from aerial photographs and existing maps | GIS Specialist | Recommended |
| **Truck Routes** | Derive from street centerline layer | Drafting Services Section | Recommended |
| **Under-utilized Buildings** | Query from parcel layer; other sources as needed | GIS Specialist; Redevelopment Agency Intern | Recommended |
| **Vacant Properties** | Query from parcel layer; other sources as needed | GIS Specialist (eventually automated) | Recommended |
| **Water Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Water Meters** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Water Quality Complaints** | Extract, cleanse, geocode, and map from complaints database (TBD) | Automated | Recommended |
| **Waterways** | Digitize polygons from aerial photographs and existing maps | Drafting Services Section; GIS Specialist | Recommended |
| **Work Orders** | Extract, cleanse, geocode, and map from work order database (TBD) | Automated | Recommended |
| **Zoning** | Based on existing maps; General Plan | Drafting Services Section | Existing |

Additional layers may be required as the Division increases its GIS utilization and incorporates additional field data.

Division staff also identified a need to link digital documents, such as Adobe PDFs for permitted applications, with parcels and address points.

## GIS Applications

### Internet GIS Data Browser

An Internet GIS data browser has been recommended to provide citizens with access to the City's geo-spatial data. Leveraging the City's existing ArcIMS platform, the City will need to develop an enterprise-wide Internet GIS data browser to provide the public with access to geo-spatial planning data. A description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### Intranet GIS Data Browser

An Intranet GIS data browser has been recommended for use by Engineering personnel. The Intranet GIS data browser should provide mapping and analysis capabilities for all personnel. This application will serve as the primary GIS application for the Engineering Division. A full description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### ArcGIS 9

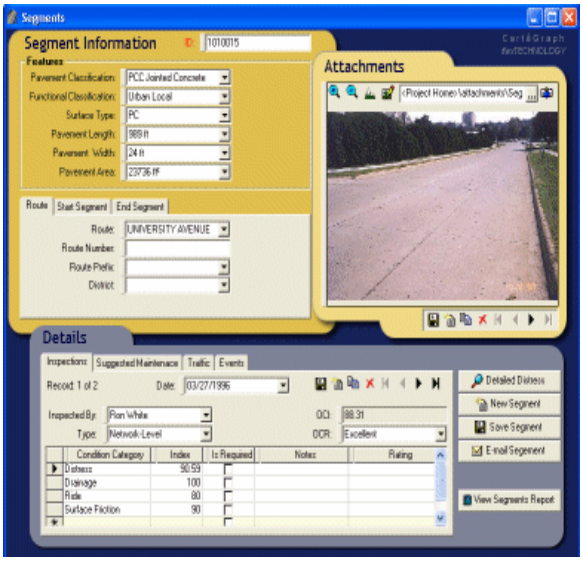
ArcView 9 is recommended for use by Engineering personnel. A description of this application is provided in the Enterprise-Wide Applications section of this chapter. One (1) license of ArcView is recommended for use as a shared resource by engineers in the division.

**GIS for Transportation Network Features: Infrastructure and Pavement Management**

The following describes GTG's recommend solution for GIS-based transportation infrastructure management: CarteGraph Systems, Inc. suite of applications. Cartegraph's MAPdirector allows for integration of all modules with ArcGIS.

CartéGraph makes asset management, work management, GIS, and data collection software for public works and utilities. Specific software modules that are applicable to the Department of Public Works include: PAVEMENT*view*, BRIDGE*view*, MARKING*view*, SIGNAL*view*, and SIGN*view.*

PAVEMENT*view*




PAVEMENT*view* allows users to maintain accurate and up-to-the-minute pavement inventory, inspection and maintenance information for high-volume paved roads to low-volume unpaved roads. PAVEMENT*view* is based on concepts introduced by the Federal Highway Administration and the U.S. Army Corps of Engineers and is suited for both field and office use. PAVEMENT*view* facilitates optimized data collection, improved records accuracy, departmental efficiency, simplified analysis and decision making, streamlined work plan development, and decreased maintenance costs. A pavement management application such as PAVEMENTview is especially important to Public Works and the City of West Sacramento because it facilitates data collection need for GASB 34.

Functionality:

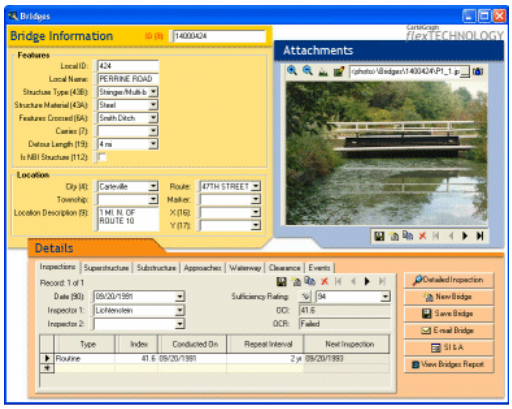
- detailed inventory of paved and unpaved road segments
- inspection records
- location identification
- identify road segment classifications
- queries and reports
- on-line SI&A forms
- reference FHWA (SHRP) and USACE distress libraries and deduct curves
- record ADT history
- establish user-defined Overall Condition Index

BRIDGE*view*

BRIDGE*view* is a tool designed specifically for bridge and culvert management. Bridge and culvert information can be recorded, queried, displayed and reported. BRIDGE*view* is designed to optimize inspection processes, improve record accuracy, streamline SI&A reporting and decrease maintenance costs. BRIDGE*view* facilitates inventory, inspection, appraisal, maintenance and state-specific Structure Inventory and Appraisal (SI&A) information for all structures. *BRIDGEview* is designed according to FHWA guidelines and National Bridge Inventory Standards, BRIDGE*view* and can be used for both the field and office.

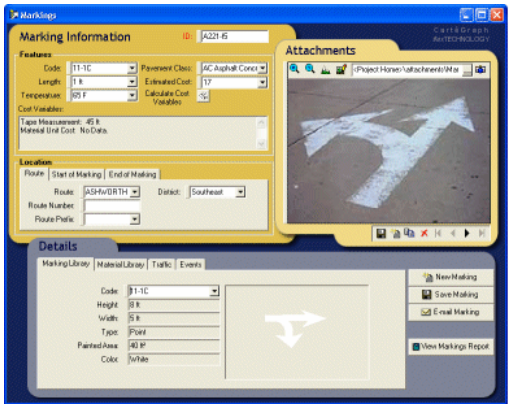
Functionality:

- complete bridge inventory
- inspection records by category and element level
- structure history and database rollback
- queries and reports
- on-line SI&A forms
- complete support for FHWA, NBI and PONTIS data
- check in/check out
- full english and metric support
- SQL server and Microsoft Access support




## MARKING*view*

MARKING*view* is a tool for developing and maintaining a database of intersections, streets and highway pavement markings. View important details including the cost of materials for reapplication, amount of paint needed for reapplication and predicted condition of the marking at any time. In-depth records that include location, features and maintenance history are available with a click of a button and can be used for reporting, budgeting, improving safety and more.



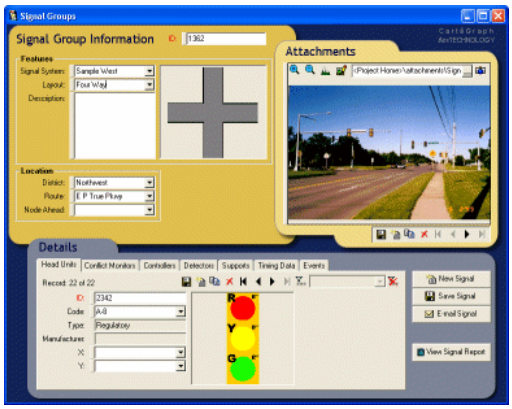

Functionality:

- identify location by vicinity, coordinate, network or intersection
- calculate estimated costs of marking applications automatically
- record data describing how the material was applied
- run queries and reports
- access on-line libraries

## SIGNAL*view*

SIGNAL*view* provides traffic engineers and technicians with a tool for the collection, inventory, maintenance and management of all components in a signal system. Its interface includes tabs on the side of the screen allows users to quickly switch between the five main areas of the program:

- Supports
- Faces
- Detectors
- Controllers
- auxiliary equipment



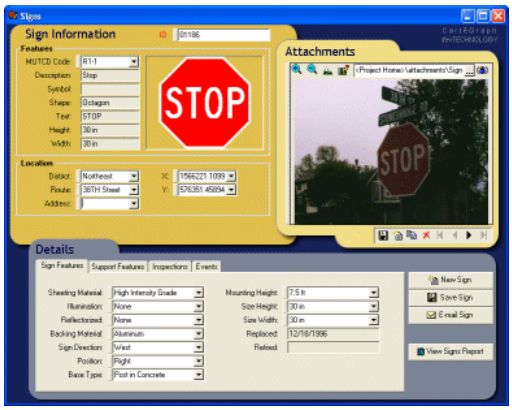

On-line reference libraries facilitate the recording and classification of every component and intersection in your system. SIGNAL*view* is designed for use in the field or in the office.

Functionality:

- inventory faces, supports, detectors, controllers and auxiliary equipment
- location identification
- attach digital images and videos
- queries and reports
- on-line signal libraries
- user-defined data entry fields
  - maintenance/scheduled activities log
  - historical rollback of timing sheets and database fields

## SIGN*view*

SIGN*view*® delivers a practical and efficient approach available for the collection, inventory, maintenance and management of all sign assets. In the field and in the office, SIGN*view* reduces the effort required to create and maintain an accurate, up-to-date sign management database.




SIGN*view* includes an on-line Federal MUTCD library, containing predefined data for all standard signs to help reduce the tedious task of data entry. Select a sign from the library and SIGN*view* automatically records the attribute information. All SIGN*view* libraries can be completely customized to reflect any unique signs organization may have.

Functionality

- detailed inventory of signs and supports
- on-line MUTCD sign library
- location identification
- complete history log
- queries and reports
- attach images and videos
- user-defined data entry fields
- data synchronization with multiple field commands

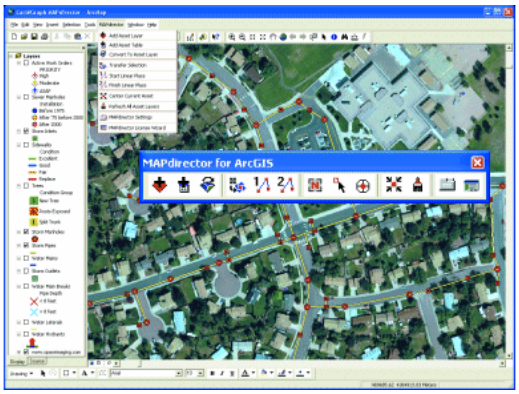
CartéGraph's MAPdirector for ArcGIS gives provides tools to view and manipulate detailed asset information from a CartéGraph database in the ESRI ArcGIS environment.

## MAPdirector

MAPdirector for ArcGIS provides tools to simplify the process of selecting and displaying information on a map, including asset condition, groups of assets, and scheduled versus completed maintenance activities.

MAPdirector for ArcGIS Features include:

- Add Asset Layer Wizard displays assets from a CartéGraph database in an ArcMap Layer
- Customizable symbology for asset graphics
- Pan and zoom
- Placement/editing tools
- Display CartéGraph asset data in tables for data query operations
- Display CartéGraph data records by selecting an asset or group of assets in ArcMap




***Cartegraph MAPdirector***

Additional details can be found at: http://www.cartegraph.com

## ArcPad 6.0

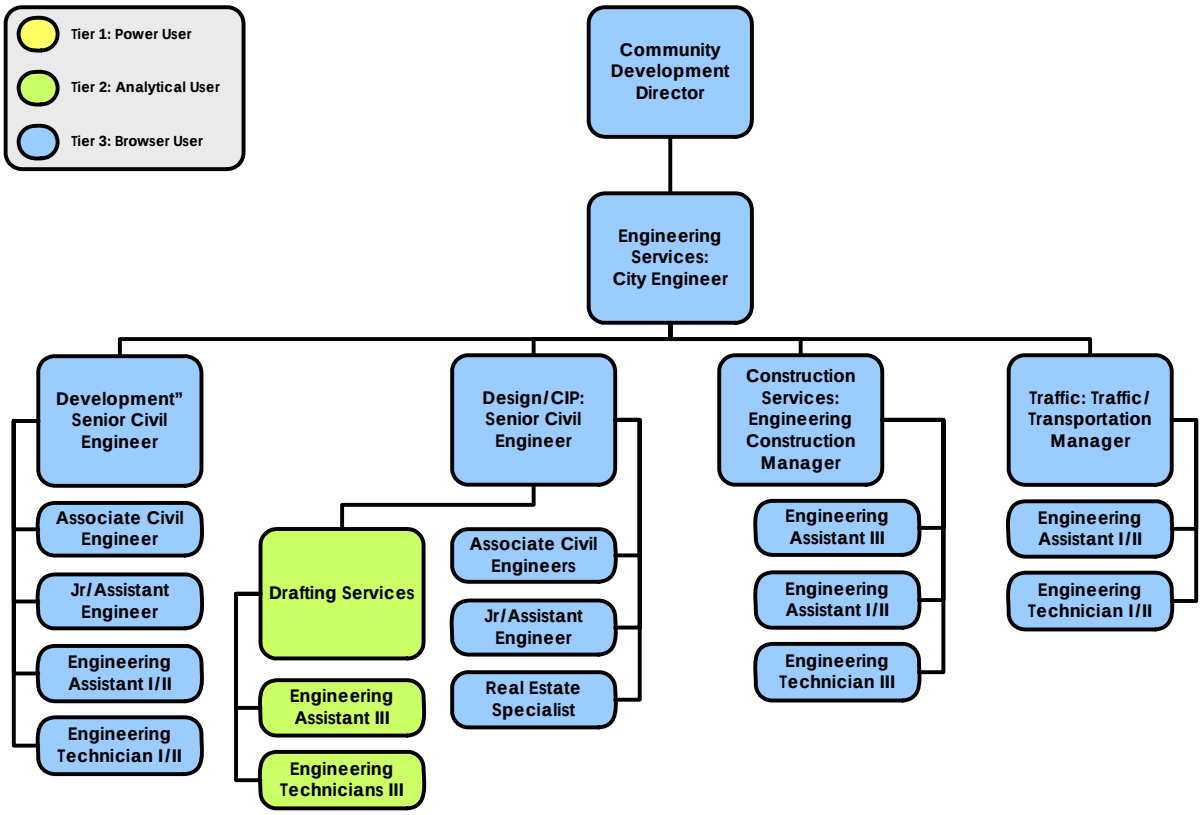
ArcPad software is an easy-to-use, lightweight, low-cost solution for mobile mapping and geographic information systems. ArcPad enhances portable touch screen computers with intuitive mapping, GIS, and GPS functionality. ArcPad makes field data collection fast and easy, improves data accuracy, and provides immediate data availability and validation. It is recommended that ArcPad technology be utilized in the Engineering Division. ArcPad will enhance and streamline activities related to maintenance and field surveys.

With ArcPad 6.0, Engineering personnel can:

- Use existing data - ArcPad supports industry-standard vector and raster image display.
- Add data from the Internet - Data can be provided from the Internet via wireless technology.
- Move around the map - ArcPad includes a number of map navigation tools including zoom and pan, spatial bookmarks, and center on the current GPS position.
- Query data - Identify features, display hyperlinks, and locate features.
- Measure distance, area, and bearings on the map.
- Navigate with GPS - Connect a GPS and with ArcPad.
- Edit data - Create and edit spatial data using input from the mouse pointer, pen, or GPS.
- Extract, convert, and project existing data using ArcGIS Desktop

## Multi-Tier GIS Application Use within the Engineering Division

The following chart describes the recommended GIS application use by the Engineering Division. A Tier 1 user is a power GIS user who should have access to a fully functioning GIS toolset. A Tier 2 users focus is data analysis in addition to general browsing capabilities. A Tier 3 user requires only general browsing GIS data functions. The Engineering Division will consist of Tier 2 and Tier 3 users.




***Engineering Division Multi-Tier GIS Application Use***

# Drafting Services Section

## Personnel and Duties

The Drafting Services Section is part of the Engineering Division. The Section employs five staff members, including:

- Engineering Assistant III (1)
- Engineering Technicians (4)

The Drafting Services Section is responsible for a variety of tasks, including surveying, design drafting, and facilities mapping/GIS.

- Surveying
  - GIS: Spatial and non-spatial data gathering activities for facility mapping purposes
  - CIP: Establishment of horizontal and vertical control networks and topographic surveying for Capital Improvement Projects
- Design Drafting (CIP)
  - Preparation of construction drawings, estimates, legal descriptions and plat maps, and division/section database management
- Facilities Mapping/GIS
  - Maintain a variety of City Maps, including but not limited to:
    - Planning Land-use and Zoning Maps
    - Utility Infrastructure System Maps
    - Street, Parcel, and Address Map
    - Specific Maps – Fire Hydrant Map

The Section is a focal point for many of the City's mapping needs—most City departments/divisions indicated their reliance on this Section for the provision of maps. As the City moves forward with its GIS implementation, the Drafting Services Section will play a key role, working closely with the GIS Specialist in meeting the City's data production and maintenance needs. The Engineering Assistant is responsible for organization, coordination, facilitation, and oversight of the Drafting Services Section. Engineering Technicians are responsible for maintaining and producing a variety of digital (primarily CADD data) in support of the Engineering Division as well as other City departments/divisions.

The Section uses GIS for mapping and some spatial analysis. GIS users in the Drafting Services Section will be Level 2 GIS Users, as their primary role will be data production and maintenance; however, some GIS use within the Section will involve some complex mapping and analysis, such as that of Level 1 GIS Users (see Chapter 2: GIS Organizational Structure and Staffing for more information on Level 2 & Level 3 GIS Users).

## Hardware and Software

The Drafting Services Section currently has five PCs as well as a Hewlett Packard printer and scanner.

All Drafting Services Section PCs have the Windows XP or Windows 2000 operating system (citywide standard).

The Drafting Services Section uses the following software applications:

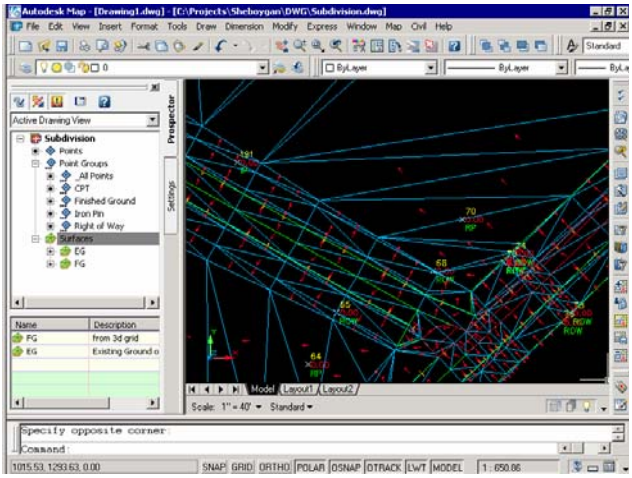
1. MS Office
2. Autodesk Land Desktop

3. Autodesk Civil Design
4. Autodesk Survey
5. Autodesk Map 3D
6. GIS DataPro
7. ArcView
8. Adobe Acrobat

The Section utilizes the aforementioned software in varying capacities. The Autodesk suite of products (CADD), GIS DataPro, and ArcView are used for data creation and mapping. Autodesk Map is the primary mapping application used by the Section, although ArcView is also used, but less frequently than Autodesk Map.

Autodesk Suite

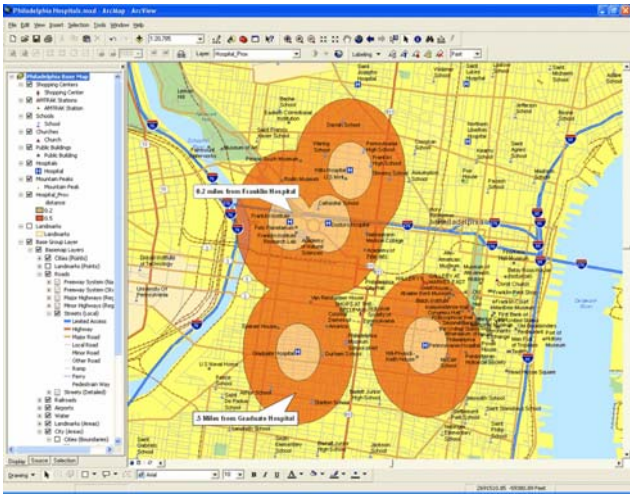
This is the Section's primary mapping and design solution. Autodesk's Land Desktop, Civil Design, Survey, and Map 3D are used to acquire, view, map, maintain, and modify facility/infrastructure data.



***Autodesk Map3D***

ArcView

ArcView is used occasionally to produce GIS data layers (Shapefiles) as well for basic mapping and spatial analysis. ArcView is also used to interface with GIS Data Pro (GPS software), allowing GPS data to be downloaded and converted to a Shapefile.



***ESRI's ArcView***

The Section also has access to GPS surveying hardware purchased by the Engineering Division; this include a Leica GS50+ GPS receiver. This hardware will prove to be a valuable resource for field collection of spatial and non-spatial field data.

## GIS Needs and Duties

The Drafting Services Section has a great opportunity to further integrate GIS to provide mapping support to the Engineering Division, and the City as a whole. It is expected that the City's recent hiring of a GIS Specialist will provide the Section with access to a valuable GIS resource. Establishing a close working relationship between the Drafting Services Section and the GIS Specialist will be crucial for the City's GIS implementation. Several options for geo-spatial data creation and management are present based on a hybrid GIS organizational structure within the City (see Chapter 2: GIS Organizational Structure and Staffing for more information).

It is expected that the Section will continue to maintain most of the City's base map data in the CADD environment; other data layers currently maintained by the Section, such as zoning and land use, will be maintained in the CADD environment and converted to Shapefile or geodatabase for distribution to other departments/divisions. Other data layers maintained by the GIS Specialist, or by both the GIS Specialist and the staff in the Section, ideally should be maintained in geodatabase or Shapefile format. Third party solutions, such as Haestad Methods GISConnect, provide CADD-GIS connectivity which allows users to modify geodatabase and Shapefile layers in the CADD environment (see GIS Applications below).

Based on this needs assessment, the Drafting Services Section has the following GIS needs:

- Coordination of GIS data production and maintenance efforts with GIS Specialist
- Standardization, centralization, and consolidation of geo-spatial data
- Data production and maintenance of base map data
- Data production and maintenance of infrastructure data
- Standards for digital submission of external maps
- Formal GIS training for Drafting Services Section staff

As aforementioned, the Drafting Services Section is and will continue to be a focal point for many of the City's mapping needs. As a result, the Section's GIS needs are closely linked to other divisions within the Community Development Department and other departments within the City. A key opportunity for all divisions/sections within the Community Development Department lies in centralization of CADD/GIS data and distribution of this data via several tiers of GIS applications. Drafting Services personnel will produce and maintain data that is critical for many of the Department's GIS needs. Working in tandem with the GIS Specialist, the Section will yield many benefits and contribute to various successes during the City's continuing implementation of GIS and complementary technologies.

Map data currently maintained by the Drafting Services Section includes:

- City Base Map:
  - <u>Schematic</u> Base Map: To which all other maps are referenced
  - <u>County Rectified</u> Base Map:
    - Addresses, Assessor Parcel Numbers, Lot Numbers
    - Centerline, Street Names
- Facilities Infrastructure Maps (all related to schematic base map:
  - Water system
  - Sewer system
  - Storm Drain system
- Planning Maps:
  - General Land-use map

    - Zoning map
- Fire Maps:
    - Hydrant Location Maps
- Community Facilities District Maps
- Sewer and Storm Drain Fee Map
- GPS Monument Map

It is also recommended that the Section continue to utilize ArcView for mapping and spatial functionality; many of the mapping and analysis requests referred to the Section will be reduced and/or eliminated upon implementation of several GIS applications in other departments/divisions. It is recommended that Drafting Services Section personnel review needs assessments sections for divisions within the Community Development Department and the Public Works Department to become familiar with GIS recommendations that are complementary to the Section's GIS needs (e.g., GIS-based transportation modeling and analysis in the Engineering Division). The Section should implement an Intranet GIS data browser to provide staff with additional access to mapping and spatial analysis functionality; this will also provide staff with familiarity with many of the data layers that will not be maintained by the Section.

☑ Coordination of GIS Data Production and Maintenance Efforts with the GIS Specialist

As aforementioned, the Section's working relationship with the GIS Specialist is crucial for the City's GIS implementation. Needs assessments for various departments/divisions throughout the City identified the need for access to GIS data as well as the creation of new GIS data layers. In addition, the Section identified a need for improved and increased communication with City departments/divisions regarding notification and/or advance notification of final map, parcel map, lot line adjustment, and/or boundary line modification approval by City Council/County recordation. In order to address these needs, it is recommended that the Section work with the GIS Specialist to develop workflows and data production/request protocols to ensure that data production and maintenance efforts are addressed in a timely, standardized manner. The GIS Specialist is expected to work as a technical liaison with external entities, such as Yolo County, to ensure that changes to data/attribute information are acquired in an optimal manner.

The Section should also work with the GIS Specialist to prioritize and schedule data development efforts. Data conversion projects and data creation projects should be assessed to determine scope, level of effort, and duration. Some data conversion efforts can be automated, using a third party solution such as Safe's Feature Manipulation Engine (FME).

☑ Standardization, Centralization, and Consolidation of Geo-spatial Data

It is recommended that the Drafting Services Section work with the GIS Specialist on the standardization, centralization, and consolidation of geo-spatial data. This is a long term goal that should be prioritized, as needed, by the Drafting Services Section and GIS Specialist in conjunction with the City's GIS Steering Committee.

The Drafting Services Section and GIS Specialist will need to establish and formalize the following standards:

- Data formats, coordinate systems, and transfer media
- Coordinate systems and datums
- Coordinate conversion
- Transfer media and backup
- Sharing data via the Internet

- Data creation and maintenance
- Data indexing strategies
- Metadata
- Security protocols

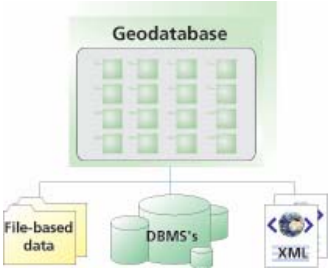
One of the recommendations made in the City's GIS implementation plan is the centralization of the City's geo-spatial data into an enterprise geodatabase. Existing infrastructure, such as SQL Server, should be leveraged to establish this geodatabase. In addition, this effort will provide an opportunity to develop shared, consistent data standards for the City. The initial objective is to provide one source for base map data used by both all departments/divisions. As aforementioned, Drafting Services personnel should continue to produce and maintain core base map data in CADD format. This data will be converted to a geo-spatial format for integration into the enterprise geodatabase on a regular basis (via an automated routine set up by the GIS Specialist).

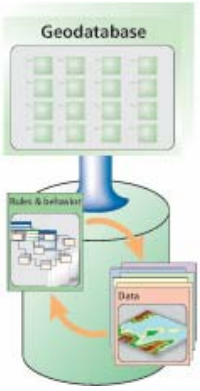
There are two primary recommendations for the management and maintenance of a centralized geodatabase:

A. Migration of Geo-Spatial Data to a Centralized Geodatabase
B. Implementation of Standards for All Geo-Spatial Data

A. Migration of Geo-Spatial Data to a Centralized Geodatabase

As aforementioned, the implementation of an enterprise geodatabase should be performed to provide a centralized data store. Proper training on the installation, configuration, maintenance, and management of the geodatabase is critical.




It is recommended that the GIS Specialist and Drafting Services Section work with the Information Technology Division to ensure that relevant technical staff receives adequate training. After implementation of the enterprise geodatabase, the City's GIS users also will need training and guidance on access and data management within the geodatabase context.

B. Implementation of Standards for All Geo-Spatial Data

Another critical issue in the City's GIS efforts is the implementation of geo-spatial data standards. Using a common standard will enable the City to operate more efficiently by reducing data conversion and by enabling streamlined data distribution internally and externally.

In addition to coordinate system and accuracy standards, the Drafting Services Section should work with the recommended GIS Specialist to develop other geo-spatial data standards, including layer and directory naming conventions, directory structures,

metadata, and index conventions. It should be noted that these standards will apply and support all enterprise geo-spatial data.

Layer Naming Convention: LD_<SCALE>_<LAYER NAME>_<VERSION>_<REVISION>

Example: LD_24000_FIRESTATIONS_2_1

Directory Naming Convention:

- <DEPARTMENT>
  - <THEME A>
  - <THEME B>
    - <SUBTHEME A>
    - <SUBTHEME B>

Example:

- WATER
  - PUMP_STATIONS
  - WATER_QUALITY
    - MONITORS
    - REACHES

***Figure DSS-1.1: Layer and Directory Naming Conventions***

## Data Production and Maintenance of Base Map Data

The Section maintains two base maps, an old schematic map and a new rectified map; both maps are maintained in CADD format. Although the Section is aiming to move away from use of the old map, the map is maintained and updated, as several other maps are referenced to this map. The old map consists of lines and text, and is geographically incorrect. The new base map was acquired from the Yolo County GIS Consortium, which maintains base map data for most cities within the County. The new base map includes addresses, assessor parcel numbers, lot numbers, right-of-way, easements, street centerline, street names, and buildings; object data is attached to the polygons and lines to provide access to attributes. The Section is currently in a transition phase, whereby it is gradually rectifying older map data to the new rectified base map.

It is expected that the Drafting Services Section will continue to update base map data, including parcels and streets within City limits—this data will be submitted to Yolo County GIS Consortium, which will maintain and manage parcels on a countywide basis. The protocol for maintenance and management of base map data is currently being addressed by the GIS Consortium. The Section should continue to work to migrate away from use of the old base map by referencing other map layers to the new base map; this effort should include infrastructure, planning, fire, and all other map layers maintained by the section.

It is recommended that the Drafting Services Section continue to produce and maintain the City's base map data (parcels, street centerlines, and eventually address points), working in close cooperation with the GIS Specialist to address any data sharing or data acquisition issues. It is also recommended that attributes currently maintained as object data for parcels and street centerlines be migrated to the SQL Server environment; primary keys will serve to link the feature geometry data with the tabular data in SQL Server. A proposed workflow for providing City departments/divisions with access to base map layers will encompass automated generation of geo-spatial data that will be linked with attributes in SQL Server via a primary key; thus while base map features will be maintained in the CADD environment, attributes used for GIS data layers will be maintained in the City's SQL Server

environment (see Standardization, Centralization, and Consolidation of Geo-spatial Data above).

☑ Data Production and Maintenance of Infrastructure Data

In addition to base map data, the Section produces and maintains much of the City's infrastructure data. This data includes water, sewer, and storm drain lines in the City. All map data is still referenced to the old base map. Other infrastructure data is produced and maintained for small projects from other departments.

At present, infrastructure map data is not referenced to the new base map; in addition, various types of infrastructure layers, including water, sewer, and storm drain are not up-to-date. Section personnel identified a need for additional staff resources to assist with migration of infrastructure maps to reference the new base map as well as to update various infrastructure features within these maps. Much of the information needed for updates and revision of infrastructure maps is not archived nor recorder in hard copy or digital form—this information resides as legacy knowledge in the Public Works Department.

As with the base map data, it is recommended that the Drafting Services Section continue to produce and maintain the City's infrastructure map data, working in close cooperation with the GIS Specialist to address any data sharing or data acquisition issues. It is also recommended that the Section, Engineering Division, and GIS Specialist work with personnel in the Public Works Department to document and archive all relevant information about the City's infrastructure—this is a much needed effort that will need to be addressed as priority in order to ensure long term success for infrastructure mapping and analysis. It is recommended that infrastructure map layers, once referenced to the new base map, should be converted to a geo-spatial format. However, as with the base map data, a workflow that encompasses automated generation of geo-spatial data linked with attributes in SQL Server is also an option; a long-term goal is to have all relevant attribute data maintained in a centralized data store (see Standardization, Centralization, and Consolidation of Geo-spatial Data above). The advantage of such a setup is that the power and functionality of the database environment can be utilized for queries, reports, and statistics.

☑ Standards for Digital Submission of External Maps

Section personnel identified that externally produced maps range in quality, medium, and global reference accuracy; quality of these maps ranges from hand-drawn sketches to digital maps from surveyors. Digital maps from surveyors sometimes lack global reference, including no coordinate system and/or reference to City monuments. As a result, technicians have had difficulty importing this data and ascertaining its accuracy.

It is recommended that the Section work with the Engineering Division's Development Section and the GIS Specialist to implement and enforce digital submission standards and guidelines. This effort can build on the existing digital submission policy in the City Municipal Code. An internal protocol must be set up to deal with external maps that do not conform to the digital submission standards.

☑ Formal GIS Training for Drafting Services Section Staff

Several departments/divisions, including the Drafting Services Section, will benefit from formal training in GIS. It is recommended that the Drafting Services Section and the recommended GIS Specialist identify key division staff to receive formal training. As some data will be moved to a geo-spatial format, it will become increasingly important to ensure that staff has

the required knowledge and skills to modify and maintain data in a GIS environment. More information on training opportunities can be found in Chapter 9: GIS Training and Education.

## GIS Data Layers

The Drafting Services Section manages and maintains an array of map data utilized throughout City departments. The Section will benefit from access to several other departmental GIS data layers (recommended and existing). It is expected that once all departmental data is integrated, consolidated, and centrally stored, that staff will have access to **all** non-classified GIS data layers from other City departments.

The table below lists all layers, both existing and recommended, identified during the needs assessment process:

| *Data Layer* | *Creation Methodology* | *Recommended Update Division or Individual* | *Existing or Recommended?* |
|---|---|---|---|
| **Address Points** | Extract, cleanse, geocode, and map from Springbrook; georeference based on aerial photography and GPS field work | Automated; GIS Specialist; Drafting Services Section | Recommended |
| **Aerial Photography** | Fly-over with control points | GIS Data Services Vendor | Recommended |
| **Backflow Devices** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Bad Bridges** | GPS data collection and integration with existing information | Fire Department; GIS Specialist | Recommended |
| **Bare Spots - Grass (Parks)** | GPS field work | GIS Specialist | Recommended |
| **Bicycle/Pedestrian Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Building Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Buildings with Site Plans** | Manually digitize polygons from plans and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Census Data** | Download from Census Bureau →http://www.census.gov/geo/www/census2k.html | GIS Specialist | Recommended |
| **Certificates of Compliance** | Extract, cleanse, geocode and map from Permits Plus database | Automated | Recommended |
| **City-owned Property** | Extract, cleanse, geocode, and map from Yolo County tax roll; other map sources as required | Automated | Recommended |
| **Commercial Addresses** | Extract, cleanse, geocode, and map from Springbrook | Automated | Recommended |
| **Community Facilities District** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Crime Data** | Extract, cleanse, and automatically map from Police VisionAIR database | Automated | Recommended |
| **Critical Facilities** | Manually digitize points from aerial photography and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Day Care Facilities** | GPS field work. | GIS Specialist; Redevelopment Agency | Recommended |
| **Drafting Water Sources** | GPS data collection; digitizing from existing maps | Fire Department; GIS Specialist | Recommended |
| **Easements** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Encroachment Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Enterprise Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Entrapment Areas** | Manually digitize polygons from aerial photography and other imagery | GIS Specialist | Recommended |
| **Facilities** | Digitize on screen; aggregate layers as needed | Drafting Services Section | Existing |
| **Fire Hydrant Permits** | Extract, cleanse, geocode and map from Permits Plus database (TBD) | Automated | Recommended |
| **Fire Hydrants** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Fire Incidents** | Extract, cleanse, geocode, and map from FirePoint or in-house database | Automated | Recommended |
| **Fire Inspections** | Extract, cleanse, geocode, and map from FirePoint or in-house database | Automated | Recommended |
| **Fire Investigations** | Extract, cleanse, geocode, and map from FirePoint or in-house database | Automated | Recommended |
| **Flood Zones** | Acquire from FEMA (free to government entities) http://www.fema.gov/fhm/ | Drafting Services Section; GIS Specialist | Recommended |
| **GCI Special Plan and Special Study Areas** | Digitize from base map data; aggregate layers as needed | GIS Specialist | Recommended |
| **General Plan** | Digitize features from aerial photographs and existing data layer | Drafting Services Section | Recommended |
| **GPS Monument Map** | GPS field work | Drafting Services Section | Existing |
| **Hazardous Materials** | GPS data collection for location; extract from FirePoint or other database once data is entered | GIS Specialist; Fire HAZMAT Manager | Recommended |
| **Housing Condition Data** | Extract, geocode, and map from database | Automated | Recommended |
| **HUB Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Impervious Surfaces** | Digitize polygons from aerial photographs; derive polygons by raster analysis of remotely-sensed data | Drafting Services Section; GIS Specialist | Recommended |
| **Industrial Pretreatment** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Irrigation lines** | Digitize from as-builts; GPS field work (may be available from GreenTech system) | Drafting Services Section; GIS Specialist | Recommended |
| **Irrigation sprinkler heads** | GPS field work (may be available from GreenTech system) | Drafting Services Section; GIS Specialist | Recommended |
| **Labor Force** | TBD | GIS Specialist | Recommended |
| **Land Use** | Digitize polygons from aerial photographs and general plan maps; existing CADD data | Drafting Services Section | Existing |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Levees** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Licensed and Unlicensed Businesses** | Extract, cleanse, geocode, and map from in-house database | Automated | Recommended |
| **Liens** | Extract, cleanse, geocode and map from Springbrook | Automated | Recommended |
| **Lighting and Landscape Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Liquor Licenses** | Acquire from state ABC database; geocode and georeference using base layers | GIS Specialist; Drafting Services Section | Recommended |
| **Major Intersections** | Use street centerline layer as source | Drafting Services Section | Recommended |
| **Measure "K" Street Rehabilitation** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Mello-Roos Districts** | Digitize from base map data; aggregate layers as needed | GIS Specialist; Redevelopment Agency | Recommended |
| **Neighborhood Watch Areas** | Digitize from base map data; GPS field work (if needed) | GIS Specialist; Drafting Services Section | Recommended |
| **Oak Trees (Heritage)** | GPS field work; validation may be possible using aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Parcels** | Acquire from Yolo County | Yolo County ( and GIS Data Services Vendor) | Recommended |
| **Park benches** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park Facilities** | Query from address point layer; attribute as needed; digitize from base map data; GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park lights** | Extract, cleanse, and map based on Excel spreadsheet maintained by Parks & Recreation Department | Drafting Services Section; GIS Specialist | Recommended |
| **Park signs** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park tables** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park trash receptacles** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park tree canopies** | Digitize from aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Parks** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Parolees** | Extract, geocode, and map from Parole download (available from California Department of Corrections) http://www.corr.ca.gov/ | Automated | Recommended |
| **Planning Division-specific Projects** | Extract, cleanse, geocode and map from Access database | GIS Specialist; Planning | Recommended |
| **Police Beats** | Digitize from base map data; other map sources as needed | GIS Specialist; Crime Analyst | Recommended |
| **Police Department Special Projects** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Police Station Location** | Manually digitize points from aerial photography and address sources | GIS Specialist; Drafting Services Section | Recommended |
| **Port** | Digitize features from aerial photographs and other maps | Drafting Services Section; GIS Specialist | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Real Estate Sales** | Geocode and map from MLS database | Automated | Recommended |
| **Reclamation District Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Record of Survey Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Redevelopment Project Areas** | Digitize from base map data; aggregate layers as needed | GIS Specialist | Recommended |
| **Rehabilitation Projects** | Extract, cleanse, geocode and map from Access database | Automated | Recommended |
| **Schools** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Sewer Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Sewer Fees Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Sexual Offender Locations** | Extract, cleans, and automatically map from VisionAIR; Megan's Law Database | Crime Analyst & GIS Specialist | Recommended |
| **Sidewalk Trip Hazards** | Based on citizen complaints; potentially GPS field work | Drafting Services Section | Recommended |
| **Signs** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Site Location Base Map** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Existing |
| **Social Service Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Speed Zones** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Recommended |
| **Sphere of Influence** | Acquire, geocode, and map locations; rectify utilizing base map data; derive spheres of influence through buffers | Drafting Services Section | Recommended |
| **Storm Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Storm Drain Fee Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Street Trees** | GPS field work; validation may be possible using aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Streets** | Derived from aerial photography; GIS Consortium | Drafting Services Section | Existing |
| **Street-Sweeping Routes** | Query route segments from existing street centerline layer | Drafting Services Section | Recommended |
| **Striping & Pavement Markings** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Recommended |
| **Tax Assessment Districts** | Aggregate parcels and assessor data; other sources, such aerial photography, as needed | GIS Specialist | Recommended |
| **Telecommunication Facilities** | Aggregate from telecommunications | GIS Specialist; Automated | Recommended |
| **Traffic Accidents** | Extract, cleanse, geocode, and map from Crossroads database | GIS Specialist; Engineer; (Crime Analyst) | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Traffic Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Traffic Calming Devices** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Traffic Counts** | Extract, cleanse, geocode and map from Crossroads database | GIS Specialist | Recommended |
| **Traffic Signals** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Transit Routes** | Derive from street centerline layer; acquire from SACOG? | Drafting Services Section | Recommended |
| **Trees (Parks)** | Digitize from aerial photographs and existing maps | GIS Specialist | Recommended |
| **Truck Routes** | Derive from street centerline layer | Drafting Services Section | Recommended |
| **Under-utilized Buildings** | Query from parcel layer; other sources as needed | GIS Specialist; Redevelopment Agency | Recommended |
| **Vacant Properties** | Query from parcel layer; other sources as needed | GIS Specialist (eventually automated) | Recommended |
| **Water Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Water Meters** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Water Quality Complaints** | Extract, cleanse, geocode, and map from complaints database (TBD) | Automated | Recommended |
| **Waterways** | Digitize polygons from aerial photographs and existing maps | Drafting Services Section; GIS Specialist | Recommended |
| **Work Orders** | Extract, cleanse, geocode, and map from work order database (TBD) | Automated | Recommended |
| **Zoning** | Based on existing maps; General Plan | Drafting Services Section | Existing |

Section staff also identified a need to link digital documents, such as Adobe PDFs or scanned image files, with parcels and address points.

## GIS Applications

### ArcGIS 9

ArcView 9 is recommended for use by Drafting Services personnel. A description of this application is provided in the Enterprise-Wide Applications section of this chapter. One (1) license of ArcView is recommended for use as a shared resource by technicians in the Section.

### Intranet GIS Data Browser

An Intranet GIS data browser has been recommended for use by Drafting Services personnel. The Intranet GIS data browser should provide mapping and analysis capabilities for all personnel. This application will serve as the primary GIS application for the Drafting Services Section. A full description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### Autodesk Suite

It is recommended that the Drafting Services Section continue to utilize the Autodesk suite of software; Autodesk Map 3D should be used in conjunction with ArcView for mapping and spatial analysis.

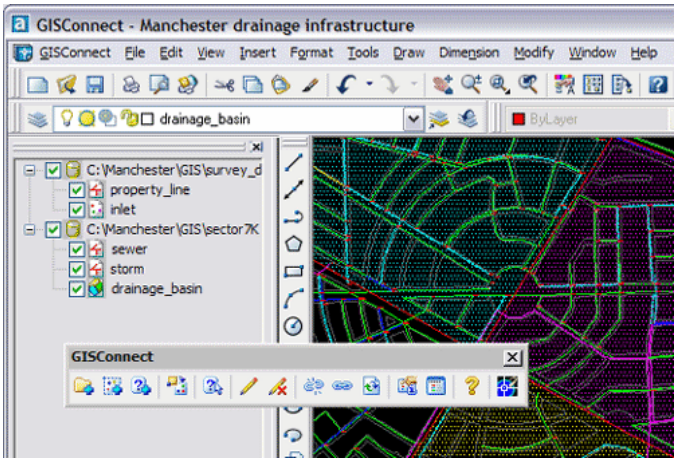
### Internet GIS Data Browser

An Internet GIS data browser has been recommended to provide citizens with access to the City's geo-spatial data. Leveraging the City's existing ArcIMS platform, the City will need to develop an enterprise-wide Internet GIS data browser to provide the public with access to geo-spatial planning data. A description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### GISConnect

Haestad Methods' GISConnect is an add-on tool for the AutoCAD environment that combines the power of ArcGIS's advanced database and geospatial capabilities with the extensive use of AutoCAD drawing tools. GISConnect adds a new toolbar and a dropdown menu within AutoCAD that allows users to add ArcGIS spatial data to a drawing in AutoCAD.

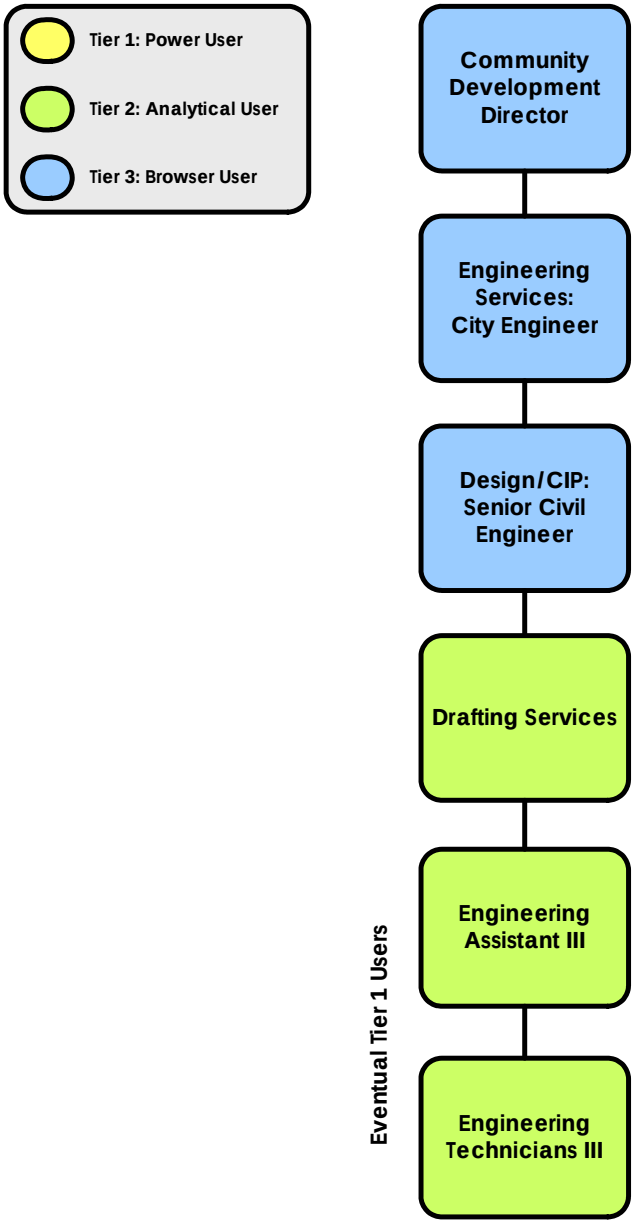
More information is available at http://www.haestad.com




***Haested Methods GISConnect***

## Multi-Tier GIS Application Use within the Drafting Services Section

The following chart describes the recommended GIS application use by the Drafting Services Section. A Tier 1 user is a power GIS user who should have access to a fully functioning GIS toolset. A Tier 2 users focus is data analysis in addition to general browsing capabilities. A Tier 3 user requires only general browsing GIS data functions. The Drafting Services Section will consist of Tier 2 Users (eventually Tier 1 Users).




***Drafting Services Section Multi-Tier GIS Application Use***

# Facilities Development and Maintenance Division

## Personnel and Duties

The Facilities Development and Maintenance Division employs eight staff members, including:

- City Architect (1)
- Architectural Projects Manager (1)
- Maintenance Superintendent (1)
- Parks Planner Specialist (1)
- Facility Maintenance Workers(4)

The Facilities Development and Maintenance Division is a new division that is responsible for design, development, and maintenance of City facilities.

The Division has two sections:

- Facilities Development
- Maintenance

The Facilities Development Section is responsible for oversight of design and construction, although both design and construction are outsourced to private firms. The Maintenance Section is responsible for maintenance of facilities, parks, and other City assets. A Parks Planner within this section oversees development of new parks (from design, through construction, to completion). The Division works in tandem with the Engineering Division, utilizing many of the same resources within the City, such as the Public Works Department and the Engineering Division's Drafting Services Section. The Division also works closely with the Parks and Recreation Department.

GIS users in the Facilities Development and Maintenance Division will be Level 3 GIS Users; however, some GIS use within the Division will involve more complex mapping and analysis, such as that of Level 2 GIS Users (see Chapter 2: GIS Organizational Structure and Staffing for more information on Level 2 & Level 3 GIS Users).

## Hardware and Software

The Facilities Development and Maintenance Division currently has 4 PCs.

All Facilities Development and Maintenance Division PCs have the Windows XP or Windows 2000 operating system (citywide standard).

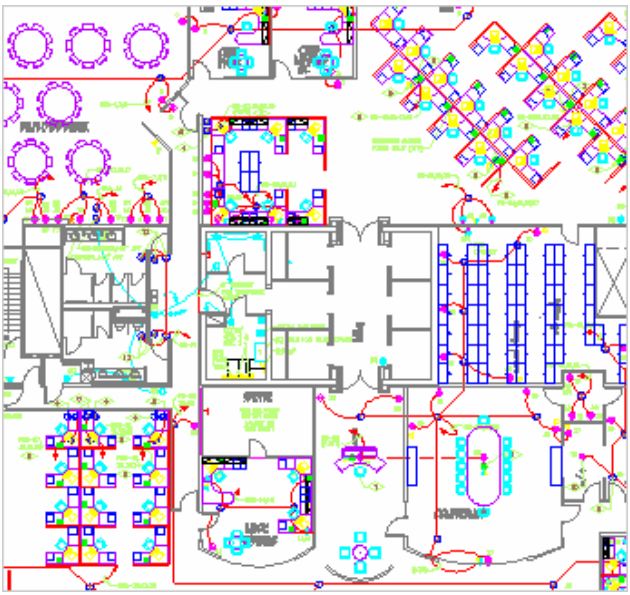
The Facilities Development and Maintenance Division uses the following software applications:

1. MS Office
2. MS Project
3. MS Visio
4. AutoCAD

The Division utilizes the aforementioned software in varying capacities. AutoCAD is used in-house for design of small projects.

AutoCAD

AutoCAD is used to used for construction and building design for small projects. Larger projects are outsourced to outside consultants, who provide the City Architect with plans for review and final approval.



***AutoDesk AutoCAD***

## GIS Needs and Duties

GIS use within the Facilities Development and Maintenance Division will have a broad scope. Division personnel will need access to accurate and complete GIS data in order to fully take advantage of the mapping and analysis capabilities of GIS. In addition, the Facilities Development and Maintenance Division will need to continue working closely in a cross-functional capacity with other City departments; the Division's responsibilities, services, and products are complementary to the objectives of other departments, including Parks and Recreation, Grants & Community Investment, Redevelopment, and Public Works. The Division's objectives require comprehensive access to various types of spatial data, including planimetrics, utility and transportation infrastructure, environmental data, and demographics. The Facilities Development and Maintenance Division will need to work closely with the GIS Specialist and the Drafting Services Section to integrate GIS as much as possible with its current and future workflows.

Based on this needs assessment, the Facilities Development and Maintenance Division has the following GIS needs:

- Mapping and spatial analysis of facilities and maintenance data
- Field access to geo-spatial data
- Public access to Geo-Spatial infrastructure data

The Facilities Development and Maintenance Division's GIS needs are closely linked to the other divisions within the Community Development Department. The Drafting Services Section in the Engineering Division manages and maintains a majority of the spatial data utilized by the Facilities Development and Maintenance Division. A key opportunity for all divisions within the Department lies in centralization of CADD/GIS data and distribution of this data via several tiers of GIS applications. It is expected that Facilities Development and Maintenance personnel will gradually garner greater involvement in facility/parks GIS data production, maintenance, and management, as technical knowledge and resources within the Division increase.

It is recommended that the Division continue to work with the Drafting Services Section for CADD/GIS data management and maintenance. For mapping and spatial analysis GIS

support, the Facilities Development and Maintenance Division should work with the GIS Specialist, who will use GIS software such as ArcEditor or ArcInfo to conduct additional mapping and analysis tasks; the GIS Specialist may also be called upon to create other cartographic products for the Facilities Development and Maintenance Division.

It is also recommended that the Division implement an Intranet GIS data browser to provide staff with access to mapping and spatial analysis functionality. This GIS data browser should include the ability for staff to view updated Division-specific information as well as the City's base GIS data layers.

Mapping and Spatial Analysis of Facilities and Maintenance Data

A key need identified by Facilities Development and Maintenance Division personnel is use of GIS to map and analyze facilities and maintenance data. A variety of projects and tasks require the ability to produce maps and derive information from spatial analyses, including proposed location analysis, land use, park facilities, and maintenance tracking and routing.

The Facilities Development and Maintenance Division identified that it could utilize GIS to assist in several tasks, including:

- Proposed construction and development location analysis
- Infrastructure mapping and analysis
- Tracking, mapping, and scheduling maintenance work in City facilities
- Linking as-built drawings to GIS data
- Project activity mapping
- Production of public meeting and exhibition maps
- Statistical analysis for budgetary preparations

The Division will be able to address many of these tasks through the use of an Intranet GIS data browser that provides access to a variety of GIS data layers derived from CADD files as well as enterprise databases (e.g., permits from Permits Plus). A key opportunity for use of GIS exists with regard to proposed construction and development location analyses; the automated mapping capabilities of GIS provide an opportunity to quickly produce a variety of scenario maps based on several layers of information. It is recommended that the Division work closely with the GIS Specialist to prioritize proposed projects that can be spatially analyzed via GIS.

Case Study: Essex, Vermont, Discovers the Power of 3D Analysis

Mention Vermont to those familiar with the northeastern United States, and they might think of quaint New England villages with tree-lined town greens, wooden covered bridges, or maple syrup. Indeed, this state of just over 600,000 people can be a very tranquil setting. Look carefully, however, and you will see a region that is changing. Making the right growth decisions is critical to the state and its 251 individual communities.

Vermont has long been a leader in GIS and 2D mapping. Its statewide orthophoto program was started in 1974 and has served as the base for GIS layer development since 1983. Traditionally, the 2D map has been the backbone of planning efforts across the state. Zoning, soils, parcels, elevation, and infrastructure layers are all readily available. Nowhere is this more evident than in the town of Essex, which is now the second largest population center in the state. Issues associated with the transition from a rural landscape to a more suburban environment confront the community every day. Located in the Champlain Valley, the town enjoys spectacular views of Vermont's Green Mountains as well as the Adirondack Mountains in neighboring New York State. Issues of aesthetics extend to building design, continuity with adjacent structures, and views of the surrounding landscape.

One area of particular interest is referred to as the New Town Center. Accessed by two major state highways and situated in a location with wide panoramic views of the mountains and valley, the area has already begun to see mixed residential and commercial growth. Zoned to accommodate buildings up to three stories, the ultimate impact on the landscape was unclear among both the citizens and town officials. In September 2003, the town's Selectboard appointed a committee to review zoning and land use issues pertaining to the Town Center area. The ultimate goal of the committee was to recommend future uses and building densities for this area. Essex has been a longtime user of ArcInfo, so the committee did not lack for traditional 2D maps to begin its work. What was missing was a way to view the area in 3D and evaluate the impact of proposed three- and even four-story structures.

Unbeknownst to the town and the newly formed committee was the fact that local ESRI Business Partner Green Mountain GeoGraphics, Ltd. (GMGG), had selected the Town Center area to test the new 3D rendering capabilities of ArcGIS 9 3D Analyst. GMGG had been selected as a beta test site for ArcGIS 9, and thus the groundwork was laid for an operational test of the public acceptance of this new rendering and simulation capability.

***Essex Cinema and the mountains to the southeast***

Getting started on the 3D scene was very much like any other GIS project; data had to be collected and assimilated into ArcGIS Desktop (ArcView, ArcInfo). This included orthophotos and terrain data from the state, parcels and zoning from the town, and CADD drawings of the site from developers. With the necessary data and terrain editing complete, construction of the scene was ready to begin. ArcGIS 9 3D Analyst comes with an extensive library of 3D symbols that can be used to render a scene with typical buildings and vegetation. Creation of the Town Center required GMGG to create custom 3D symbols of buildings and vegetation on the site.

To create the existing and proposed structures, GMGG used software from ESRI Business Partners @Last Software (Boulder, Colorado) and MultiGen-Paradigm (San Jose, California). GMGG found that both programs produce high-quality results that import easily into ArcGIS 9 3D Analyst.

Trees and other vegetation are an important part of almost any landscape. ArcGIS 3D Analyst comes with 3D symbols for more than 200 tree species from all over the world.

***The Whittier Building complex, looking north***

This sampling of tree species is a terrific start for the ArcGIS 3D Analyst user, but to represent more species or examples of individual species at different ages or seasons, users will need to expand the library.

In the case of the Town Center area, GMGG was looking for a way to simulate how the area might look in 20 or 30 years and evaluate how tree growth might affect views of the mountains. After an extensive search, GMGG found a company in France called Bionatics. Its REALnat software product grows tree symbols from mathematical seeds that are species specific. Trees can be grown to a specified age and season in just a matter of minutes. Seeds can be reused as often as necessary, and the tree symbols generated can be saved in OpenFlight format, which will quickly import into ArcGIS 9 3D Analyst. With REALnat, it quickly became obvious that extensive tree creation, which might have taken days or weeks, could now be done in just a few hours.

With the 3D environment created, GMGG approached members of the town's Economic Development office, asking for an opportunity to show the work and to gauge their reaction to this new virtual environment. Word spread, and soon the town recognized the power of what had been created with 3D Analyst, and in January 2004, GMGG made the first public presentation of its 3D work from the Town Center. In attendance were the committee members and representatives of the development community.

The presentation proved to be a resounding success. For more than one hour the committee and developers had the presenter navigating to every possible vantage point. Both existing buildings and vegetation were displayed, along with proposed buildings in both three- and four-story renditions.

"The presentation seemed to have a calming effect over the audience as their confidence in the 3D environment grew," reports Gary Smith, a principal at GMGG. "At an earlier meeting, artist renderings of the proposed buildings had been dismissed because they looked too much like college dormitories. These same buildings were more easily accepted once they had been viewed in the 3D virtual environment."

***Grocery store with proposed brick buildings in the background***

Before the presentation, a development partner tried to prevent the 3D environment from being shown out of fear that it would not produce favorable results. That same developer subsequently asked that two new buildings be added to the 3D database of the Town Center.

In the cover letter of the report to the Selectboard, the Town Center committee chair specifically recommended that the Selectboard members see the 3D presentation as it clearly helped the committee reach agreement and write its summary report. Within a week of receiving the report, the Selectboard requested the opportunity to view the 3D scene. From this very positive experience, the town is now looking for ways to continue 3D scene development of other growth areas.

"It might be too early to proclaim the end of the artist rendering," Smith says, "but the impact of GIS, using the virtual 3D environments of ArcGIS, will become a powerful tool. 3D simulation is here to stay."

**Case Study Courtesy of ESRI ArcNews Magazine*

☑ Field Access to Geo-Spatial Data

Personnel in the Maintenance Section, as well as staff throughout the Division, will benefit from field access to maps and GIS data. At present, field personnel in each division rely on hard copy maps provided on an ad-hoc basis by the Drafting Services Section. There are two methods for Construction personnel to access spatial information in the field:

I. Map Books
II. Mobile Computers

Map books are recommended as a basic means of providing field personnel with access to updated and accurate maps. Once designed and developed, these map books can provide both short and long-term access for a variety of staff (including part-time workers). Mobile computers, specifically hand-held computers, are recommended as more sophisticated means of providing field personnel with access to dynamic mapping and basic spatial analysis capabilities. Mobile computers are recommended for use in the long term, as field personnel become more familiar with GIS and the need for field-based GIS becomes more prevalent within the Division.

*I. Map Books*

The most cost effective solution for access to spatial information in the field is via map books. Map books can be generated for all Construction staff. Each page can display a different section of the City or region. The location of pertinent features, such as signs, water, sanitary sewer, and storm water infrastructure, can be displayed on top of base map information, such as labeled streets, tax parcels, and aerial photography. Map books represent an effective means of referencing the location of all pertinent features. As features are changed or added, new map books can be generated to reflect these changes.

*II). Mobile Computers*

A more advanced method for accessing spatial data in the field is through the use of mobile computers, including notebook computers, tablet PCs and hand-held computers. A GIS data browser, such as ESRI's ArcPad, can be loaded on hand-held computers, allowing the same capabilities offered by map books, but also the ability to query attributes, such as streets, infrastructure, and facilities; link to GPS receivers, and more. These mobile computers, configured with ArcPad, can also be used by staff to update information while working in the field.

It is recommended that hand-held computers be purchased for field staff use. A GIS data browser, such as ArcPad, should be loaded onto each hand-held computer. Initially one (1) hand-held computer is recommended for Year 2; an additional two (2) hand-held computers are recommended for Year 3.

It is recommended that the Division have complete and accurate map books created in Year 1 of this three-year phased GIS implementation. GIS access via mobile (hand-held) computers for the Maintenance Section is recommended for Years 2 and 3.

Public Access to Geo-Spatial Infrastructure Data

As part of the City's enterprise-wide GIS implementation, the Facilities Development and Maintenance Division should work with the GIS Specialist to disseminate spatial information to the public by providing a mapping application that will enable citizens to map City-maintained infrastructure and facilities. This effort should be coordinated with the Engineering Division as well, as the two Divisions are responsible for complementary data.

As part of the City's objective to provide an Internet GIS data browser, the Division should coordinate with the GIS Specialist to integrate divisional GIS data into the Internet-based application. In addition the Division should identify additional functionality that may be required in addition to the City's base enterprise offering.

More information on Internet GIS data browsers can be found in the Enterprise-Wide Applications section of this chapter.

## GIS Data Layers

The Facilities Development and Maintenance Division will benefit from access to several other departmental GIS data layers. It is expected that once all departmental data is integrated, consolidated, and centrally stored, that staff will have access to **all** non-classified GIS data layers from other City departments.

Division personnel expressed that access to the following GIS data layers would be beneficial:

| *Data Layer* | *Creation Methodology* | *Recommended Update Division or Individual* | *Existing or Recommended?* |
|---|---|---|---|
| **Address Points** | Extract, cleanse, geocode, and map from Springbrook; georeference based on aerial photography and GPS field work | Automated; GIS Specialist; Drafting Services Section | Recommended |
| **Aerial Photography** | Fly-over with control points | GIS Data Services Vendor | Recommended |
| **Bicycle/Pedestrian Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Building Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Buildings with Site Plans** | Manually digitize polygons from plans and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Census Data** | Download from Census Bureau →http://www.census.gov/geo/www/census2k.html | GIS Specialist | Recommended |
| **Certificates of Compliance** | Extract, cleanse, geocode and map from Permits Plus database | Automated | Recommended |
| **City-owned Property** | Extract, cleanse, geocode, and map from Yolo County tax roll; other map sources as required | Automated | Recommended |
| **Commercial Addresses** | Extract, cleanse, geocode, and map from Springbrook | Automated | Recommended |
| **Community Facilities District** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Critical Facilities** | Manually digitize points from aerial photography and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Easements** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Encroachment Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Enterprise Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Facilities** | Digitize on screen; aggregate layers as needed | Drafting Services Section | Existing |
| **Fire Hydrants** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Flood Zones** | Acquire from FEMA (free to government entities) http://www.fema.gov/fhm/ | Drafting Services Section; GIS Specialist | Recommended |
| **General Plan** | Digitize features from aerial photographs and existing data layer | Drafting Services Section; GIS Specialist | Recommended |
| **GPS Monument Map** | GPS field work | Drafting Services Section | Existing |
| **Hazardous Materials** | GPS data collection for location; extract from FirePoint once data is entered | Drafting Services Section; GIS Specialist | Recommended |
| **Impervious Surfaces** | Digitize polygons from aerial photographs; derive polygons by raster analysis of remotely-sensed data | Drafting Services Section; GIS Specialist | Recommended |
| **Land Use** | Digitize polygons from aerial photographs and existing maps; existing CADD data | Drafting Services Section | Existing |
| **Levees** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Licensed and Unlicensed Businesses** | Extract, cleanse, geocode, and map from in-house database | Automated | Recommended |
| **Lighting and Landscape Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Major Intersections** | Use street centerline layer as source | Drafting Services Section | Recommended |
| **Measure "K" Street Rehabilitation** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Parcels** | Acquire from Yolo County | Yolo County ( and GIS Data Services Vendor) | Recommended |
| **Parks** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Port** | Digitize features from aerial photographs and other maps | Drafting Services Section; GIS Specialist | Recommended |
| **Reclamation District Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Record of Survey Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Rehabilitation Projects** | Extract, cleanse, geocode and map from Access database | Automated | Recommended |
| **Schools** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Sewer Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Sewer Fees Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Signs** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Site Location Base Map** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Existing |
| **Speed Zones** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Recommended |
| **Storm Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Storm Drain Fee Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Streets** | Derived from aerial photography; GIS Consortium | Drafting Services Section | Existing |
| **Striping & Pavement Markings** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Recommended |
| **Traffic Accidents** | Extract, cleanse, geocode, and map from Crossroads database | GIS Specialist; Engineer; (Crime Analyst) | Recommended |
| **Traffic Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Traffic Calming Devices** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Traffic Counts** | Extract, cleanse, geocode and map from Access database | GIS Specialist | Recommended |
| **Traffic Signals** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Transit Routes** | Derive from street centerline layer; acquire from SACOG? | Drafting Services Section | Recommended |
| **Truck Routes** | Derive from street centerline layer | Drafting Services Section | Recommended |
| **Under-utilized Buildings** | Query from parcel layer; other sources as needed | GIS Specialist; Redevelopment Agency | Recommended |
| **Vacant Properties** | Query from parcel layer; other sources as needed | GIS Specialist (eventually automated) | Recommended |
| **Water Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Waterways** | Digitize polygons from aerial photographs and existing maps | Drafting Services Section; GIS Specialist | Recommended |
| **Zoning** | Based on existing maps; General Plan | Drafting Services Section | Existing |

Additional layers may be required as the Division increases its GIS utilization and incorporates additional field data.

Division staff also identified a need to link digital documents, such as Adobe PDFs for permitted applications, with parcels and address points.

## GIS Applications

Internet GIS Data Browser

An Internet GIS data browser has been recommended to provide citizens with access to the City's geo-spatial data. Leveraging the City's existing ArcIMS platform, the City will need to develop an enterprise-wide Internet GIS data browser to provide the public with access to

geo-spatial planning data. A description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### Intranet GIS Data Browser

An Intranet GIS data browser has been recommended for use by Facilities Development and Maintenance personnel. The Intranet GIS data browser should provide mapping and analysis capabilities for all users. This application will serve as the primary GIS application for the Division. A full description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### ArcPad 6.0

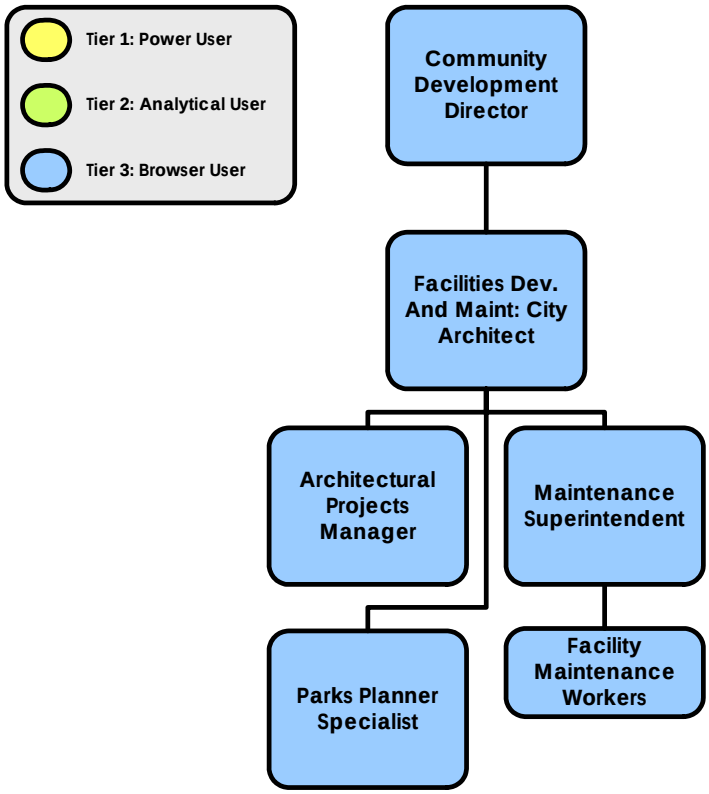
ArcPad software is an easy-to-use, lightweight, low-cost solution for mobile mapping and geographic information systems. ArcPad enhances portable touch screen computers with intuitive mapping, GIS, and GPS functionality. ArcPad makes field data collection fast and easy, improves data accuracy, and provides immediate data availability and validation. It is recommended that ArcPad technology be utilized in the Facilities Development and Maintenance Division. ArcPad will enhance and streamline location analysis, field surveying, and facilities maintenance.

With ArcPad 6.0, Division personnel can:

- Use existing data - ArcPad supports industry-standard vector and raster image display.
- Add data from the Internet - Data can be provided from the Internet via wireless technology.
- Move around the map - ArcPad includes a number of map navigation tools including zoom and pan, spatial bookmarks, and center on the current GPS position.
- Query data - Identify features, display hyperlinks, and locate features.
- Measure distance, area, and bearings on the map.
- Navigate with GPS - Connect a GPS and with ArcPad.
- Edit data - Create and edit spatial data using input from the mouse pointer, pen, or GPS.
- Extract, convert, and project existing data using ArcGIS Desktop

## Multi-Tier GIS Application Use within the Facilities Development and Maintenance Division

The following chart describes the recommended GIS application use by the Facilities Development and Maintenance Division. A Tier 1 user is a power GIS user who should have access to a fully functioning GIS toolset. A Tier 2 users focus is data analysis in addition to general browsing capabilities. A Tier 3 user requires only general browsing GIS data functions. The Facilities Development and Maintenance Division will consist of Tier 2 and Tier 3 users.




***Facilities Development and Maintenance Division Multi-Tier GIS Application Use***

# Planning Division

## Personnel and Duties

The Planning Division employs six staff members, including:

- City Planner (1)
- Senior Planners (2)
- Associate Planners (2)
- Assistant Planner (1)

The Mission of the Planning Division is to manage changes in the use of land so that the West Sacramento Community - as a whole - is best served.

The Planning Division has several functions, including:

Process requests for development entitlements including tentative subdivision maps, parcel maps, use permits, general plan amendments, rezone amendments, lot line adjustments etc.
Review building permits and business licenses.
Provide information to citizens and developers on land use entitlement processing, general plan designation and zoning.
Prepare and maintain the general plan and zoning map of the City.
Prepare land use studies and plans as needed.
Environmental review (CA environmental quality act)

Personnel in the Planning Division typically review between 700-800 building permits per year. The Division expects to review more than 3,000 permits for new development—it is expected that this number will continue to increase as the City's growth with new development continues.

The Division uses GIS for mapping and some spatial analysis. One planner utilizes ESRI ArcView to conduct mapping and analysis. The majority of GIS users in the Planning Division will be Level 3 GIS Users; however, some GIS use within the Division will involve more complex mapping and analysis, such as that of Level 2 GIS Users (see Chapter 2: GIS Organizational Structure and Staffing for more information on Level 2 & Level 3 GIS Users).

## Hardware and Software

The Planning Division currently has six PCs.

All Planning Division PCs have the Windows XP or Windows 2000 operating system (citywide standard).

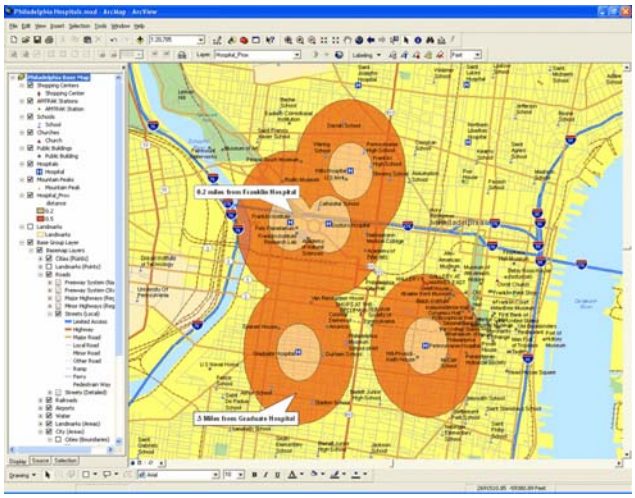
The Planning Division uses the following software applications:

1. MS Office
2. ArcView
3. Accela (Permits)
4. Photoshop

The Division utilizes the aforementioned software in varying capacities. As aforementioned, ArcView is used for mapping and spatial analysis.

ArcView

ArcView is used extensively to produce zoning and general plan designation maps as well as a major project map for other departments to use. The Division also uses ArcView to generate other cartographic products for use by administrative and field staff.



***ESRI's ArcView***

## GIS Needs and Duties

There is great potential for increasing the utilization of GIS in the Planning Division. The Planning Division manages and maintains a variety of data that has a spatial component. In addition, the Division's objectives require comprehensive knowledge of various types of spatial data, including planimetrics, zoning, and environmental data. The Planning Division should work closely with the GIS Specialist to integrate GIS as much as possible with its workflows.

Based on this needs assessment, the Planning Division has several GIS needs:

- Mapping and spatial analysis of land use and zoning data
- Automated neighborhood and vicinity mapping
- Planning support systems
- Public access to geo-spatial planning data
- Formal GIS training for Planning Division staff

The Planning Division's GIS needs are closely linked to the other divisions within the Community Development Department. The Drafting Services Section in the Engineering Division manages and maintains a majority of the data utilized by the Planning Division. A key opportunity for all divisions within the Department lies in centralization of CADD/GIS data and distribution of this data via several tiers of GIS applications. It is expected that Planning personnel will gradually garner greater involvement in planning-specific GIS data production, maintenance, and management, as technical knowledge and resources within the Division increase.

It is recommended that the Division continue to use software such as ArcView to produce maps and conduct basic spatial analyses. For advanced GIS support, the Planning Division should work with the GIS Specialist, who can use robust GIS software such as ArcEditor or ArcInfo to conduct additional mapping and analysis tasks; the GIS Specialist may also be called upon to create additional cartographic products for the Planning Division.

It is also recommended that the Division implement an Intranet GIS data browser to provide staff with access to mapping and spatial analysis functionality. This GIS data browser should include the ability for staff to view updated Division-specific information as well as the City's base GIS data layers.

Mapping and Spatial Analysis of Land Use and Zoning Data

A key need identified by Planning Division personnel is increased and improved use of GIS to map and analyze land use and zoning data. A variety of Planning projects and tasks require the ability to produce maps and derive information from spatial analyses, including updates to the master plan, traffic modeling, and development/updates to the City's water plan.

The Planning Division identified that it could utilize GIS to assist in several tasks, including:

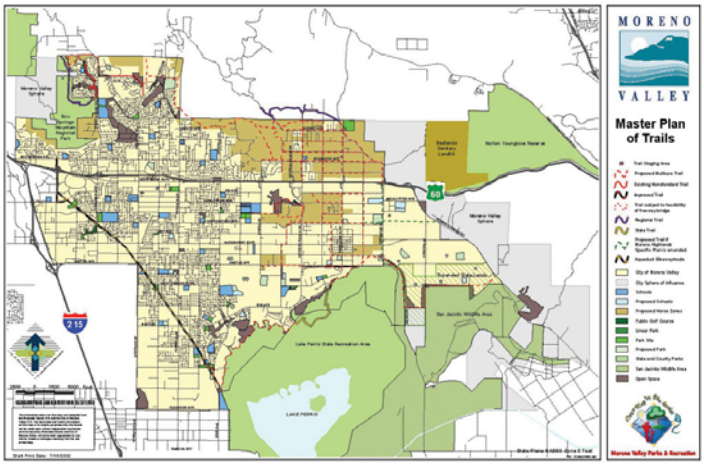
- Proposed development location analysis
- Land use and land development mapping and analysis
- Zoning data mapping and analysis
- Environmental inventories mapping and analysis
- Project activity mapping
- Traffic modeling
- Building inspection and code enforcement mapping and analysis
- Production of public meeting and exhibition maps
- Statistical analysis for budgetary preparations
- Spatial and quantitative analysis of long-range planning issues: demographics and growth, housing, economic development, environmental protection, and infrastructure

Division personnel also indicated that they receive maps from the Department of Conservation, FEMA, and the U.S. Census Bureau as well as maps from individual developers on a project-by-project basis. It is recommended that the Division work with the GIS Specialist on the acquisition of FEAM and Census Bureau GIS data layers, as well as any other relevant GIS data available from Federal agencies. In addition, the Division should work with the GIS Specialist to establish standards, if necessary, for digital map/data submission from developers—this effort should be carried out in conjunction with the Engineering Division, which has an existing set of submission standards for digital data that may be able to be leveraged for use by the Planning Division.

Case Study: Moreno Valley, California, Manages Explosive Growth With GIS

The GIS mapping of trails has allowed the Parks and Recreation Department to complete the package needed for Planning Commission review/approval.

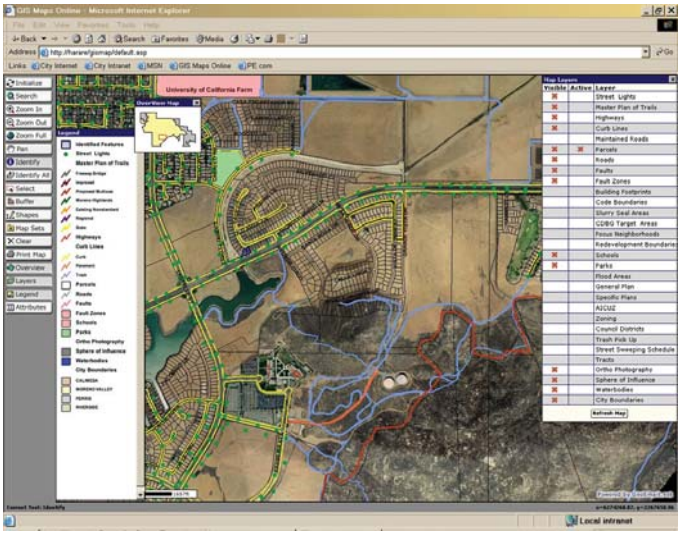
Cities with explosive growth need to optimize their resources. This is a truism regardless of their size, shape, or location. Case in point: Based on preliminary Census 2000 data, Moreno Valley in Riverside County is the sixth fastest growing city in California and 26th in the nation. Once an infant among California cities, Moreno Valley, situated 70 miles east of Los Angeles, now has 150,000 residents—a 450 percent increase over its 1980 population of 28,000.




***The GIS mapping of trails has allowed the Parks and Recreation Department to complete the package needed for Planning Commission review/approval.***

Like many other cities across the United States, Moreno Valley first acquired GIS to help manage its growth. The city began its GIS journey with desktop mapping software that was used by various departments. For the most part, the software was used for mapping, visualization, and query, with its users working independently.

The city eventually realized it needed a more strategic plan to deploy its GIS and turned to its newly hired GIS coordinator Michael Heslin for help. Heslin conducted interviews with various city agencies and performed an extensive GIS needs assessment. He also investigated how other local government agencies managed information; in the process he studied other enterprise implementations and instantly recognized the many benefits that were possible.



***Moreno Valley's GIS includes the ability to look up a property by the assessor parcel number, address, or property owner as well as generate notification mailings, view buffer maps, and print full property records.***

What resulted was a clear understanding that an enterprise GIS implementation was needed to streamline Moreno Valley's GIS processes and leverage the true analysis capabilities a GIS would provide. In addition, Heslin recognized the need for leveraging data managed independently within separate departments. An enterprise approach would allow various departments to use data managed outside their own department. Plus, the city wanted more powerful functionality.

Using his prior knowledge and experience, bolstered with the information resulting from the interviews and investigation, and taking into consideration the city had 32 seats of ArcView, Heslin made his decision. He realized that migrating to ArcInfo would add advanced geoprocessing and data conversion capabilities including tools for data creation, update, query, mapping, and analysis. In addition, ArcIMS could provide an intuitive, Web-based platform for sharing data and applications easily throughout the city. Thus, in 2001, the city selected and successfully made the move to ArcGIS software and then had a true enterprise GIS in place. The city uses ArcInfo 8.3, ArcView 8.3, ArcView 3.2, and ArcIMS 4.0.1 and is now deploying GIS for virtually all city departments including planning, public works, fire, law enforcement, parks and recreation, and economic development. Today, the city is doing more with fewer resources and doing it in less time.

*With a Little Help from Their Friends*

The city quickly began capturing data and performing a wide range of GIS applications. In addition, several other municipal, county, and state agencies already using ESRI GIS software were contacted, and information sharing began to take place. Now Moreno Valley has a vast array of existing, up-to-date data sets to work with as part of its own GIS work.

"Prior to GIS, many of the analysis capabilities available today were simply not available," adds Heslin. "By moving to an enterprise GIS, you can better share and distribute information. And you have the whole analysis capability. It has real, lasting value in numerous ways.

"City staff had used the databases in the past to store their departmental information," continues Heslin. "We moved to an enterprise GIS system, meaning information is deposited in a central location and can be shared from department to department using a common data standard. Users can retrieve any available information from their desktop rather than knocking on doors or calling people to request information."

*ArcGIS Applications*

Moreno Valley's GIS includes the ability to look up a property by the assessor parcel number, address, or property owner as well as generate notification mailings, view buffer maps, and print full property records.

An important GIS application involved an impact study for a proposed hiking trail project. The city needed to decide whether the proposed multiuse trails project was a worthy endeavor. The GIS Department collected data from different sources including paper maps, on-the-fly digitizing of aerial photos, GPS mapping, input from a trails committee, and other public sources. GIS analysis was performed by evaluating a number of different variables including impact on funding, integration into existing trails, and more. Trails were mapped using aerial images, some were mapped in the field, and some were already stored in digital format and input into ArcGIS.

"Once the data was in GIS, calculations became a snap," says Heslin. "We could calculate linear feet for any type of trail, calculate how much a trail would cost, determine which properties it would cross, and more. It essentially saved several hundred hours of manually mapping trails and performing analysis."

Collaborative efforts were made with other municipalities. The cities of Riverside and Corona, both also within Riverside County, got together with Moreno Valley and shared land use, planning, zoning, parks, and other information for a California Department of Transportation (Caltrans) project to get a better understanding of trails and their interconnection between these cities.

"We've learned a lot from other government agencies, both larger and smaller than we are, that have done similar things and have important lessons to share," says Heslin. "There's a great user community out there to learn from, and Moreno Valley is certainly taking advantage of this simple fact."

The GIS Department shares its database with the Fire Department so it can have a better understanding of roads, access ways, and other data crucial in an emergency response and for emergency mitigation planning.

"There's a huge benefit for how decisions are being made because there's more accurate, detailed information available to more people," says Heslin. "Our enterprise GIS provides a jump-start to City Hall and other professionals who need to do a vast array of diverse research. It also helps us work with other cities in joint projects."

Users accessing the database have a large number of tools for performing queries and analysis. For instance, a search can be performed by street location, ZIP Code, parcel number, zone identification, or any number of spatial and asset identifiers. The automated

links between spatial and tabular data provide a sophisticated integration method for greater analysis.

"Government employees can look at a map and drill down to view related map data or look at a database record and then access a map," adds Heslin. "People may not even know exactly what they're looking for but, geographically, they know it's around a general area. They can then drill down and pull up other layers of information. They couldn't do this before. If they're researching a project in the city, they may want to see what impact it will have on school systems, parks, traffic, or other entities. They can make better decisions and, ultimately, save money by making sure budget dollars are spent in the best manner possible."

The city also recently finalized the development of an ArcIMS software-based Intranet site. "With an Intranet-based interface to our information, we can serve a greater number of government employees more efficiently," concludes Heslin.

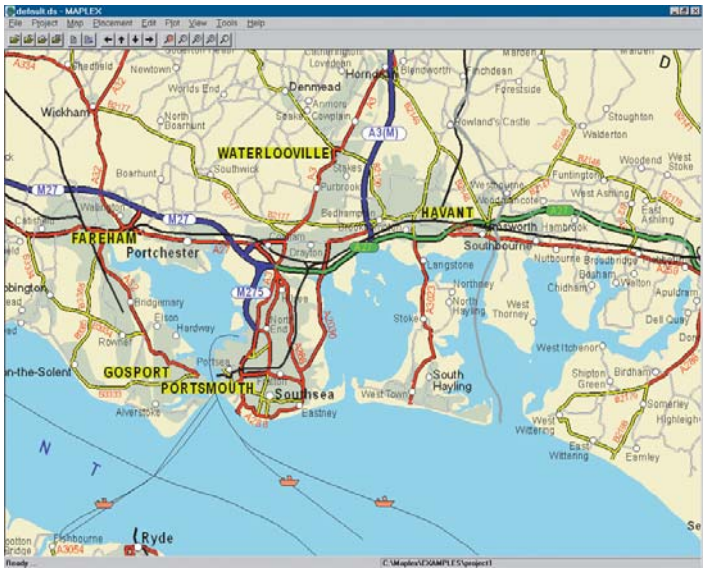
Future applications include integrating GIS with Moreno Valley's permitting system. The city is also in the process of developing an economic development Internet site.

**Case Study Courtesy of ESRI ArcNews Magazine*

☑ Automated Neighborhood and Vicinity Mapping

Planning Departments across the country are turning to GIS for automation of several tasks, including the production of neighborhood and vicinity maps for public meetings and public distribution. The Planning Division will be able to better serve its public duties by utilizing an automated mapping application that enables staff members to quickly and efficiently create neighborhood and vicinity maps. At present, there is no automated means for generation of these maps.

It is recommended that a standalone desktop application be developed to address these mapping needs. The application should be based on ESRI technology to facilitate integration with the City's existing/proposed platform and to enable streamlined access to the City's geo-spatial data. Subject to centralization of geo-spatial data in a geodatabase, it is recommended that the Planning Division work with an outside consultant to custom-develop an ArcGIS-based application for the Division's specific needs. In addition to providing custom automated mapping capabilities, the application should support versioning of data, especially for use in proposed development plans; by using versioning, any approved changes to specific boundaries or land use features can be easily and effectively reconciled with the original data (i.e., central geodatabase). This application should be shared with the Engineering Division, which has also received recommendation for an automated neighborhood and vicinity mapping application.




As part of the automated mapping application, and in order to ensure a high cartographic quality in publicly distributed maps, it is recommended that ESRI's Maplex software be integrated with the aforementioned automated mapping application. Maplex is sophisticated, high-end cartographic design software for creating quality labeling and annotation text for map generation. Utilizing an integrated approach that uses both ArcGIS and Maplex will yield cartographic quality products that can be created by both technical and non-technical staff.

***Figure PL-1.1: Maplex Cartographic Output***

An Intranet GIS data browser is an additional resource that can be used by Planning Division staff to view and map GIS data. It is recommended that the Division utilize an Intranet GIS data browser to provide mapping and spatial analysis capabilities for non-technical staff (more information on this application is provided in the Enterprise-Wide Applications section of this chapter).

☑ Planning Support Systems

Another potential utilization of GIS within the Planning Division is the analysis of proposed development scenarios during plan reviews. It is recommended that the Planning Division procure a third party extension for ArcGIS that will enable departmental staff to leverage existing GIS infrastructure to perform these types of analysis. The solution should provide the ability to version temporary scenario data, as this will facilitate the reconciliation of approved data changes to master data sources (more information on these applications is provided in the GIS Application section below).

☑ Public Access to Geo-Spatial Planning Data

The Planning Division expressed the need to disseminate spatial information to the public by providing a mapping application that will enable citizens to view land use and zoning information.

As part of the City's objective to provide an Internet GIS data browser, the department should coordinate with the GIS Specialist to integrate departmental GIS data into the Internet-based application. In addition the department should identify additional functionality that may be required in addition to the City's base enterprise offering.

More information on Internet GIS data browsers can be found in the Enterprise-Wide Applications section of this chapter.

Public access to geo-spatial planning data will increase productivity by reducing the need for staff to personally respond to questions from citizens. In addition to providing public access to mapping via an Internet GIS data browser, it is recommended that the Planning

Division purchase and maintain a public access kiosk at the Division front counter. The kiosk will allow citizens that come into the office to view and query zoning and land use information without disturbing or disrupting staff productivity. The kiosk should provide an intuitive, user-friendly mapping interface that provides users the ability to view, query, and print relevant land use information.

Formal GIS Training for Planning Division Staff

Several departments/divisions, including the Planning Division, will benefit from formal training in GIS. It is recommended that the Planning Division and the recommended GIS Specialist identify key division staff to receive formal training. More information on training opportunities can be found in Chapter 9: GIS Training and Education.

## GIS Data Layers

The Planning Division will benefit from access to several other departmental GIS data layers. It is expected that once all departmental data is integrated, consolidated, and centrally stored, that staff will have access to **all** non-classified GIS data layers from other City departments.

Division personnel expressed that access to the following GIS data layers would be beneficial:

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Address Points** | Extract, cleanse, geocode, and map from Springbrook; georeference based on aerial photography and GPS field work | Automated; GIS Specialist; Drafting Services Section | Recommended |
| **Aerial Photography** | Fly-over with control points | GIS Data Services Vendor | Recommended |
| **Bicycle/Pedestrian Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Building Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Buildings with Site Plans** | Manually digitize polygons from plans and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Census Data** | Download from Census Bureau →http://www.census.gov/geo/www/census2k.html | GIS Specialist | Recommended |
| **Certificates of Compliance** | Extract, cleanse, geocode and map from Permits Plus database | Automated | Recommended |
| **City-owned Property** | Extract, cleanse, geocode, and map from Yolo County tax roll; other map sources as required | Automated | Recommended |
| **Commercial Addresses** | Extract, cleanse, geocode, and map from Springbrook | Automated | Recommended |
| **Community Facilities District** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Crime Data** | Extract, cleanse, and automatically map from Police VisionAIR database | Automated | Recommended |
| **Critical Facilities** | Manually digitize points from aerial photography and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Day Care Facilities** | GPS field work. | GIS Specialist; Redevelopment Agency | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Planning Division-specific Projects** | Extract, cleanse, geocode and map from Access database | GIS Specialist; Planning | Recommended |
| **Easements** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Encroachment Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Enterprise Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Facilities** | Digitize on screen; aggregate layers as needed | Drafting Services Section | Existing |
| **Fire Hydrants** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Flood Zones** | Acquire from FEMA (free to government entities) http://www.fema.gov/fhm/ | Drafting Services Section; GIS Specialist | Recommended |
| **General Plan** | Digitize features from aerial photographs and existing data layer | Drafting Services Section | Recommended |
| **GPS Monument Map** | GPS field work | Drafting Services Section | Existing |
| **Hazardous Materials** | GPS data collection for location; extract from FirePoint once data is entered | Drafting Services Section; GIS Specialist | Recommended |
| **HUB Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Impervious Surfaces** | Digitize polygons from aerial photographs; derive polygons by raster analysis of remotely-sensed data | Drafting Services Section; GIS Specialist | Recommended |
| **Land Use** | Digitize polygons from aerial photographs and existing maps; existing CADD data | Drafting Services Section | Existing |
| **Levees** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Licensed and Unlicensed Businesses** | Extract, cleanse, geocode, and map from in-house database | Automated | Recommended |
| **Lighting and Landscape Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Major Intersections** | Use street centerline layer as source | Drafting Services Section | Recommended |
| **Measure "K" Street Rehabilitation** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Parcels** | Acquire from Yolo County | Yolo County ( and GIS Data Services Vendor) | Recommended |
| **Parks** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Planning Department Special Projects** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Police Department Special Projects** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Port** | Digitize features from aerial photographs and other maps | Drafting Services Section; GIS Specialist | Recommended |
| **Real Estate Sales** | Geocode and map from MLS database | Automated | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Reclamation District Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Record of Survey Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Rehabilitation Projects** | Extract, cleanse, geocode and map from Access database | Automated | Recommended |
| **Schools** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Sewer Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Sewer Fees Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Signs** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Site Location Base Map** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Existing |
| **Social Service Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Speed Zones** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Recommended |
| **Storm Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Storm Drain Fee Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Streets** | Derived from aerial photography; GIS Consortium | Drafting Services Section | Existing |
| **Striping & Pavement Markings** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Recommended |
| **Tax Assessment Districts** | Aggregate parcels and assessor data; other sources, such aerial photography, as needed | GIS Specialist | Recommended |
| **Traffic Accidents** | Extract, cleanse, geocode, and map from Crossroads | GIS Specialist; Engineer; (Crime Analyst) | Recommended |
| **Traffic Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Traffic Calming Devices** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Traffic Counts** | Extract, cleanse, geocode and map from Access database | GIS Specialist | Recommended |
| **Traffic Signals** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Transit Routes** | Derive from street centerline layer; acquire from SACOG? | Drafting Services Section | Recommended |
| **Truck Routes** | Derive from street centerline layer | Drafting Services Section | Recommended |
| **Under-utilized Buildings** | Query from parcel layer; other sources as needed | GIS Specialist; Redevelopment Agency | Recommended |
| **Vacant Properties** | Query from parcel layer; other sources as needed | GIS Specialist (eventually automated) | Recommended |
| **Water Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Waterways** | Digitize polygons from aerial photographs and existing maps | Drafting Services Section; GIS Specialist | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Zoning** | Based on existing maps; General Plan | Drafting Services Section | Existing |

Additional layers may be required as the Division increases its GIS utilization and incorporates additional field data.

Division staff also identified a need to link digital documents, such as Adobe PDFs for permitted applications, with parcels and address points.

## GIS Applications

Internet GIS Data Browser

An Internet GIS data browser has been recommended to provide citizens with access to the City's geo-spatial data. Leveraging the City's existing ArcIMS platform, the City will need to develop an enterprise-wide Internet GIS data browser to provide the public with access to geo-spatial planning data. A description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

Intranet GIS Data Browser

An Intranet GIS data browser has been recommended for use by Planning personnel. The Intranet GIS data browser should provide mapping and analysis capabilities for all personnel. This application will serve as the primary GIS application for the Planning Division. A full description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

ArcGIS 9

ArcView 9 is recommended for use by Planning personnel. A description of this application is provided in the Enterprise-Wide Applications section of this chapter. One (1) license of ArcView is recommended for use by a planner. This planner should continue to utilize ArcView to produce maps and conduct spatial analyses.

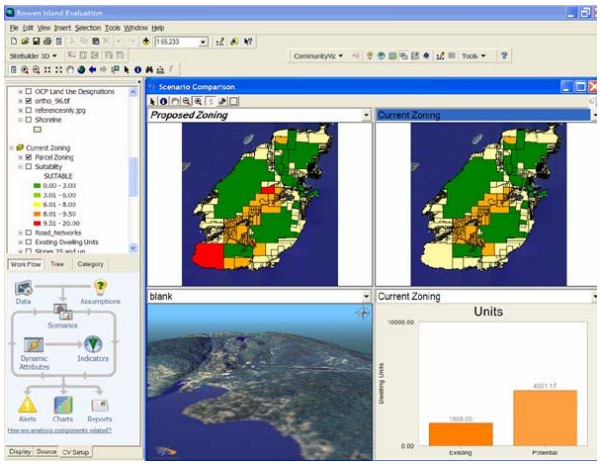
Planning Support Systems

A planning support extension for ArcGIS has been recommended for use by the Planning Division. A planning support application will enable the department to analyze proposed development scenarios and improve decision-making. In addition, integrated GIS applications that provide access to a geodatabase will maximize efficiency through versioning and redundant data production. Included below are three options for ArcGIS-based planning support systems that the department should consider and assess.

Scenario 360

Scenario 360 is GIS-based decision support software for planners and resource managers. Scenario 360 is an ArcGIS extension that adds interactive analysis tools and a decision-making framework to the ArcGIS platform. Scenario 360 is a valuable tool that enables viewing, analyzing, and understanding of land-use alternatives and impacts.

More details are available at http://www.communityviz.com

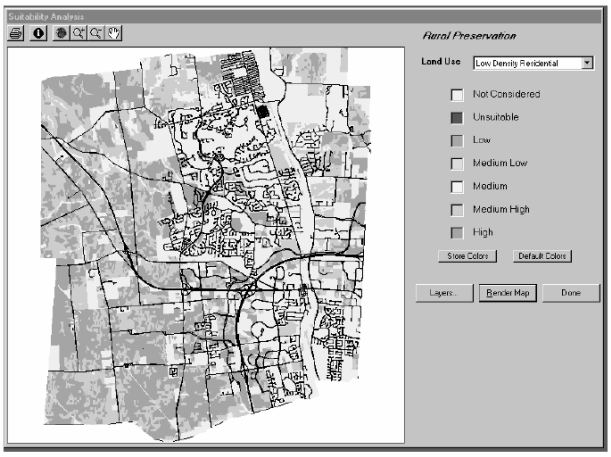



***Scenario 360 by CommunityViz***

What If?

What if? is an interactive GIS-based system which supports all aspects of the land use planning process: conducting a land suitability analysis, projecting future land use demand, allocating this demand to suitable locations, and evaluating the likely impacts of alternative policy choices and assumptions.

More details are available at http://www.what-if-pss.com

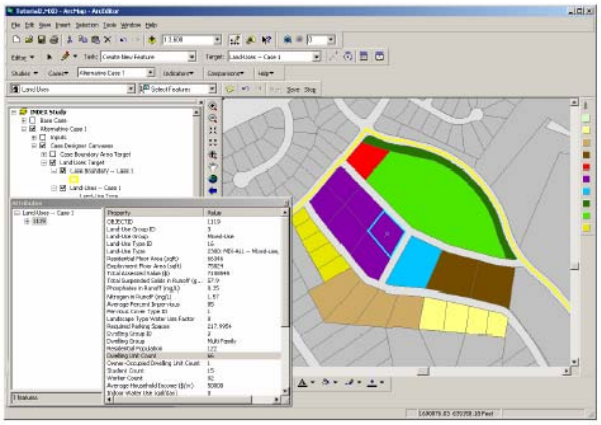



***What If? Planning Support System***

INDEX Software

INDEX is an integrated suite of tools designed to support the entire process of community planning and development. INDEX is used to design and visualize alternative planning scenarios, analyze and score their performance, and compare and rank alternatives. Once plans are adopted, INDEX supports implementation by evaluating development proposals against plan goals.

More details are available at http://www.crit.com

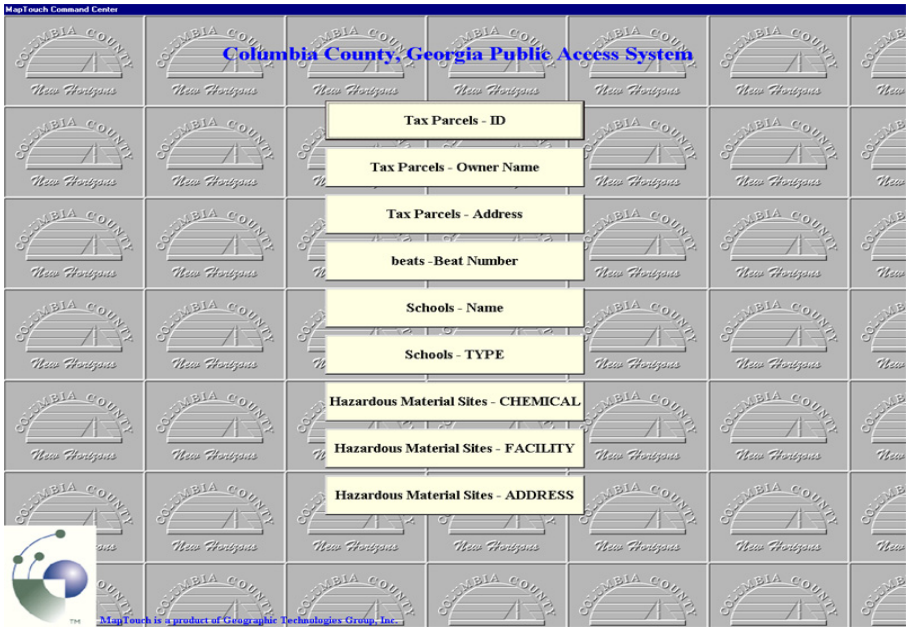


***Index Software***

## Public Access Kiosk Application

Many public access attempts required the user to use a mouse and keyboard and have an understanding of how to use a Windows based application. These expectations eliminate 70% of potential users. The Internet has become one medium of disseminating data to the public. However, there is still a need to have public access to data physically at an organization's buildings. Many people come to a facility, such as the Planning Department office, with specific questions about the area and services provided. A well-written public access application will allow a user to find the answers for themselves.

To be effective, a public access application must be easy to use. For many users, this means an application that does not require use of a mouse or keyboard. Touch screen monitors have enabled applications that do not require a mouse and keyboard to become a reality. A touch screen kiosk application should be implemented utilizing Tier 3 (Browser User) software. Buttons and slider bars must be large so that they are easily selected by touching the screen.




Sample Introduction Screen for Touch Screen Kiosk

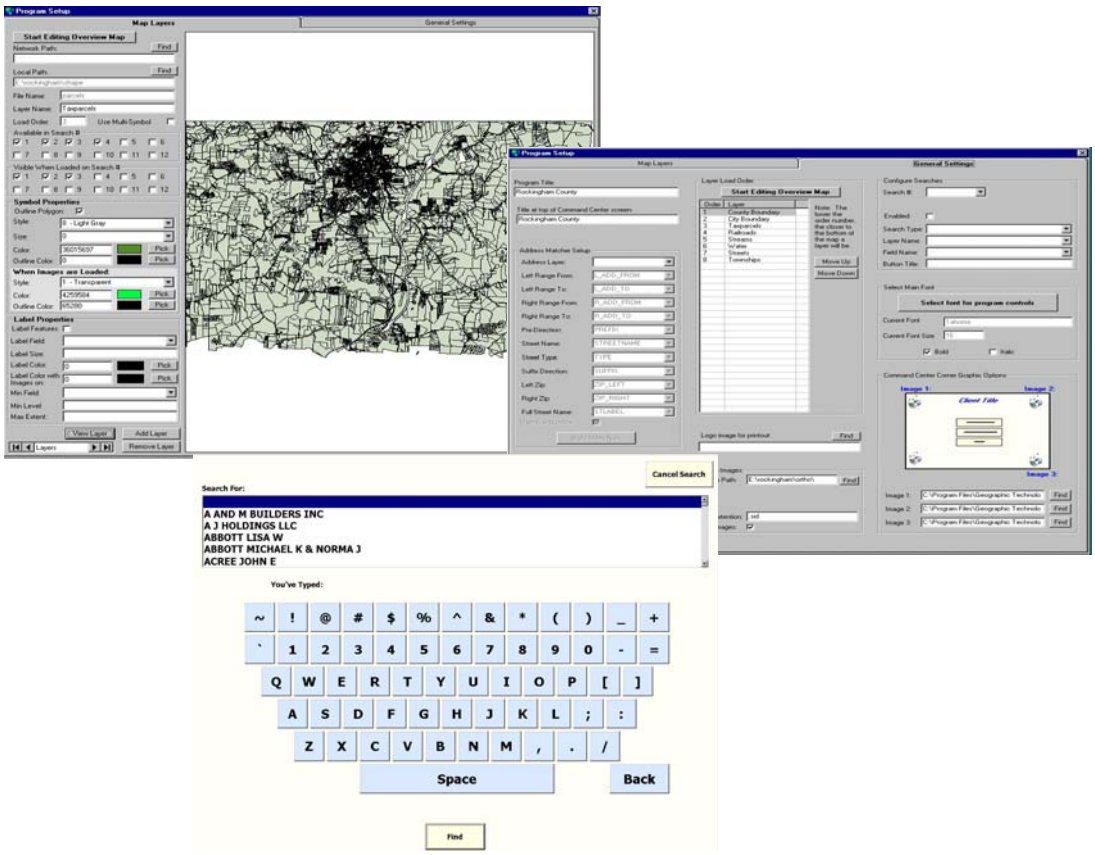
This application should be flexible so that it can be used at other facilities/sites to provide public access with other data sets. Once the public access application is written it should allow for quick changes and customization.

The public access application should target the following goals:

- Configurable for at least 10 preset queries
- Extremely user friendly — no keyboard, no mouse
- Designed with the latest GIS technology — ESRI MapObjects™ in conjunction with Visual Basic™
- Must have an administration package for complete control of layers, colors, and data
- Network ready for automatic update of configuration and setup files
- Easy to customize data setup and query configuration
- Supports imagery and ortho-photography

- Easy and quick setup

For keyboard entry, the touch screen application should replicate a keyboard on the screen.




Administrative Tools for Touch Screen
Keyboard Dialog – Touch Screen Application

The kiosk application should be very streamlined, offering only the essential GIS functionality such as; printing, pan, zoom in, zoom out, identify, and turning layers on and off.

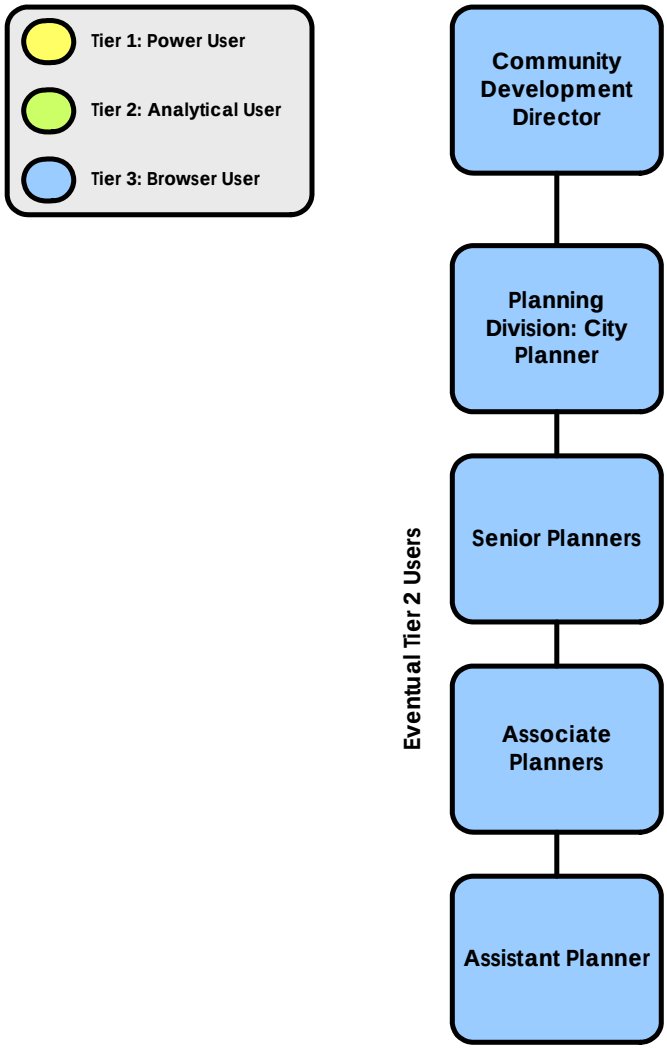
Kiosk Application with Key GIS Functions

All options available to the user must be equally user friendly.

User-Friendly Buttons – Public Information Kiosk

Multi-Tier GIS Application Use within the Planning Division

The following chart describes the recommended GIS application use by the Planning Division. A Tier 1 user is a power GIS user who should have access to a fully functioning GIS toolset. A Tier 2 users focus is data analysis in addition to general browsing capabilities. A Tier 3 user requires only general browsing GIS data functions. The Planning Division will consist of Tier 2 and Tier 3 users.




***Planning Division Multi-Tier GIS Application Use***

# Finance Department

## Personnel and Duties

The Finance Department employs thirteen staff members, including:

- Director of Finance/Treasurer (1)
- Finance Manager (1)
- Accounting Technicians (4)
- Refuse & Recycling Manager (1)
- Accountant (3)
- Administrative Aid (2)
- Payroll Technician (1)

The Finance Department is responsible for these services:

- General Accounting
- Budgeting
- Investments
- Cash Management
- Utility Billing
- Collection of Taxes, Assessment Fees, and Fines
- Issuing and Maintenance of Business Licenses and special event permits

In addition to these financial services, the Finance Department administers the City's refuse collection service and recycling programs. The Department works closely with the Public Works Department, which is responsible for meter reading and usage entry into the Finance Department's Springbrook Utility Billing System.

The department currently does not use GIS directly. GIS users in the Finance Department will be Level 3 GIS Users (see Chapter 2: GIS Organizational Structure and Staffing for more information on Level 3 GIS Users).

## Hardware and Software

All Finance Department PCs have the Windows XP or Windows 2000 operating system (citywide standard).

The Finance Department uses the following software applications:

1. MS Office
2. Springbrook (Utility Billing)
3. Bi-Tech Financial System
4. In-house applications for budgeting, special event permits, work orders and lien database.

The Finance Department currently does not use any GIS software.

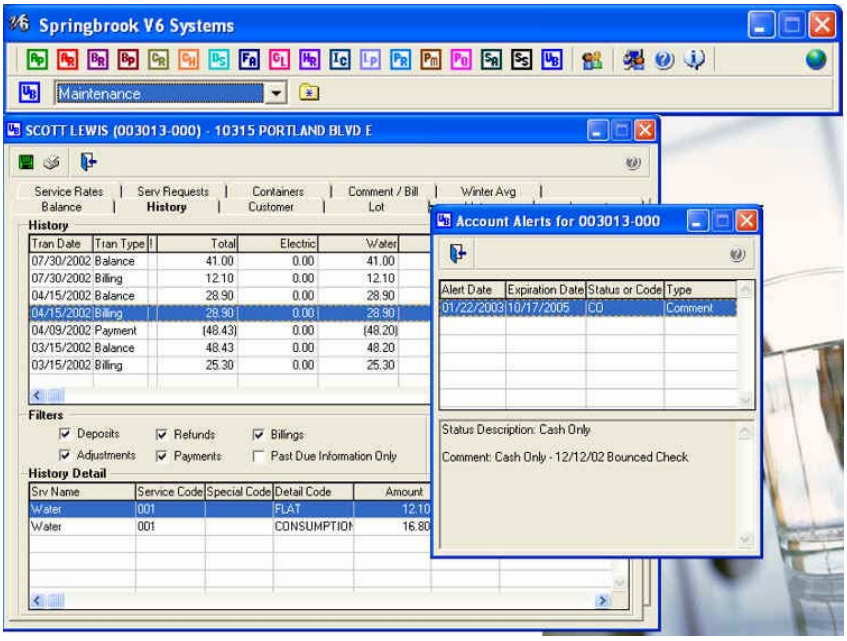



***Figure F-1.1: Springbrook Interface***

## GIS Needs and Duties

The Finance Department is poised to take advantage of GIS in support of various departmental functions. The Department has several GIS needs, including:

- Mapping analysis in support of finance operations
- Use of GIS as an auditing tool
- Special district administration
- Utility rate determination
- Customer service routing
- Mapping liens

The Department will be able to address many of these needs by utilizing an Intranet GIS application in conjunction with support from the GIS Specialist.

An Intranet GIS data browser is recommended for Finance personnel to conduct basic spatial analysis and to produce maps. For advanced analysis and other tasks such as data creation, the Finance Department should work with the GIS Specialist, who can use advanced GIS software such as ArcView or ArcInfo to conduct many of these tasks; the GIS Specialist may also be called upon to create other cartographic products in support of Finance operations.

It is also recommended that the GIS Specialist implement a GIS-based routing application. Routing analyses, such as customer service routing, can be performed using ESRI's Network Analyst in conjunction with ArcGIS.

### Mapping and Spatial Analysis in Support of Finance Operations

GIS can be utilized to provide support of Auditing, Special District Administration, Utility Rate Determination, Customer Service Account Tracking, and City-Owned Property/Asset Tracking; these analyses should be conducted by the GIS Specialist, with guidance and support from relevant Finance personnel. Finance Department personnel indicated that

they would like to map the location of each City-owned property, in order to display, query, and analyze this data in conjunction with other City of West Sacramento spatial data layers. In order to create this layer, an accurate address or knowledge of the location of each property must be obtained. City property records can be address-matched to a street centerline layer, and the resulting points can be moved to the center of the structure by using aerial photography.

Once a City-owned property layer is created, records can be updated directly into the GIS layer, or other data, such as Springbrook data can be periodically extracted to create an updated data layer. Initial data creation can be outsourced, or the Finance Department can request assistance from the GIS Specialist. Mapping and spatial analysis can be conducted via an Intranet GIS data browser.

☑ GIS as an Auditing Tool

The Finance Department identified auditing as a key issue for GIS-based analyses. Utilizing the City's parcel data, GIS can be utilized to determine parcel-specific utility information, such as which parcels have service, wells, and/or septic systems; audits on unimproved properties can also be performed. In addition to utility service audits, GIS can be utilized to compare commercial water service with active permits.

In order to make these audits viable, several new data layers will need to be created by extracting information from several databases, including the utility billing database. The GIS Specialist can assist in data creation and complex spatial analyses; mapping and identification of utility service within parcels can be conducted by Finance personnel through use of an Intranet GIS application.

☑ Special District Administration

Another key issue identified by Finance personnel is special district administration. A quick success that can be gained with GIS is a parcel validation analysis based on the Yolo County Assessors fiscal year tax roll. Parcel validation should include a comparison of values based on frontage, square footage, or flat fee. This analysis can be performed utilizing the City's parcel layer in conjunction with the tax database. In addition, information stored within the Accela database can be used to determine franchise garbage haulers (in relation to parcels) and whether appropriate fees have been assigned.

☑ Utility Rate Determination

GIS analyses can also be used to assist with utility rate determination. Housing and parcel information, such as number of bedrooms per property (utility customer), parcel size, and parcel size less building square footage, can be utilized to determine flat rates for water billing; number of bedrooms can be utilized to determine flat rates for sewer billing.

☑ Customer Service Routing

Yet another key issue identified by Finance Personnel is customer service routing for meter reading, street sweeping, and refuse collection. The City's street centerline layer can be used to allow customer service personnel to conduct optimal routing for meter reading, street sweeping, and refuse collection. It is recommended that the Department work with the GIS Specialist to implement a preliminary GIS-based routing application; the application should provide staff with the ability to print route maps. Pending successful implementation of a routing application, it is also recommended that the GIS Specialist should enhance the routing application, as required, to include any additional data or functionality identified by the Finance Department. GIS analyses to determine mailing addresses for new routes should

also be implemented. Another opportunity for customer service is the utilization of a GIS-based Reverse 911 application. Reverse 911 technology can be used to notify customers of maintenance, schedule changes, and past-due billing. More information on Reverse 911 applications is provided in the GIS Applications section below.

ArcGIS Network Analyst is recommended for use in customer service routing. By utilizing Network Analyst, Finance Department will be able to conduct:

- Drive-Time Analysis
- Point-to-Point Routing
- Route Directions
- Service Area Definition
- Shortest Path
- Optimum Route
- Closest Facility
- Origin Destination Matrix

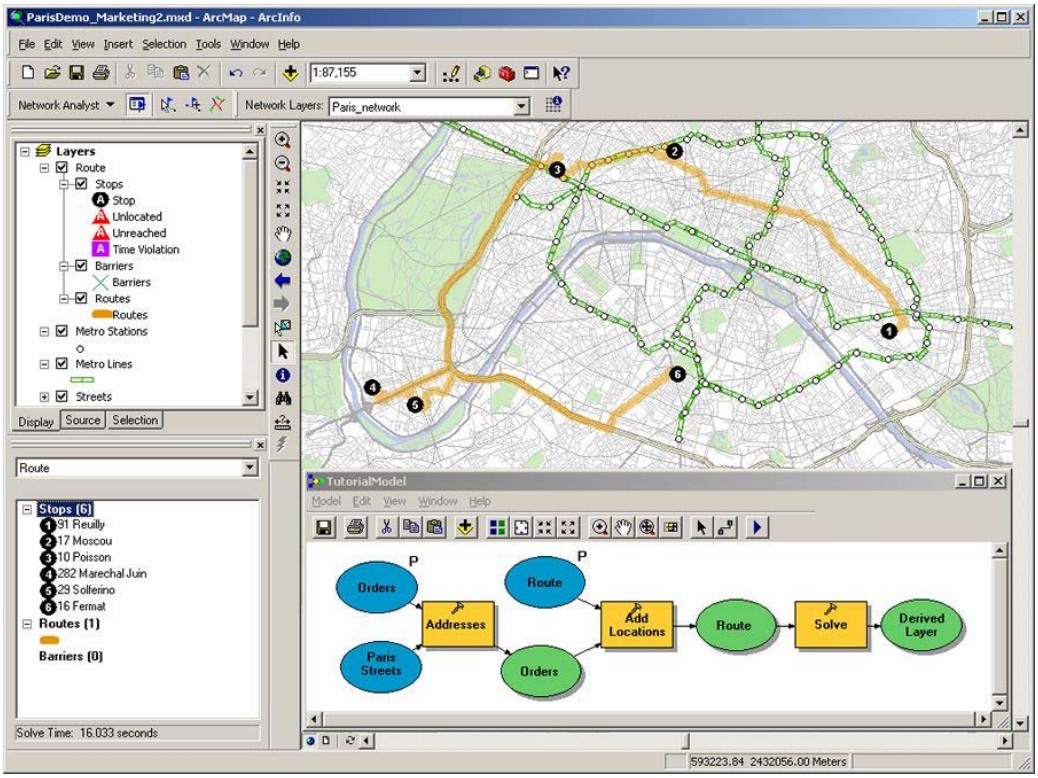



***Figure F-1.2: ArcGIS Network Analyst Interface (Note the model builder on the bottom of the screen)***

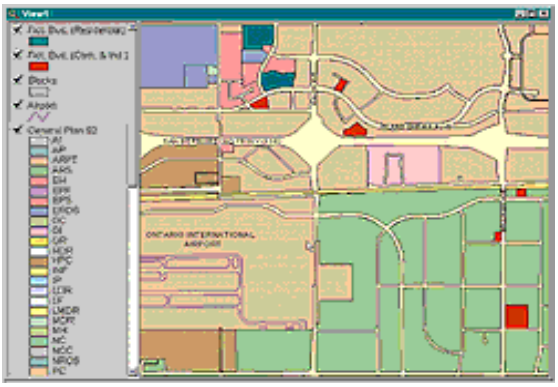
Unlicensed Business Tracking

Department staff indicated that querying and mapping unlicensed business is a key need. In addition to creating a property layer, the Department should work with the GIS Specialist to create dynamic data layer that provides up-to-date business license information, based primarily on utility billing information stored in Springbrook. GIS has proven to be a valuable tool for unlicensed business analysis and increased revenue generation (see Case Study section below). This type of analysis should be conducted in conjunction with the GIS Specialist.

Mapping Liens

The City maintains a lien database that identifies the parcels that have delinquent utility liens, mortgage liens and police liens. Finance personnel identified a need for utilizing GIS to map this lien information. It is recommended that as with unlicensed business tracking, the Department should work with the GIS Specialist to spatially enable the lien database. Mapping and analysis of this information can be conducted utilizing an Intranet GIS data browser (see GIS Applications below); in addition, the GIS Specialist can provide additional mapping and analysis support.

Case Study: The City of Ontario, CA Collects Revenue More Efficiently



Faced with the uncertain economic climate in Southern California in 1993, many cities realized they needed to collect existing revenues more vigorously. Noncompliance with local business licensing laws was costing them thousands of dollars in lost license fees and sales tax, and uncollected penalties.

Instead of simply spending more staff time using the same old collection methods, the City of Ontario "built a better mousetrap" using the City's GIS. The resulting application was less labor intensive and produced far more revenue than more traditional methods.

Ontario, located in Southern California, has 6,000 businesses in its 36.8-square-mile jurisdiction. The potential revenues to be gained were enticing but the task of physically inspecting all businesses in the City was formidable. The traditional method of finding illegally-operating businesses required employees of the Revenue Division to canvass each neighborhood block by block on foot and then manually cross-reference licenses and inspections.

The revenue application began as a request from the Revenue Division for a map showing the commercial and industrial locations in the City. Revenue Division staff would be sent out to do a physical inventory based on this map that would focus their efforts and eliminate areas where businesses were very unlikely to be found. This original plan would have increased the efficiency of the physical inventory, but GIS staff realized that this audit could be more effectively done without ever leaving City Hall.

A pilot program was devised to test the GIS audit concept. Using ArcView GIS, staff searched the land use database for all parcels containing two or more commercial or industrial uses such as high rises, shopping centers, or industrial parks. The data associated with the assessor's parcel number (APN) were extracted and cross-referenced to the privilege license data file.

All parcels lacking a sufficient number of licenses for the reported uses were matched to the property owners and property management firms. Five hundred and seventy parcels were found that fit this profile. Mailing labels were generated from the privilege license database and generic letters sent to all property owners or management firms requesting a list of tenants.

The tenant list created from the responses obtained was run against the privilege license file. Tenants without privilege licenses were identified and notified by mail. Funds, not only for delinquent licenses but also for sales tax, were collected without staff having to walk a single City block.

The $114,972 collected by the pilot program was just the beginning. Privilege license recovery is the gift that keeps on giving. Once businesses have been identified and entered into the city database, they become an ongoing source of revenue. This revenue was realized using just two hours of staff time from the GIS department to perform the property searches and analysis, generate files, and create labels, all at a cost of just $30. This contrasts sharply with the 117 hours and $13,062 that would have been needed to perform a traditional field inventory.

GIS is effective because it taps into the geographic component--whether it is an address or a parcel number--that ties city database files to locations in the real world. This makes "invisible" businesses magically appear. Businesses present in the parcel layer are conspicuous by their absence from the privilege license database.

Not only does GIS allow efficient analysis of city databases for revenue auditing, but it is a project management tool for conducting and monitoring audits. The area to be audited can be divided into manageable chunks so that staff is not overburdened. Map-driven audits allow for a systematic inventory of the entire city in a timely fashion. Areas of noncompliance can be targeted. These project management benefits of GIS audits are intrinsic. No extra project management program requiring staff training time and maintenance is required.

The ease of use of ArcView GIS coupled with the ability to customize the interface and functionality for users meant the system could move into the department with a minimum of training and resistance. The application has been popular with Revenue Division staff who appreciate that it makes them much more effective. "By using the GIS technology, it has certainly made my job easier, faster, more accurate, and efficient. I am able to audit for unlicensed businesses by computer and maps rather than complete field work. GIS is great!" says Pansy Welton, auditor/collector for the City of Ontario.

Because ArcView GIS is able to easily integrate data from many sources, city license files can be run against commercially available data sets such as MetroScan and TRW. These data sets are a cost-effective way to get data that are updated much more frequently than assessor's data. Geocoding verifies data from city files by forcing data back into the database that would otherwise drop out if selections were made by areas such as ZIP Codes or census blocks.

A natural progression from the Privilege license Audit was the Commercial Property Audit, which identifies owners of commercial land who lease out their properties but do not pay privilege license or sales taxes to the City as required. While the traditional Commercial Property Audit found $27,000 worth of license income, the GIS implementation of the same audit generated $200,000.

The success of the privilege license and commercial property audits quickly led to revenue audits for other fees and licenses. The City of Ontario currently performs GIS audits on industrial parks, commercial properties, warehouse properties, and on the downtown assessment area, as well as creating maps for outside consultants to use in field audits.

The newest auditing application is the Fictitious Business Name Audit. It is not uncommon for businesses to file a "Doing Business As" statement with county, state, and federal agencies, but to then fail to obtain a current local privilege license. Ontario purchased the "Doing Business As" county database file for a mere $5, ran the file against City records, and uncovered illegally operating businesses that were not previously found.

Chris Thomas, former GIS Specialist for the City of Ontario and now local government industry manager at ESRI, originated and refined revenue auditing for Ontario. He strongly believes starting a GIS program with revenue auditing may be the best route for many cities currently without GIS capabilities. "Revenue auditing with GIS allows a city to grow their GIS by quickly producing revenue and enlisting the support of city officials," says Thomas.

## GIS Data Layers

The Finance Department will benefit from access to several other departmental GIS data layers. It is expected that once all departmental data is integrated, consolidated, and centrally stored, that staff will have access to **all** non-classified GIS data layers from other City departments.

Finance Department personnel expressed that access to the following GIS data layers would be beneficial:

| *Data Layer* | *Creation Methodology* | *Recommended Update Division or Individual* | *Existing or Recommended?* |
|---|---|---|---|
| **Address Points** | Extract, cleanse, geocode, and map from Springbrook; georeference based on aerial photography and GPS field work | Automated; GIS Specialist; Drafting Services Section | Recommended |
| **Aerial Photography** | Fly-over with control points | GIS Data Services Vendor | Recommended |
| **Census Data** | Download from Census Bureau →http://www.census.gov/geo/www/census2k.html | GIS Specialist | Recommended |
| **Certificates of Compliance** | Extract, cleanse, geocode and map from Permits Plus database | Automated | Recommended |
| **City-owned Property** | Extract, cleanse, geocode, and map from Yolo County tax roll; other map sources as required | Automated | Recommended |
| **Commercial Addresses** | Extract, cleanse, geocode, and map from Springbrook | Automated | Recommended |
| **Enterprise Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Facilities** | Digitize on screen; aggregate layers as needed | Drafting Services Section | Existing |
| **HUB Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Land Use** | Digitize polygons from aerial photographs and existing maps; existing CADD data | Drafting Services Section | Existing |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Licensed and Unlicensed Businesses** | Extract, cleanse, geocode, and map from in-house database | Automated | Recommended |
| **Parcels** | Acquire from Yolo County | Yolo County ( and GIS Data Services Vendor) | Recommended |
| **Parks** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Port** | Digitize features from aerial photographs and other maps | Drafting Services Section; GIS Specialist | Recommended |
| **Real Estate Sales** | Geocode and map from MLS database | Automated | Recommended |
| **Schools** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Sewer Fees Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Storm Drain Fee Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Streets** | Derived from aerial photography; GIS Consortium | Drafting Services Section | Existing |
| **Tax Assessment Districts** | Aggregate parcels and assessor data; other sources, such aerial photography, as needed | GIS Specialist | Recommended |
| **Vacant Properties** | Query from parcel layer; other sources as needed | GIS Specialist (eventually automated) | Recommended |
| **Waterways** | Digitize polygons from aerial photographs and existing maps | Drafting Services Section; GIS Specialist | Recommended |
| **Zoning** | Based on existing maps; General Plan | Drafting Services Section | Existing |

Additional layers may be required as the department increases its GIS utilization and incorporates additional field data.

## GIS Applications

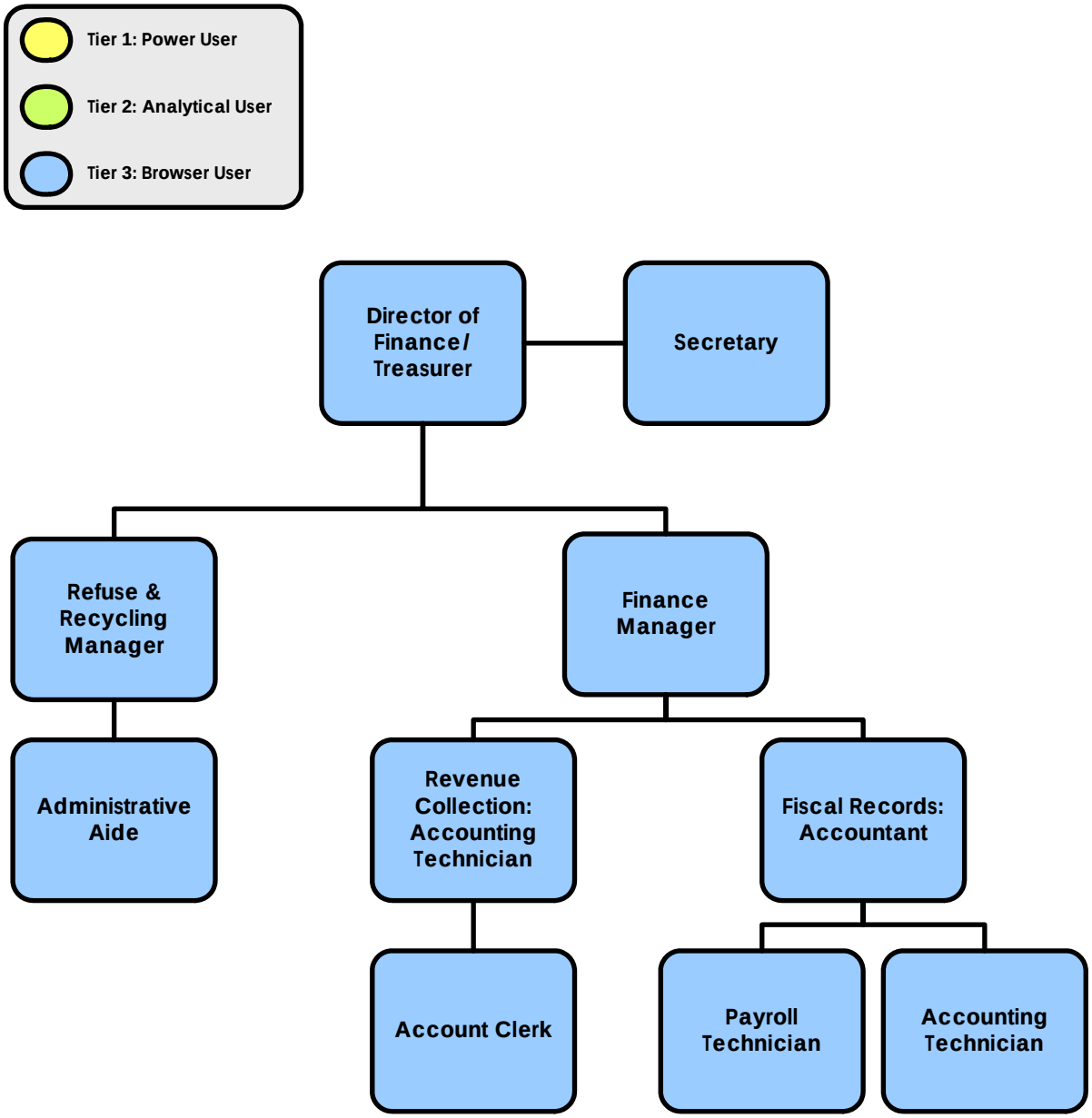
To meet all of the Department's GIS goals, as outlined in the previous sections, the following GIS software is recommended. A detailed description of each of the recommended applications, where applicable, is provided in the Enterprise-wide application section later in this chapter.

### Intranet GIS Data Browser

An Intranet GIS data browser has been recommended for use by Finance Department Personnel. A full description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

## Multi-Tier GIS Application Use within the Finance Department

The following chart describes the recommended GIS application use by the Finance Department. A Tier 1 user is a power GIS user who should have access to a fully functioning GIS toolset. A Tier 2 users focus is data analysis in addition to general browsing capabilities. A Tier 3 user requires only general browsing GIS data functions. The Finance Department will consist of Tier 3 users.




***Finance Department Multi-Tier GIS Application Use***

# Fire Department

## Personnel and Duties

The Fire Department employs fifty-five staff members, including:

- Fire Chief 1
- Division Chiefs (4)
- Office Manager (1)
- HAZMAT Manager (1)
- Fire Inspector (1)
- Captains (12)
- Engineers (15)
- Firefighters (18)
- Administrative (2)

The West Sacramento Fire Department has the mission of protecting life, environment, and property within the City of West Sacramento. To effectively complete this mission, the Department has located four fire stations throughout the City, each of which houses one front line fire engine equipped to handle a variety of emergency calls. The four fire stations operate 24 hours a day, 7 days a week with a combined staffing of 15 personnel on duty. Firefighters work 24-hour tours of duty. There are three work groups called "shifts". Additionally, an off duty Division Chief is assigned as Duty Chief to respond to all structure fires and other major emergencies to provide Incident Command and Scene Management.

Outside the City limits, the Fire Department is responsible for the unincorporated area south of the City of West Sacramento boundary to Babel Slough Road and across to the old Arcade Station on Jefferson Blvd. The Fire Department has Automatic Aid agreements with Yolo County Fire Departments, and a Mutual Aid agreement with the City of Sacramento Fire Department.

The current Fire Department response standard is that an appropriately staffed unit will arrive at the scene of an emergency within the city limits in five minutes, 95 percent of the time from the time of fire crew notification. Five minutes is comprised of 1-minute “turnout” time (to hear the dispatch, don the appropriate protective clothing and get the apparatus moving), plus 4 minutes of actual driving time.

The Fire Department has three divisions, which provide a wide range of services for the community. These divisions are:

- Emergency Services
- Fire Prevention /Hazardous Materials
- Fire Administration

The Department currently does not utilize GIS; a GIS-based study was conducted for the Fire Department (see GIS for ISO Rating Improvement section below).

The City of West Sacramento Fire Department responded to a total of 5,205 calls for service in 2002.

## Hardware and Software

The Fire Department currently has over 23 PCs. All Fire Department PCs have either the Windows XP or Windows 2000 operating system (citywide standard).

The Fire Department uses the following software applications:

1. MS Office
2. FirePoint
3. MS Visio

The department utilizes the aforementioned software in varying capacities. Currently no GIS software is utilized by any Fire Department personnel. FirePoint, the Department's Record Management System (RMS), can be spatially-enabled by extracting and mapping information maintained in the FirePoint database. However, Department personnel identified the potential need for migrating to a different RMS application. Should the Department decide to migrate to a different Fire Department Records Management System (FDRMS), it is recommended that the City's GIS Specialist be included in the decision-making process to ensure that the new FDRMS can be closely integrated with the City's GIS platform. Potential FDRMS applications include HTE's FIRES Management System, FireHouse software, and Tiburon Fire RMS.

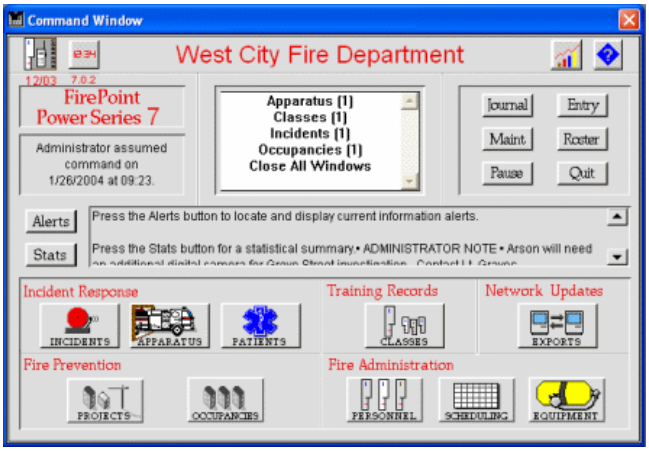
### FirePoint

FirePoint has 40 fire service applications that can be deployed from a main interface. Users can run several FirePoint applications simultaneously in different windows.

FirePoint Client Server utilizes easy-to-maintain server technology for fast data access over fire department networks. Systems are matched to the networking capabilities of a fire department. FirePoint single-user systems can operate on one PC or forward incidents, apparatus, patient and training records over a network for merging on a single PC.

Key features available in FirePoint include:

- User defined fields
- Spell checking
- Digital camera interface
- Graphic report generators
- Multiple processes, multi-tasking




***FirePoint Interface***

## GIS Needs and Duties

GIS will be crucial in the Department's evolution to integrate technology in support of incident response and fire safety. The Fire Department will be able to utilize GIS in day-to-day tasks, such as vehicle tracking, incident response, and public outreach. In addition, the Department will also be able to utilize GIS for strategic objectives, using sophisticated analyses to improve decision-making as well as reducing response times.

Based on this needs assessment, the Fire Department has several GIS needs, including:

- Spatial analysis of fire incidents and inspections
- GIS for ISO rating improvement

- Field access to geo-spatial data
- Automatic vehicle location (AVL)
- Public access to geo-spatial fire data

Spatial Analysis of Fire Incidents and Inspections

The Fire Department should work with the GIS Specialist to gain quick successes based on mapping and analysis of fire stations, response times (see GIS for ISO Rating section below), hazards, and incidents.

Fire Department staff should utilize an Intranet GIS data browser to conduct basic spatial analysis and to produce maps. There are several commercially available solutions that can facilitate the types of analysis required by the Fire Department. For more advanced analysis and other tasks such as data creation, the Fire Department should work with the GIS Specialist, who can use advanced GIS software such as ArcView or ArcInfo to conduct many of these tasks; the GIS Specialist may also be called upon to create other cartographic products for the Fire Department.

It is also recommended that the Fire Department purchase a GIS data browser application for use in vehicle computers as well as computers used by field personnel. Although the Department currently does not utilize mobile computers in vehicles, it is recommended that the Department procure these resources as a long term goal; one option is to implement a pilot project, with one or two mobile computers and the recommended GIS data browser, to determine the feasibility and viability of field-based mapping and analysis. Incident information that resides in the Department's FirePoint Records Management System can be extracted and the location of each incident mapped via its address. Applications such as GeoManager (or Safe FME), which allows integration of legacy database systems with GIS, can be used to extract data from FirePoint. Please refer to the GIS Applications section of below for more information on a GIS data browser, FME, and/or GeoManager.

The Fire Department can utilize GIS to assist in several tasks, including:

- Reducing the Insurance Services Office (ISO) rating
- New station location analysis (see Figure FD-1.1)
- Tracking hazardous materials
- Optimizing and reducing response times
- Optimal routing
- Optimal districting
- Evacuation route planning
- Incident Pin mapping
- Arson Fire mapping
- Drive-time studies
- Viewing alternate street routes
- Showing inspected businesses and location of code violations
- Statistical analysis for budgetary preparations
- Using maps to train personnel
- Optimal spill response – downstream and upstream tracing
- Evacuation route planning
- Using maps for training personnel
- Homeland Security activities

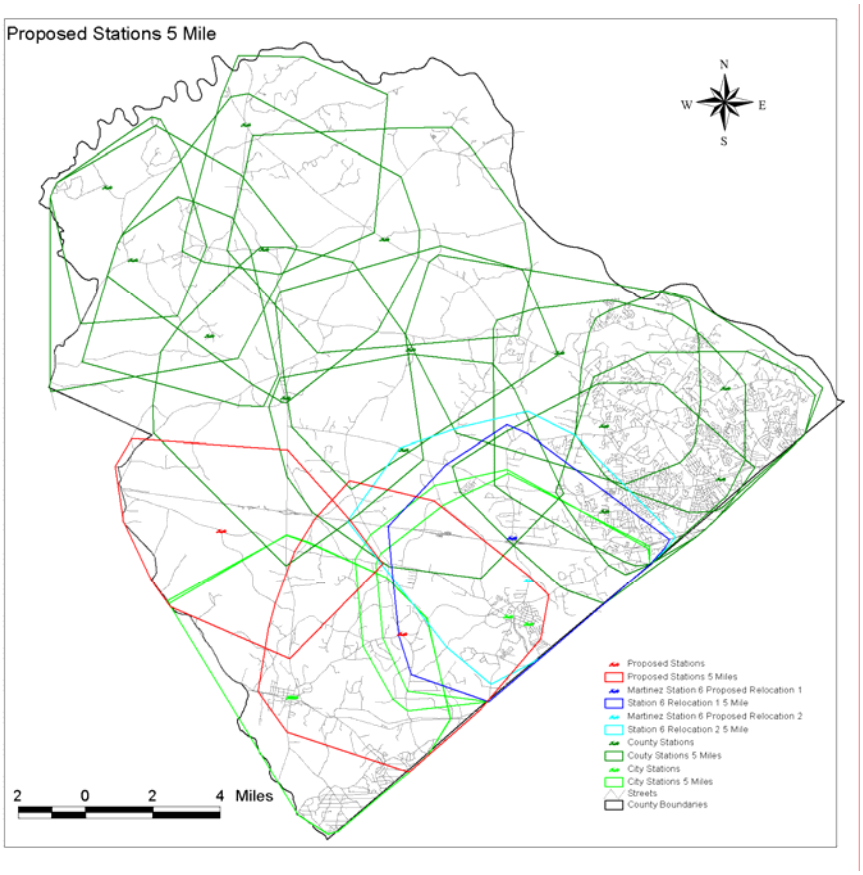
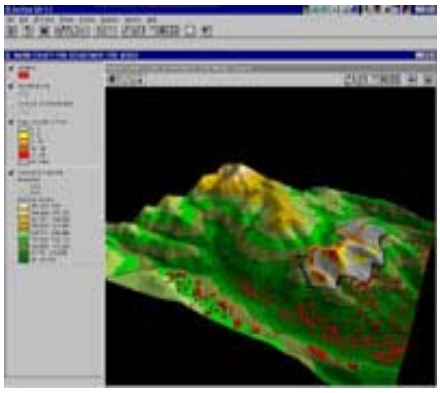



***Figure FD-1.1: Fire Station Location Analysis Using GIS***

Department staff indicated that one of the priorities for GIS use within the Department is the reduction of response times.

Case Study: Fire Agencies Improve Response Time with GIS

Fire agencies on all levels strive to preserve lives, property, and natural resources. Many agencies have embraced GIS as a tool that helps them balance needs, uses, and hazards to promote sustainability of the environment while identifying and limiting vulnerability.



Effectively handling fires, whether structural fires in densely populated areas or wildfires raging over thousands of acres of forested land, involves planning strategic response on a regional scale, developing a tactical response for a specific event, formulating and carrying out a mitigation program, and analyzing incident data to improve policies and training programs- all activities enhanced by GIS. GIS-based fire tools range from Internet applications using Internet Map Server (IMS) technology to desktop applications developed using ArcView GIS and its extensions to sophisticated real-time enterprise-wide applications using ArcInfo.

*Developing Regional Strategies*

Strategic planning answers three location-based questions: Where are the hazards? Where are the areas at highest risk? Where are the most valuable resources located? GIS is especially suited to answer these queries. Typically, strategic plans are made on a regional level with all agencies that have jurisdiction in the region involved in planning or at least agreeing to basic strategies.

Overlaying vegetation data with topography and transportation networks shows where fuel is present and identifies areas that may be hard to reach. Mapping historical data on fires, lightning strikes, arson activity, and other related events available from databases and paper records showing where fires occurred in the past can be used to gauge the likelihood of future fires. Finally, resources that are required to manage and recover from a fire such as water sources or transportation networks or resources that represent an unacceptable loss such as a hospital must be located. Aggregating data representing hazard, risk, and value factors for a region identifies areas with the highest priority.

Geography can provide a framework for organizing data from many sources that relate to fire strategy development. GIS, with its data integration and visualization capabilities that foster collaboration, is the natural vehicle for an intraorganizational and interagency development of strategic plans. GIS improves fire response by centralizing data in many formats and from many sources and integrating it with other technologies such as GPS. This means current information is quickly delivered in an easy-to-grasp format. In addition, powerful modeling capabilities, available from the desktop as well as on workstations, let planners model what-if scenarios to test the soundness of strategies. Fire agencies have exploited the power of GIS to their advantage in all types of settings.

The Cedar City Interagency Fire Center (CCIFC) in Cedar City, Utah, dispatches fire personnel for a number of agencies including the Bureau of Land Management, the National Park Service, the Bureau of Indian Affairs, and the State of Utah. When responding to a fire, CCIFC dispatchers plot real-time GPS positions and reference them against the GIS, which contains data on ownership; roads; wildlife habitats; slope classification; fire fuels; zones of moderated suppression; and other related themes that consolidate text, tabular, and other data previously available only from wall maps, manuals, and separate databases. Now dispatchers need only query an area to obtain concise instructions on the constraints and objectives for the area in question.

*Making a Tactical Fire Plan*

With a strategic plan in place, a more effective tactical plan can be developed. By having information on the risk to an area coupled with an idea of the location of the most valuable resources in the area, fire management can determine how and where to allocate resources when a fire does occur. Prior to an event, management can organize fire prevention activities and position suppression resources where they will be most effective. This means fire prevention budgets are spent in the most beneficial manner and resources can be used in ways that maximize protection to fire personnel as well as lives, property, and natural resources. In a typical scenario involving multiple fires, the agency managing the event has to allocate resources between

competing areas. However, by developing both strategic analysis and a tactical plan, prioritizing areas and allocating resources will be optimized.

*Improving Response*

Responding to a specific incident requires more information than strategic planning. The analysis of hazard, risk, and value is revisited in much more detail. In the case of wildfires, data on topography such as slope and aspect as well as vegetation, weather, transportation, and other factors are used to further assess the risk for an area. Data on previous fire occurrences coupled with land use patterns and management goals give a more refined view of risk for this area. Value is determined by standard inventory types such as inhabited places or timberlands.

The Mapping Services Section for the Ventura County Fire Protection Agency, managed by Jim Kniss, has integrated GPS data with GIS to rapidly get crucial information into the hands of incident commanders. The agency has created a series of custom ArcView GIS extensions that import GPS data gathered by flying the perimeter of the fire and use standard Incident Command System symbology. These standard extensions can generate an initial attack map within 30 minutes of acquiring the incident data. The Mapping Services Section, which is responsible for all mapping products and services, also generates emergency response map books for all fire companies and cooperating agencies, wall maps for each fire station, and special tactical maps.

Tactical response planning in an urban setting requires street network data, information on hazardous materials locations, and prefire survey information such as floor plans or hydrant location and capacity data. The Winston–Salem Fire Department in North Carolina implemented a system that uses ruggedized PCs mounted on emergency vehicles that run a custom GIS application built using MapObjects and NetEngine. The application displays a map showing the optimal route to the emergency. This route can be instantly modified to take into account streets that are blocked. The application also provides information on all available fire hydrants, any known hazardous materials in the area, the locations of special needs populations, and other pertinent information. A touch screen lets firefighters pan and zoom on the map and use icons that link the GIS application to additional information such as floor plans, diagrams, or other prefire survey information.

*Developing Mitigation Procedures*

Determining where and how much vegetation must be cleared around structures and developing appropriate construction material standards are just two methods for mitigating the effects of fires. The City of Laguna Beach, California, has used GIS to pursue both policies. In 1993, a fire driven by high wind conditions caused extensive damage to the City and resulted in the loss of 286 homes. The City has used GIS to help rebuild the portions of the community that were destroyed in the fire. GIS proved so useful that it has been adopted as a tool to improve City operations. As a result of the 1993 fire, Laguna Beach extensively updated the safety element in the General Plan. The availability of mapping, aerial photographs, and analysis tools in GIS helped speed and improve the revision process. The new safety element includes an emergency routing program and fuel modification specifications and requires an emergency preparedness plan that is updated on an annual basis. Zoning Analyst, a custom ArcView GIS extension developed by ESRI business partner Geographic Information Services, Inc., assists planners in providing public information, processing cases, generating public notification letters, and producing maps.

*Better Policies*

Not only is GIS used to develop and implement fire mitigation policies for local governments, but it can also help improve the policies and practices of fire agencies. Using GIS to model the terrain, path of the fire, weather conditions, and personnel movements during a fire incident illustrates the interaction of these factors in a way that is impossible with written reports.

Modeling data from the South Canyon fire that led to the deaths of 14 firefighters near Glenwood Springs, Colorado, in 1994 vividly demonstrated how the weather and terrain affected the path taken by fire. DEM data was modeled using the ArcView 3D Analyst extension, and attribute data created from scanned maps and aerial photos from the official report was incorporated into the model. Studying incidents such as the South Canyon fire using GIS can help improve fire response policies and training to minimize danger to firefighting personnel.

**Case Study Courtesy of ESRI ArcUser Magazine*

GIS for ISO Rating Improvement

The City of West Sacramento's Fire Department can use GIS to improve its ISO rating. Less expensive fire insurance premiums are the result of a lower ISO rating. The ISO rating process requires fire departments to have the following resource documents and mapping capabilities:

a. *Community Street Map – To Scale*
   Plotted information Base
   - Named streets
   - Community boundary lines
   - Areas NOT built upon
   - Fire Station locations

b. *Community Water Map – To Scale*
   Plotted Information Base
   - Named streets
   - Water mains by size
   - Fire hydrants – numbered
   - Water tanks / Storage – capacity
   - Water pumping stations
   - Pressure zone(s)
   - Static water suction points
   - Dry hydrants

c. *Map – Drawings of Water Supply Works*
   Plotted Information Base
   - Intake supply line – size
   - Filtration-Purification Arrangement – capacity gpm
   - Pump Arrangement – capacity vs. head
   - Clear well(s): arrangement/capacity
   - Primary feeders: size arrangement

d. *Fire District Map – To Scale*

Plotted Information Base

- Fire Protection Response Boundary – served by community
- Five mile response boundary
- Boundary of areas served by hydrants
- Static water suction points
- Dry hydrants
- Bridge capacities
- Schools
- Shopping Centers
- Commercial Centers

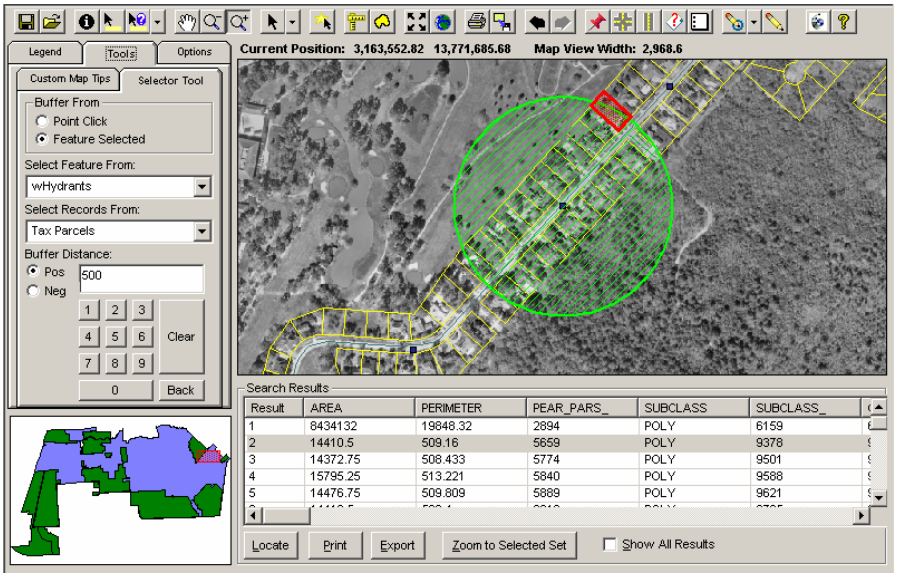



***Figure FD-1.2: Using GIS to Improve ISO Ratings. A Query Based on 500 Foot Buffer around a Fire Hydrant Shows Which Properties Can Be Reached***

e. *Regional Fire Protection Map – To Scale*

Plotted Information Base

- Location of automatic aid companies
- Location of outside aid companies

The Fire Department and GIS Specialist should build on the "Deployment Analysis to Determine Fire Station Determine Fire Station Coverage" study conducted by CityGate Associates in October 2003. This study utilized GIS to analyze and derive a variety of information about the Fire Department's fire response and station locations. Maps produced for the study included Existing Stations RHAVE (Risk, Hazard, and Value Evaluation) Scoring, Distribution 4/8 Min Travel Time (see Figure FD-1.3), Existing Stations and Alternate Proposed Locations, and various response/travel time analyses. Several GIS data layers were produced for the analysis, including "best-fit" stations, structures, incidents, routes, and drive times. This study is a showcase of the power of GIS and how it can benefit the Department.

It is recommended that the Fire Department continue to utilize GIS to analyze its station locations as well as its response to incidents. The 2003 study provides a great foundation for the GIS Specialist, who can use the analyses and summary report as a baseline for future fire station and response time analyses. In addition, the data produced for the project should be leveraged, updated as needed, and integrated as part of the City's enterprise GIS data.

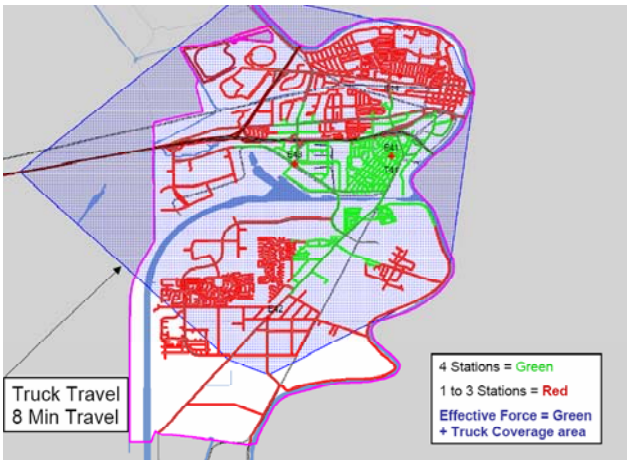



***Figure FD-1.3: Existing Concentration—8 Minute Travel Time Map Produced for "Deployment Analysis to Determine Fire Station Determine Fire Station Coverage" study***

☑ Field Access to Geo-Spatial Data

There are two methods for Fire Department personnel to access spatial information in the field:

I. Map Books
II. Mobile Computers

*I. Map Books*

The Fire Department utilizes hard copy map books. The Department may wish to transition away from the map books in the long-term because of the maintenance required for updating and distributing the map books.

*II). Mobile Computers*

A more advanced method for accessing spatial data in the field is through the use of mobile computers, including notebook computers, tablet PCs and hand-held computers. A GIS data browser can be loaded on mobile computers, allowing the same capabilities offered by map books, but also the ability to conduct address searches; query attributes of all information, such as hydrant type, flow rate, types of hazardous material stored at a location; link to digital site plan images, and more.

It is recommended that ruggedized notebook computers be purchased for each fire response vehicle. Notebook computers are preferable to tablet PCs or hand-held computers because of their increased memory and screen size. These notebook computers should be ruggedized to withstand the rigors of use in the field. A GIS data browser should be loaded onto each ruggedized note. These field computers can be configured with pre-loaded (static data) or utilizing wireless communications infrastructure, these computers (with GIS data browsers) can access data on a real-time basis.

It is recommended that the Fire Department have complete and accurate map books created for all response vehicles in Year 1 of this three-year phased GIS implementation. It is recommended that the Fire Department have preliminary GIS access via mobile computers for Year 1. Comprehensive GIS access (all users) via mobile computers is recommended for Year 2.

### Automated Vehicle Location (AVL)

Many fire departments are implementing Automated Vehicle Location (AVL) systems to monitor via GPS the location of all fire emergency response vehicles. AVL can also be used for any City vehicle. Knowing the location of fire vehicles will allow dispatchers to more efficiently allocate resources and improve response times. Additionally, the location of personnel in danger can be tracked. It has been said that if AVL can save the life of one officer, it is worth the investment.

The Fire Department should coordinate with the Police Department and YCCESA to conduct a review of available AVL systems. Ideally, AVL will be tightly integrated with the Computer-Aided Dispatch application implemented by YCCESA as well as the City's other GIS infrastructure and database systems.

The department should use AVL in conjunction with existing mobile computing equipment to ensure that this information can be viewed in data browsers in the field as well as in operations offices.

### Public Access to Geo-Spatial Fire Data

The Fire Department expressed the need to disseminate spatial information to the public by providing a mapping application that will enable the citizens to view and analyze fire risk information. The mapping application should incorporate the ability for the public to determine proximity to fire stations, hydrants, response times, and risk zones.

As part of the City's objective to provide an Internet GIS data browser, the Department should coordinate with the GIS Specialist to integrate departmental GIS data into the Internet-based application. In addition the Department should identify additional functionality that may be required in addition to the City's base enterprise offering.

A formal review and assessment process should be established prior to making any information available, as some data may be sensitive or confidential. Reviews should be coordinated with the GIS Specialist and approved by the Fire Chief and City Attorney to ensure that no sensitive or confidential data is distributed publicly.

More information on Internet GIS data browsers can be found in the Enterprise-Wide Applications section of this chapter.

## GIS Data Layers

The Fire Department will benefit from access to several other departmental GIS data layers. It is expected that once all departmental data is integrated, consolidated, and centrally stored, that staff will have access to **all** non-classified GIS data layers from other City departments.

Fire Department personnel expressed that access to the following GIS data layers would be beneficial:

| *Data Layer* | *Creation Methodology* | *Recommended Update Division or Individual* | *Existing or Recommended?* |
|---|---|---|---|
| **Address Points** | Extract, cleanse, geocode, and map from Springbrook; georeference based on aerial photography and GPS field work | Automated; GIS Specialist; Drafting Services Section | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Aerial Photography** | Fly-over with control points | GIS Data Services Vendor | Recommended |
| **Bad Bridges** | GPS data collection and integration with existing information | Fire Department; GIS Specialist | Recommended |
| **Bicycle/Pedestrian Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Buildings with Site Plans** | Manually digitize polygons from plans and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Census Data** | Download from Census Bureau →http://www.census.gov/geo/www/census2k.html | GIS Specialist | Recommended |
| **City-owned Property** | Extract, cleanse, geocode, and map from Yolo County tax roll; other map sources as required | Automated | Recommended |
| **Commercial Addresses** | Extract, cleanse, geocode, and map from Springbrook | Automated | Recommended |
| **Crime Data** | Extract, cleanse, and automatically map from Police VisionAIR database | Automated | Recommended |
| **Critical Facilities** | Manually digitize points from aerial photography and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Day Care Facilities** | GPS field work. | GIS Specialist; Redevelopment Agency | Recommended |
| **Drafting Water Sources** | GPS data collection; digitizing from existing maps | Fire Department; GIS Specialist | Recommended |
| **Easements** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Entrapment Areas** | Manually digitize polygons from aerial photography and other imagery | GIS Specialist | Recommended |
| **Facilities** | Digitize on screen; aggregate layers as needed | Drafting Services Section | Existing |
| **Fire Hydrants** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Fire Incidents** | Extract, cleanse, geocode, and map from FirePoint or in-house database | Automated | Recommended |
| **Fire Inspections** | Extract, cleanse, geocode, and map from FirePoint or in-house database | Automated | Recommended |
| **Fire Investigations** | Extract, cleanse, geocode, and map from FirePoint or in-house database | Automated | Recommended |
| **Flood Zones** | Acquire from FEMA (free to government entities) http://www.fema.gov/fhm/ | Drafting Services Section; GIS Specialist | Recommended |
| **Hazardous Materials** | GPS data collection for location; extract from FirePoint or other database once data is entered | GIS Specialist; Fire Hazmat MGR | Recommended |
| **Housing Condition Data** | Extract, geocode and map from database | Automated | Recommended |
| **Land Use** | Digitize polygons from aerial photographs and existing maps; existing CADD data | Drafting Services Section | Existing |
| **Levees** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Major Intersections** | Use street centerline layer as source | Drafting Services Section | Recommended |
| **Parcels** | Acquire from Yolo County | Yolo County ( and GIS Data Services Vendor) | Recommended |
| **Parks** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Port** | Digitize features from aerial photographs and other maps | Drafting Services Section; GIS Specialist | Recommended |
| **Schools** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Sewer Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Social Service Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Speed Zones** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Recommended |
| **Storm Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Streets** | Derived from aerial photography; GIS Consortium | Drafting Services Section | Existing |
| **Transit Routes** | Derive from street centerline layer; acquire from SACOG? | Drafting Services Section | Recommended |
| **Truck Routes** | Derive from street centerline layer | Drafting Services Section | Recommended |
| **Vacant Properties** | Query from parcel layer; other sources as needed | GIS Specialist (eventually automated) | Recommended |
| **Water Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Waterways** | Digitize polygons from aerial photographs and existing maps | Drafting Services Section; GIS Specialist | Recommended |
| **Zoning** | Based on existing maps; General Plan | Drafting Services Section | Existing |

The Fire Department would also like to link aerial photographs to mapping applications and scanned floor/structure plans to address points. The Fire Department should work with the GIS Specialist and the Building Department to determine additional layers that may be required as the Department increases its GIS utilization and incorporates additional field data.

## GIS Applications

To meet the Department's GIS goals the following GIS software is recommended. A detailed description of each of the recommended applications, where applicable, is provided in the Enterprise-wide application section later in this chapter.

### Fire and Incident Analysis

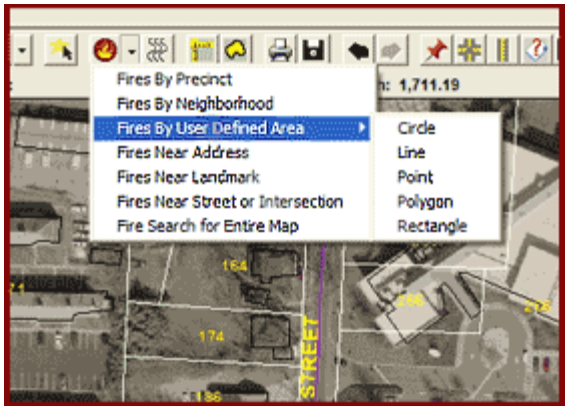
A fire and incident analysis application is recommended for use by the Fire Department (with support from the GIS Specialist) to help review existing deployment policies and develop new strategies. The application should allow the Department to integrate data from the FirePoint RMS with GIS allowing personnel map and analyze data. By identifying incident patterns and response effectiveness, resources can be more optimally redeployed.

The application should address NFPA Standard 1710 compliance. The following analyses providing information down to the street block level for all locations:

- First Due - Identify the first due within a specified response time.
- Running Order - Identify the full running orders.
- Concentration - Determine the number of stations able to respond within a specific response time at any location.
- Station Analysis - Analyze the response capabilities of Fire/EMS stations. Determine the estimated response zones and incident coverage by drive time.
- Response Comparison - Compare estimated response times with actual response times.
- Response Time Maps - Create average response time maps for any boundary layer.

Incident analysis should allow users to:

- Visualize incident patterns
- Map repeat calls
- Create density maps
- Analyze new station locations or relocations
- Maximize limited resources
- Adjust district boundaries
- Locate arsonists
- Map fires by proximity to landmarks
- Identify high risk areas
- Analyze trends over time
- Compare Fire/EMS data to demographic data

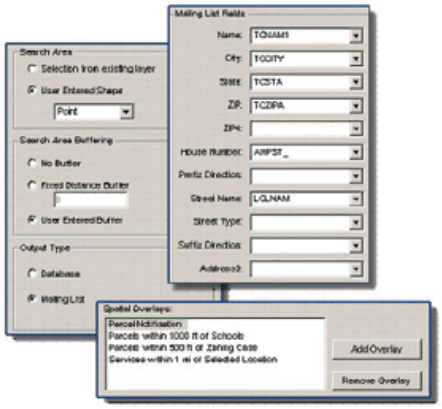


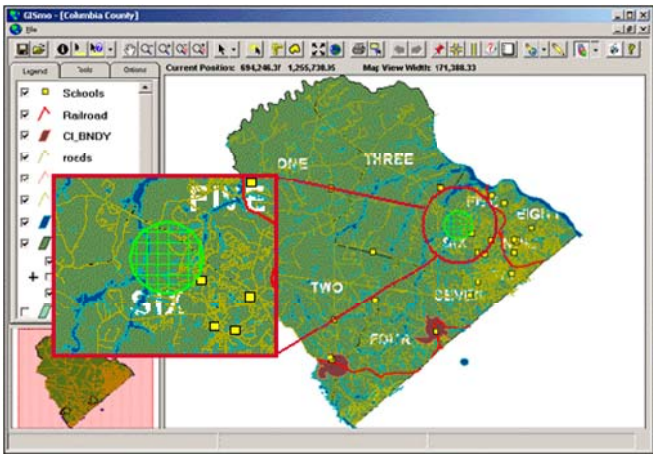

## GIS Data Browser

A GIS data browser is recommended for use in the Department's mobile and vehicle computers. The interface should allow for dynamic configuration of existing GIS data. Local government employees and staff have long required the ability to map and analyze existing GIS data. The GIS data browser should provide users with the ability to view, search, query, and browse GIS data in a quick and easy manner.

Features should include:

- Color, Scale Dependency, Labeling Options
- Field Alias and Filtering by Layer
- Network Centric Configuration
- Print Template Creator Tool
- Address Matching Settings
- Map Tip Configuration
- Search Configuration
- Export Data
- Print to Scale
- Annotate Maps
- Buffer Selection
- Spatial Selection
- Save & Load Projects
- Smart Intersection Finder



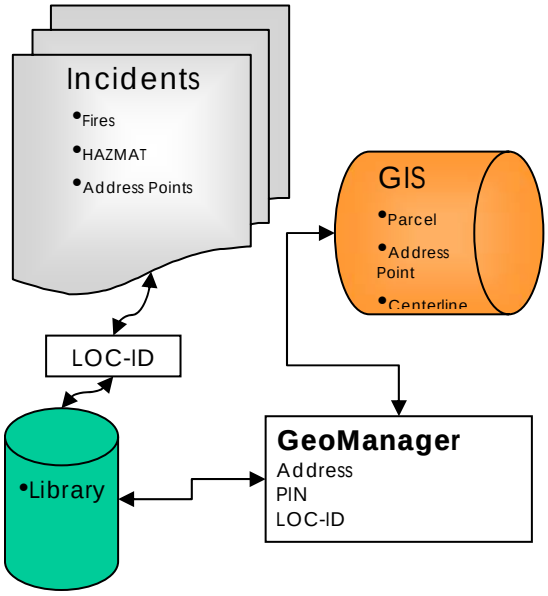



***Typical GIS Data Browser Interface***

Up to ten (10) license of a GIS data browser are recommended initially. Subject to the Department's utilization of such an application, additional licenses may be required in the future. More information on GIS data browsers is provided in the Enterprise-Wide Applications section of this chapter.

## GeoManager

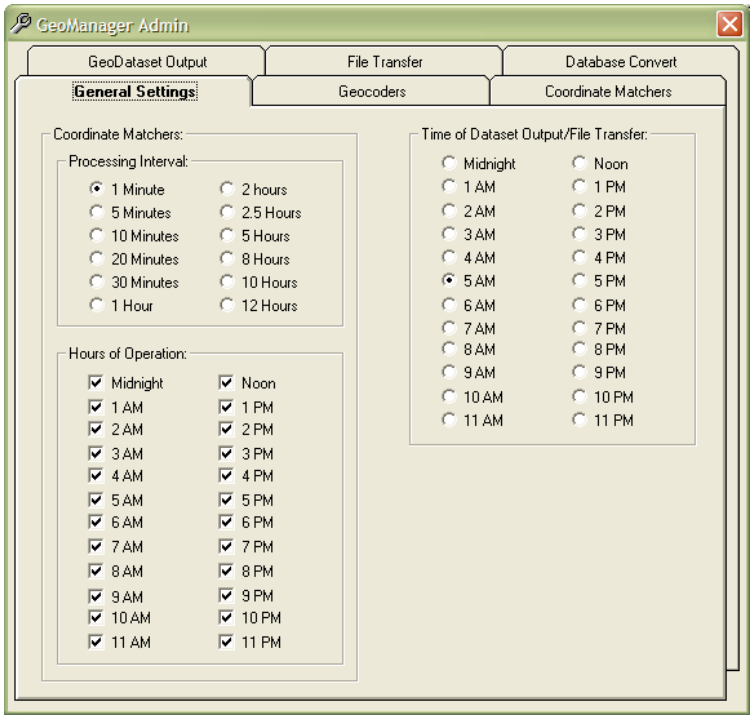
GeoManager application is an automated geo-coding service that creates GIS data layers from non-spatial relational databases. The results of a successful geo-coding effort will be stored in an industry standard relational database management system (DB2, Oracle, SQL Server, and Access). The automated process is based completely on standard SQL statements and is customized to utilize a variety of stored location-based data (Parcel PIN, Address, Location-ID, etc.). A second function of the automated service is to generate GIS layers in an industry standard portable format (shapefiles) that could be utilized by a variety of applications. These GIS layers will be created to user specifications. X,Y coordinates will be utilized to display features in a GIS layer.




One (1) license of GeoManager is recommended initially. Subject to the Department's utilization of GeoManager, additional licenses may be required in the future.

### Practical Example – Incidents

All incidents related to a specific location ID can be mapped by linking each building permit to a spatial feature The GeoManager can generate and export the resulting shapefile on a regularly scheduled basis.

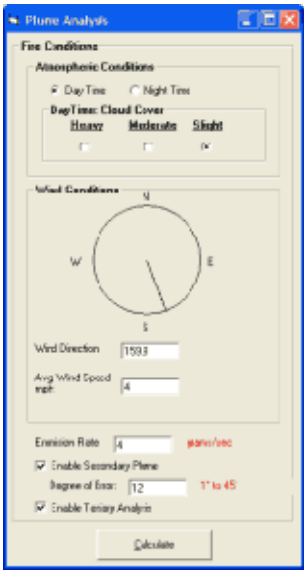



***GeoManager Service Settings***

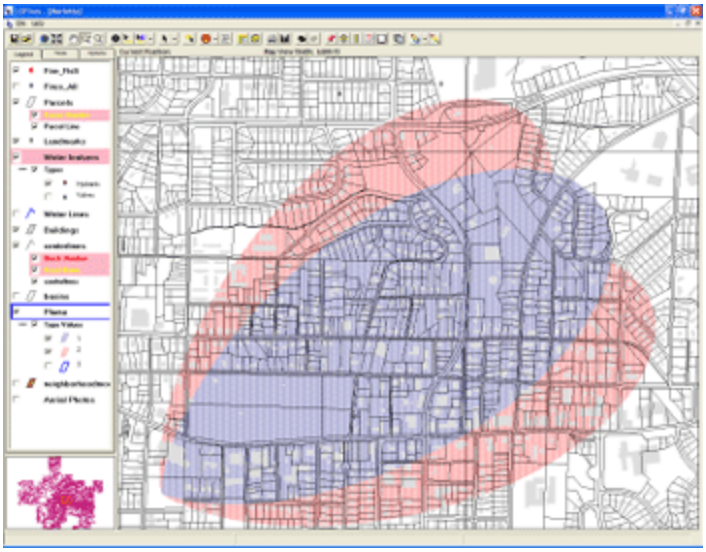
## Hazardous Material Tracking

One of the most dangerous situations for fire fighters and citizens is a fire at a site that has hazardous materials. Fire departments are required by the Superfund Amendment & Reauthorization Act to track the location of known hazardous materials. This is commonly referred to as SARA Title III hazardous materials tracking. It is highly recommended that this information be entered into the FirePoint system or a database (MS SQL Server) and then made available in a GIS format. This data should be tied to the parcel GIS layer and accessible via each PC at the fire stations and in the future through laptop computers mounted on apparatus. It is also recommended that this data be accessible from each fire truck. This could be accomplished by loading GIS software on laptop computers.

GIS can also be used to conduct hazardous material release/contamination modeling. GIS offers a means for deriving time-critical information, such as plume analyses for gas releases, water and sewer contamination modeling (contaminants in water/sewer systems), and risk/catastrophe modeling.




***Example of Plume Analysis Modeling Interface***



***A Plume Analysis Map Can Provide Valuable Information for Determining Contamination Paths, Rates of Dispersion, and Identification of Affected Populations***

### Internet GIS Data Browser

An Internet GIS data browser has been recommended to provide citizens with access to the City's geo-spatial data. Leveraging the City's existing ArcIMS platform, the City will need to develop an enterprise-wide Internet GIS data browser to provide the public with access to geo-spatial fire data. A description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### Intranet GIS Data Browser

An Intranet GIS data browser has been recommended for use by Fire Department personnel. A full description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### Reverse 911

GIS has proven to be a valuable technology for community alerting and public outreach, such as Reverse 911. Reverse 911 is inherently a GIS application as spatial selection and analysis are fundamental for the effective utilization of Reverse 911. Reverse 911 is a requirement of the City's technology strategy plan; it is recommended that the Fire Department leverage the GIS-based Reverse 911 solution that the City decides to implement.

The uses of GIS-based Reverse 911 applications include:

- **Emergency Evacuations**
- Missing Person Alerts
- **HAZMAT Emergency**
- Crime Prevention Safety Tips
- Public Service Announcements
- **Fire Safety Tips**
- **Neighborhood Fire Alerts**
- Utilities Service Alerts

- Investigation Assistance
- Prison Escape Alerts
- Sexual Offender and Predator Notices
- Parolee and Juvenile Check-ups
- **Search and Rescue Operations**
- Neighborhood Watch Meeting Notices

Several effective GIS-based Reverse 911 applications are currently available on the market. It is recommended that the City procure and implement a solution that integrates GIS technology with the telecommunications capability of the Internet. Listed below is GTG's recommended Reverse 911 application.

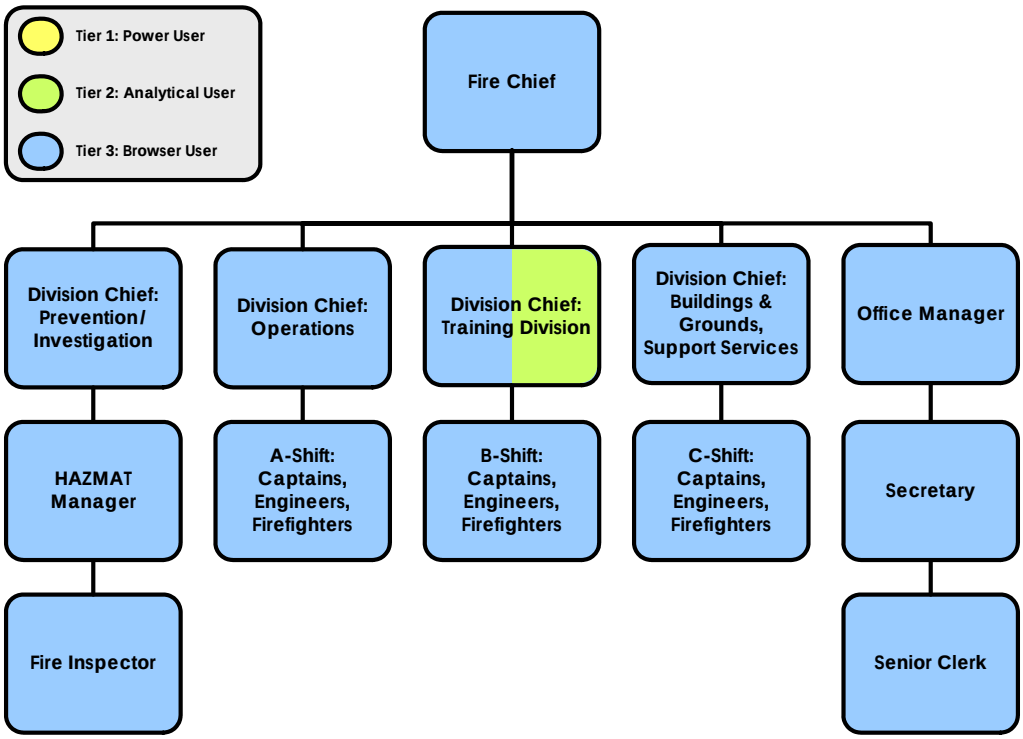
***CodeRED™ Emergency Telephone Calling System***

The CodeRED™ Emergency Telephone Calling System is a high-speed telephone communication service available for emergency notifications. CodeRED™ utilizes Internet mapping capability for geographic targeting of calls, coupled with a high speed telephone calling system capable of delivering customized, pre-recorded emergency messages at the rate of up to 60,000 calls per hour. CodeRED™ subscribers control their emergency broadcasts from anywhere in the world via a secure Internet Portal.

More information can be found at http://www.coderedweb.com

## Multi-Tier GIS Application Use within the Fire Department

The following chart describes the recommended GIS application use by the Fire Department. A Tier 1 user is a power GIS user who should have access to a fully functioning GIS toolset. A Tier 2 users focus is data analysis in addition to general browsing capabilities. A Tier 3 user requires only general browsing GIS data functions. The Fire Department will initially consist of Tier 3 users; it is expected that one division chief will gradually become a Tier 2 user.




***Fire Department Multi-Tier GIS Application Use***

# Grants & Community Investment Department

## Personnel and Duties

The Grants & Community Investment (GCI) Department employs eight staff members, including:

- Director (1)
- Program Managers (3)
- Administrative Aid(1)
- Administrative Analyst (1)
- Secretary (1)
- Senior Clerk (1)

The GCI Department has three divisions within the department:

- Housing
- Community Investment
- Grant Implementation

The Community Investment Division acts as a clearinghouse for grant activity for the City, including tracking of grants, notifying departments of funding sources available for city/agency projects and programs, and management of the grant writer contract for actual preparation of grant applications. Other Community Investment projects and programs are staffed by personnel allocated to the Housing and Grant Administration Divisions. The Department also assists other departments in relocation activities, both permanent and temporary.

In addition, the Department implements or administers special non-housing projects and programs. The Neighborhood Enhancement Program (NEP) is an example of a special program under this division. The NEP is designed to revitalize focused neighborhoods in the City. This program works in close coordination with other departments, agencies, and community stakeholders to meet the goals of the program.

The GCI Department will be a Level 3 GIS User (see Chapter 2: GIS Organizational Structure and Staffing for more information on Level 3 GIS Users).

## Hardware and software

All GCI Department PCs have the Windows 2000 or Windows XP operating system (citywide standard).

The GCI Department uses the following software applications:

1. MS Office
2. TransUnion
3. RealQuest

## GIS Needs and Duties

A key opportunity for the GCI Department lies in the use of GIS to augment current efforts aimed at identification, analysis, and evaluation of housing needs, neighborhood enhancement, and various types of grants. As the City proceeds to implement GIS across the enterprise, the GCI Department will be able to leverage geo-spatial data, mapping applications, and analytical methodologies to improve workflows, decision-making, and public outreach.

Based on this needs assessment, the GCI Department has the following GIS needs:

- Mapping and spatial analysis for support of community investment programs and projects
- Cartographic products for grant proposals
- Public access to geo-spatial housing and land data

Existing GCI Department staff should use an Intranet GIS data browser to conduct basic spatial analysis and produce maps. All readily-available City GIS data layers should be made available via this GIS data browser; in addition, housing, land use, and tax district GIS data layers produced for use by GCI should be available via the GIS data browser. The Intranet GIS data browser will provide easy access for all City employees to display, query, and analyze spatial information about properties.

For advanced analysis and other tasks such as data creation, the GCI Department should work with the City GIS Specialist, who can use advanced GIS software such as ArcView or ArcInfo to conduct many of these tasks; the GIS Specialist may also be called upon to create other cartographic products for the GCI Department.

Mapping and Spatial Analysis for Support of Community Investment Programs and Projects

One of the most significant benefits that the GCI Department will realize from the implementation of GIS and complementary technologies is increased and improved access to information. The Department will be able to understand relationships between different types of data in a spatial context, thereby improving decision-making; maps will be used to provide the public with valuable housing and neighborhood information in a geographic context; grant applications and materials will include maps and quantitative information from spatial analyses that will give emphasis to areas in need of assistance.

The GCI Department will be able to utilize GIS in several tasks, including:

- Viewing and analyzing City demographic information
- Proposed real estate project location analysis
- Identifying vacant and underutilized land
- Community Development Block Grant (CDBG) administration and analysis
- Environmental Assessment (EA) and Cost Benefit Analysis (CBA) for projects, programs, and CDBGs
- Affordable housing monitoring and site location analysis
- School route modeling and analysis
- Focus area identification and evaluation
- General land use and infrastructure mapping and analysis
- Citizen education and advocacy
- Statistical analysis for budgetary preparations
- Using maps to train personnel

Working in conjunction with the GIS Specialist, the GCI Department will be able to derive valuable, spatially-driven information on key issues for each of the Department's divisions. It is recommended that the Department work with the GIS Specialist to identify and prioritize GIS-based analyses that can be performed on a project or program basis. Among these analyses, the GIS Specialist can provide support for demographics, real estate sales, tax assessment districts, inclusionary/affordable housing, parcel-specific environmental assessments, housing/property condition, and vacant land.*

Some of the information that the GCI will be able to visualize and analyze via a GIS interface includes:

- Real Estate Sales: See all data for a period of time and calculate a median sales price. The City has passed an affordable housing bill – therefore they must see median household prices.
- Housing Element: Vacant and Underutilized Land Survey.*
- Zoning: Determine how zoning impacts housing and property values.
- Tax Assessment Districts: Targeted at the Inclusionary program.
- Affordable Housing (Figure GCI-1.1): Monitor units multi-family units (e.g. crime stats are good)
- Environmental Assessment (EA): Work with Planning and utilize to conduct cost/benefit analysis.
- Code Enforcement: Find any type of units that qualify for other programs (e.g., house that has lots of infractions, violations, or RED tag [unsafe]). Funds could be sent to these code enforcement violators or sell the property, thereby saving the structural integrity of a building within the City.
- Parcel by Parcel Analysis: Track owners, age and configuration of parcel.
- Safe Routes to School: Find different ways to make the most traveled routes to school safer (e.g. paving, parking, etc.)
- Neighborhood Enhancement Program (NEP): Identify City resources and areas in need of improvement.

*It should be noted that the Redevelopment Agency is currently working with an intern to map and assess vacant properties within the City. It is recommended that the data being produced for this project should be centralized under GIS, with the GIS Specialist providing guidance and input with regard to data standards, data structure, and archival organization.

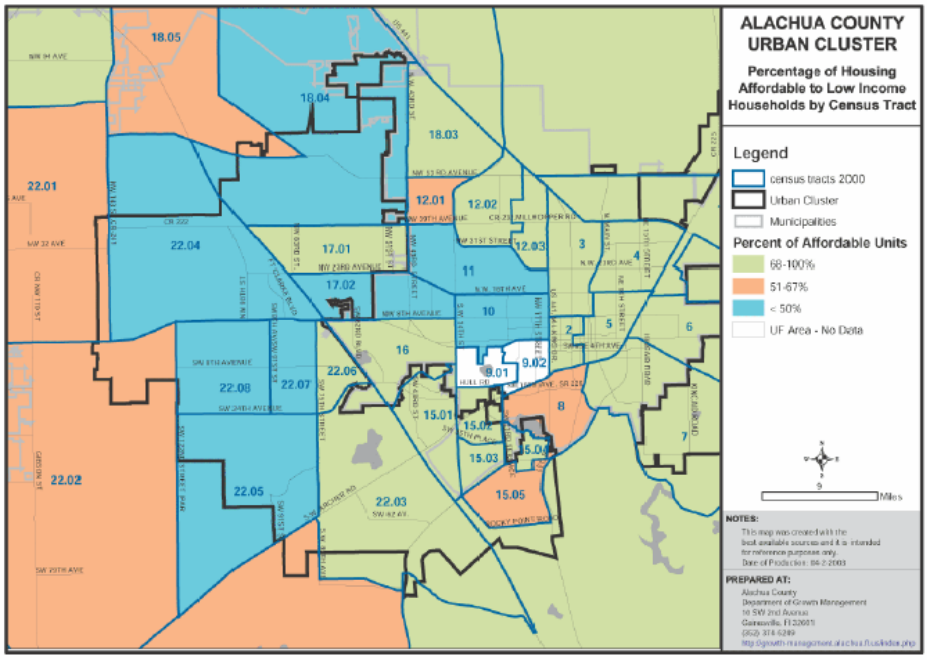



***Figure GCI-1.1: Alachua County, FL Affordable Housing GIS Analysis***

**Case Studies:**

The following case studies are included to provide the GCI Department with examples of how GIS is being used to address some of the issues for which the Department is responsible, including housing, neighborhood revitalization, environmental assessment, and grant administration.

<u>GIS Helps Laguna Niguel Use Federal Money More Effectively</u>

One of the goals of local governments is not just obtaining sufficient funds, but being able to use those funds in the most beneficial way. The City of Laguna Niguel used the spatial analysis capabilities of ArcView GIS to decide how to administer funds from the Housing and Urban Development Department (HUD) in a way that maximized the number of areas that could qualify to receive funding.

***Areas that qualify for CDBG funds with county administration.***

***Much larger area that would qualify for CDB funds if the city administered the program.***

Laguna Niguel is a study in doing a lot with a little and in little time.

Located in Southern California's Orange County, Laguna Niguel has a population of 56,000. City staffing is lean. Wade Kloos, an associate planner for Laguna Niguel for the past six years, and an intern, ARE the GIS Department. Kloos actually spends only about 20 percent of his time working on GIS projects. Though the City's parcel map was produced by a consultant using ArcInfo, Kloos uses ArcView GIS for all the City's GIS projects.

HUD's Community Development Block Grant (CDBG) programs promote sound community development through awarding grants to qualifying communities. Grants help cities provide public services, carry out neighborhood revitalization, and administer economic development programs.

Entitlement grant amounts are determined by a statutory formula that uses several objective measures of community need including poverty, population, housing overcrowding, age of housing, and growth lag. When Laguna Niguel's population passed 50,000, the City qualified as an entitlement city under HUD guidelines that allowed it to choose whether to continue to allow the County to administer the City's CDBG grants or to administer those monies itself.

What's the difference, you say? It hinges on the effect of HUD's qualifying threshold for the number of low to moderate households in any census block. If the County administered Laguna Niguel's CDBG program, HUD would use the County's median household income, and 36.4 percent of households within any census block would be required to be low to moderate income for that block to qualify. Under City administration using the City's median household income, only 16.8 percent of households in a census block would have to be categorized as low to moderate for that block to be eligible for funds. The City had to decide if the benefit to the community of expanding qualifying areas sufficiently offset the additional staff resources needed to administer the program.

In about two hours, Kloos created the census block themes, analyzed census blocks by income level, and generated thematic maps showing which areas would qualify under the County's threshold and under the City's threshold. Only two census blocks qualified under the County administration option, while seven census blocks qualified under the City administration option. Armed with these maps it was easy to demonstrate to the City Council that the City could significantly increase the benefit from the $335,000 in CDBG funds through City administration of the program. City Manager Tim Casey opted to devote all CDBG funds to project work rather than charge staff time against CDBG funds.

After providing the spatial analysis information that supported the City's decision to administer the CDBG program, Kloos became the CDBG coordinator. Other projects Kloos has completed using ArcView GIS include a real property inventory that gave the City a record of all its real estate holdings. Kloos also used ArcView GIS to produce conceptual designs for proposed MetroLink stations, saving the City from hiring an engineering firm to complete the designs.

"We are low tech and low budget. I like to think we are a model of what a small City can do," says Kloos.

**Case Study Courtesy of ESRI ArcUser Magazine*

<u>City of Tucson Leverages GIS to Assist with Grant Applications</u>

The Planning Department at the City of Tuscon, Arizona has utilized GIS to overlay crime information on base maps for analysis and added census information to those same maps to apply for grants targeting special populations such as at-risk youth. In addition, the library is planning to work with Community Services to disseminate information about housing programs. For example, customers could do their own checking to see if a certain address is in a "low/mod" area which qualifies for certain grants. Future TPPL applications include periodic comprehensive demographic analysis of all library branch and Main service areas, as well as areas not currently within three-miles of a library.

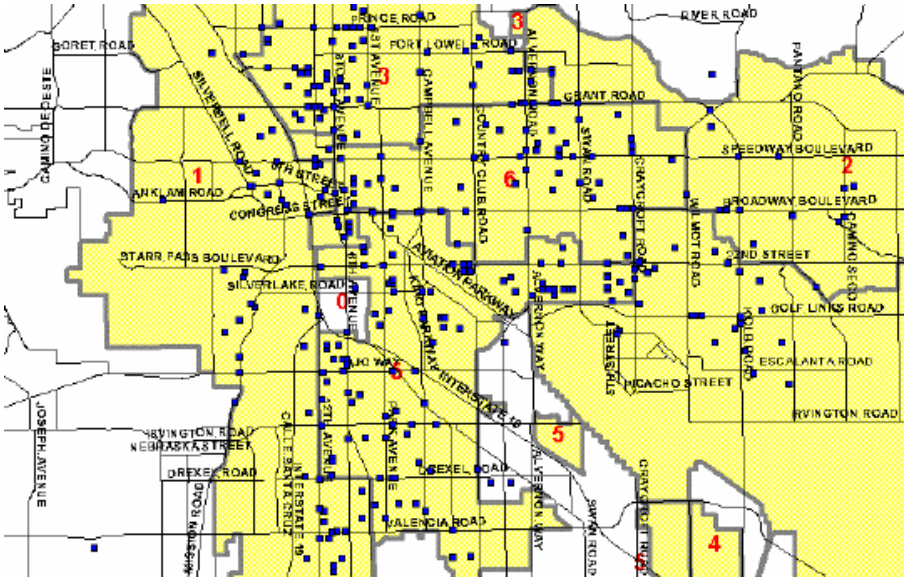



***Figure GCI-1.2: GIS-Based Analysis of Burglaries in City of Tucson, AZ***

<u>EPA Brownfields Grants in the Southeast</u>

<u>Anniston, AL Brownfields Assessment Demonstration Pilot $200,000</u>
Anniston's objective is to support the transfer of the targeted brownfields properties to public or private entities capable of returning them to economically or socially productive use compatible with the community. Activities planned as part of the pilot include: establishing a Brownfields Task Force Committee to conduct outreach activities within the community regarding appropriate reuse of the sites; conducting assessments of targeted properties and developing cost analyses and remediation plans for cleanup; and developing a Geographic Information System (GIS) with information about the targeted sites.

<u>Montgomery, AL Brownfields Assessment Demonstration Pilot $200,000/Greenspace $50,000</u>
Montgonery's goal is to obtain an economically viable and sustainable mixed use development along its riverfront. The city intends to accomplish this objective through a planned redevelopment that emphasizes a limited number of isolated projects. Activities planned as part of the pilot and greenspace funding include: reviewing riverfront land use history and incorporating the results into a Geographic Information Systems (GIS) database; conducting Phase I and Phase II environmental site assessments on brownfields sites within the planned riverfront trail area; developing guidance for land use planning; and implementing the redevelopment plan community participation program.

<u>Selma, AL Brownfields Assessment Demonstration Pilot $200,000</u>
Selma's objectives are to target three city-owned properties; the 50-acre All-Lock Plant, the Waterfront district, and the Selma East Area Pond, for assessment and redevelopment planning to help reverse the city's 30-year economic decline. Actions planned as part of the pilot include: completing environmental audits of city-owned properties; conducting Phase I and Phase II environmental site assessments at three priority sites; incorporating brownfields properties into a database inventory and linking the inventory to a Geographic Information Systems (GIS); and conducting outreach and public participation.

Charleston, SC Brownfield Supplemental Assistance $150,000

Charleston's goal is to targets additional brownfields in the Charleston Enterprise Community (EC) for development into a light industrial park for manufacturing and distribution. Charleston's plans for the Supplemental Assistance include: reviewing historical records for all EC properties, developing a Geographic Information System (GIS) and incorporating it into the city planning department's GIS; conducting Phase I and Phase II assessments of at least three additional sites; prepare redevelopment plans for four brownfields in the federal EC; and expand public involvement by creating a brownfields web site, hosting a brownfields conference.

Cartographic Products for Grant Proposals

The GCI Department will benefit from the generation of cartographic products for use in grant proposals. Several different products, such as base and thematic maps as well as 3D landscape renderings, can be used to enhance grant proposals. In addition, these products can be utilized to provide status updates to funding organizations. Maps can also be used to educate the public at meetings and to provide training for personnel.

Many of the needed maps can be created by utilizing the recommended GIS data browser. For more complex maps, it is recommended that GCI personnel work with the GIS Specialist to generate several map and visualization templates that can b used to quickly produce maps. An ideal long-term goal is to develop automated mapping applications (or macros) that can be used by GCI staff to quickly produce maps for various interest areas.

Cartographic products should incorporate other media, including CADD drawings for proposed infrastructure, digital images and photographs, and reports.

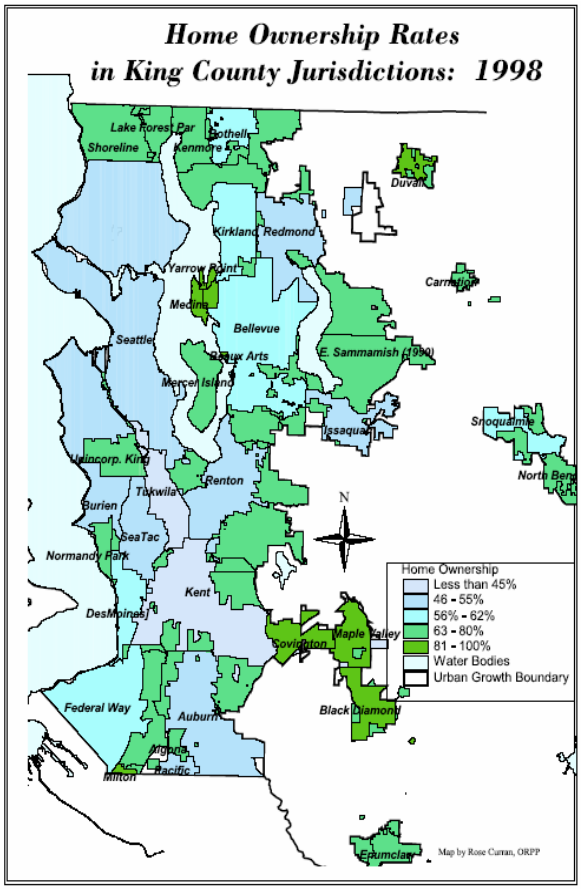



*Figure GCI-1.3: GIS-Based Analysis of Ownership Rates in King County, WA*

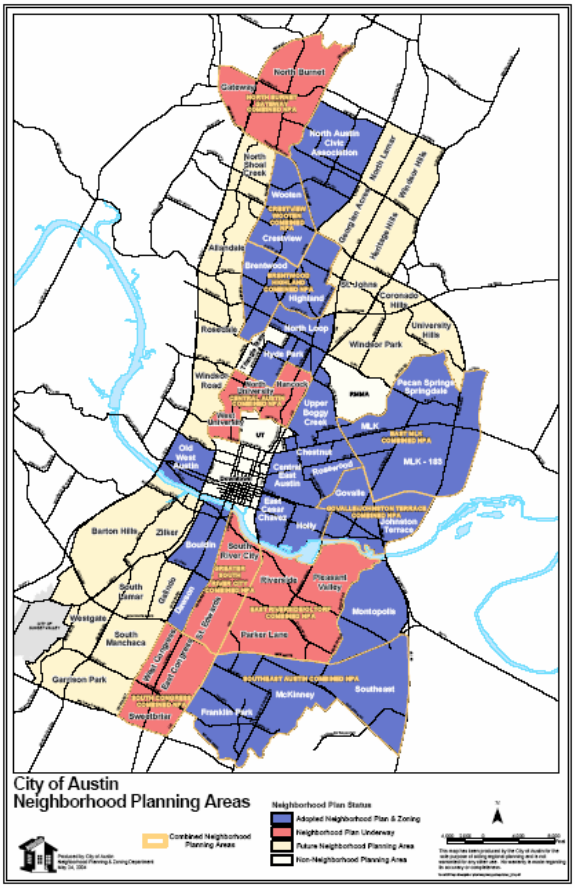



*Figure GCI1.4: Reference Map Shows City of Austin, TX Neighborhood Planning Areas*

Public Access to Geo-Spatial Housing and Land Data

GCI personnel expressed the need to disseminate spatial information to the public by providing a mapping application that will enable the citizens to view housing and land information, including the aforementioned data sets. The mapping application should incorporate the ability for the public to view housing, neighborhood, and demographic data integrated with address locations and parcels.

As part of the City's objective to provide an Internet GIS data browser, the Department should coordinate with the GIS Specialist to integrate the GCI-relevant GIS data into the Internet-based application.

More information on Internet GIS data browsers can be found in the Enterprise-Wide Applications section of this chapter.

## GIS Data Layers

The GCI Department will benefit from access to several other departmental GIS data layers. It is expected that once all departmental data is integrated, consolidated, and centrally stored, that staff will have access to **all** non-classified GIS data layers from other City departments.

GCI Department personnel expressed that access to the following GIS data layers would be beneficial:

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Address Points** | Extract, cleanse, geocode, and map from Springbrook; georeference based on aerial photography and GPS field work | Automated; GIS Specialist; Drafting Services Section | Recommended |
| **Aerial Photography** | Fly-over with control points | GIS Data Services Vendor | Recommended |
| **Bicycle/Pedestrian Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Buildings with Site Plans** | Manually digitize polygons from plans and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Census Data** | Download from Census Bureau →http://www.census.gov/geo/www/census2k.html | GIS Specialist | Recommended |
| **City-owned Property** | Extract, cleanse, geocode, and map from Yolo County tax roll; other map sources as required | Automated | Recommended |
| **Commercial Addresses** | Extract, cleanse, geocode, and map from Springbrook | Automated | Recommended |
| **Community Facilities District** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Crime Data** | Extract, cleanse, and automatically map from Police VisionAIR database | Automated | Recommended |
| **Day Care Facilities** | GPS field work. | GIS Specialist; Redevelopment Agency | Recommended |
| **Enterprise Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Facilities** | Digitize on screen; aggregate layers as needed | Drafting Services Section | Existing |
| **GCI Special Plan and Special Study Areas** | Digitize from base map data; aggregate layers as needed | GIS Specialist | Recommended |
| **General Plan** | Digitize features from aerial photographs and existing data layer | Drafting Services Section | Recommended |
| **Hazardous Materials** | GPS data collection for location; extract from FirePoint or other database once data is entered | GIS Specialist; YCCESA | Recommended |
| **Housing Condition Data** | Extract, geocode, and map from database | Automated | Recommended |
| **HUB Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Land Use** | Digitize polygons from aerial photographs and existing maps; existing CADD data | Drafting Services Section | Existing |
| **Licensed and Unlicensed Businesses** | Extract, cleanse, geocode, and map from in-house database | Automated | Recommended |
| **Liens** | Extract, cleanse, geocode and map from Springbrook | Automated | Recommended |
| **Lighting and Landscape Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Major Intersections** | Use street centerline layer as source | Drafting Services Section | Recommended |
| **Oak Trees (Heritage)** | GPS field work; validation may be possible using aerial photography | Drafting Services Section; GIS Specialist | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Parcels** | Acquire from Yolo County | Yolo County ( and GIS Data Services Vendor) | Recommended |
| **Parks** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Port** | Digitize features from aerial photographs and other maps | Drafting Services Section; GIS Specialist | Recommended |
| **Real Estate Sales** | Geocode and map from MLS database | Automated | Recommended |
| **Rehabilitation Projects** | Extract, cleanse, geocode and map from Access database | Automated | Recommended |
| **Schools** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Sewer Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Social Service Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Storm Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Streets** | Derived from aerial photography; GIS Consortium | Drafting Services Section | Existing |
| **Tax Assessment Districts** | Aggregate parcels and assessor data; other sources, such aerial photography, as needed | GIS Specialist | Recommended |
| **Traffic Accidents** | Extract, cleanse, geocode, and map from Crossroads database | GIS Specialist; Engineer; (Crime Analyst) | Recommended |
| **Traffic Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Traffic Calming Devices** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Traffic Counts** | Extract, cleanse, geocode and map from Access database | GIS Specialist | Recommended |
| **Traffic Signals** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Transit Routes** | Derive from street centerline layer; acquire from SACOG? | Drafting Services Section | Recommended |
| **Truck Routes** | Derive from street centerline layer | Drafting Services Section | Recommended |
| **Under-utilized Buildings** | Query from parcel layer; other sources as needed | GIS Specialist; Redevelopment Agency | Recommended |
| **Vacant Properties** | Query from parcel layer; other sources as needed | GIS Specialist (eventually automated) | Recommended |
| **Water Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Waterways** | Digitize polygons from aerial photographs and existing maps | Drafting Services Section; GIS Specialist | Recommended |
| **Zoning** | Based on existing maps; General Plan | Drafting Services Section | Existing |

Additional layers may be required as the department increases its GIS utilization and incorporates additional field data.

## GIS Applications

To meet the Department's GIS goals the following GIS software is recommended.

### Intranet GIS Data Browser

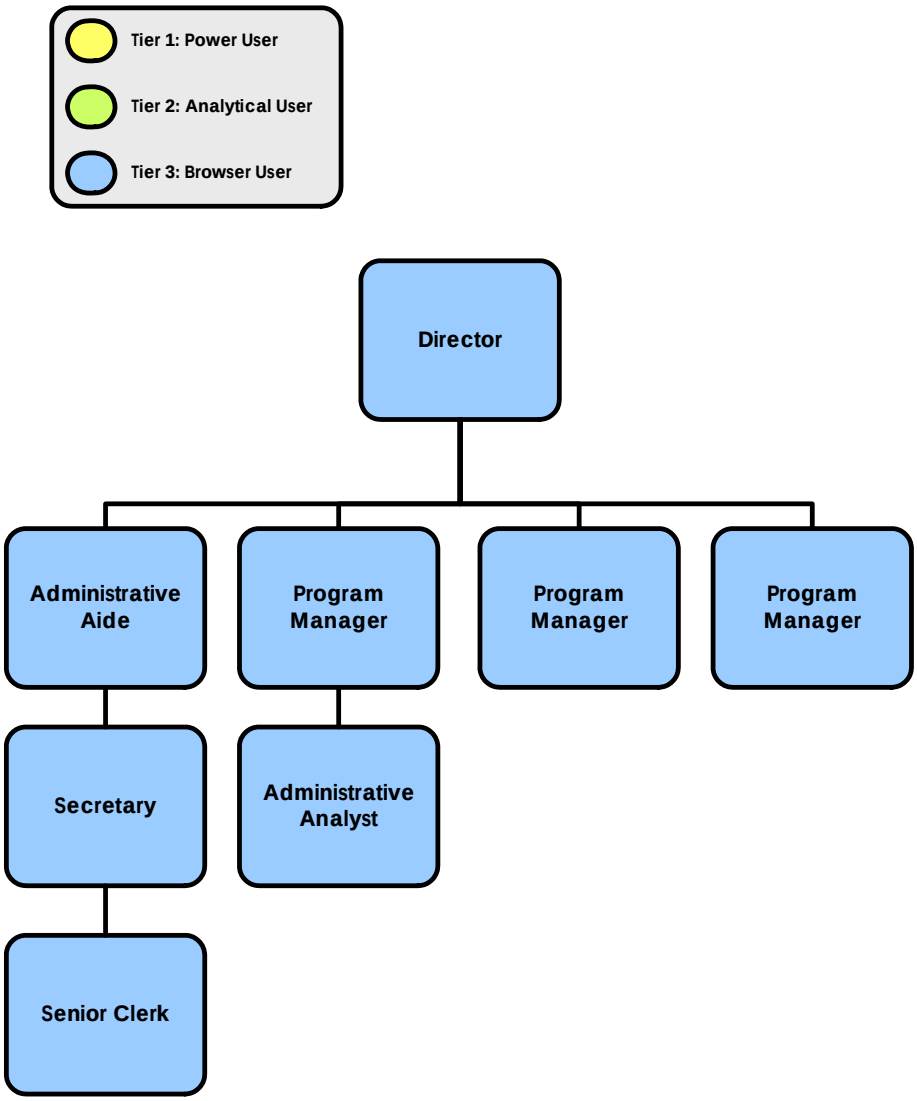
An Intranet GIS data browser has been recommended for use by GCI Department personnel. A full description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### Internet GIS Data Browser

An Internet GIS data browser has been recommended to provide citizens with access to the City's geo-spatial data. Leveraging the City's existing ArcIMS platform, the City will need to develop an enterprise-wide Internet GIS data browser to provide the public with access to geo-spatial property data. A description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

## Multi-Tier GIS Application Use within the GCI Department

The following chart describes the recommended GIS application use by the GCI Department. A Tier 1 user is a power GIS user who should have access to a fully functioning GIS toolset. A Tier 2 users focus is data analysis in addition to general browsing capabilities. A Tier 3 user requires only general browsing GIS data functions. The GCI Department will consist of Tier 3 users.




***GCI Department Multi-Tier GIS Application Use***

# Human Resources Department

In general, there is no GIS functionality or data access needed by the Human Resources Department. However, people are an integral part of any successful enterprise-wide GIS implementation. This section provides information on three issues important to the Human Resources Department:

- Recommended GIS Positions
- Recommended Job Descriptions
- GIS Staffing Issues

## GIS Positions

One GIS-specific position is recommended within the City of West Sacramento:

1. **GIS Specialist**; reporting to the Information Technology Manager

This position has recently been created and filled. However, this needs assessment provides a general job description that should be used to revise or update the current GIS Specialist's job description. In addition to the GIS Specialist, the City is currently hiring at least one student intern to work with the GIS Specialist. It is recommended that the City continue to utilize these interns to support and assist with the enterprise-wide GIS implementation. A sample job description for the intern is provided as well (based on the current listing).

## Recommended Job Descriptions

### GIS Specialist

**Department:** Information Technology

**Supervisor's Title**: Manager

**Nature of Position**: This position requires a broad range of management, business, and technical skills to guide the successful implementation of an enterprise-wide GIS within the City of West Sacramento. The GIS Specialist has overall responsibility for ensuring that key GIS work elements – hardware, software, networks, databases, and staff resources – are managed, maintained, and enhanced to meet agreed-upon City requirements.

Oversee all enterprise GIS operations including database management and administration, data structure and metadata development, system administration, GIS software selection, implementation and user support, GIS project management, budgeting, marketing, and training.

**Education:** Bachelor's Degree in Geography, Computer Science, Earth Science, Engineering, Planning, or related discipline and 5 years experience in GIS project management for local governments, or an equivalent combination of education and experience.

**Skills:** Experience with government GIS applications, especially in such business areas such as planning, public utilities, transportation, police, fire, EMS, and tax parcel creation and maintenance. Experience developing schedules and managing complex information technology projects. Familiarity with business process analysis as it relates to GIS. Active participation in professional GIS,

mapping, and/or surveying organizations and activities. Verbal, written, and interpersonal communication skills. Ability to communicate technical information in a non-technical manner. Ability to lead and motivate work teams.

**Computer Skills:** Experience with ESRI's ArcGIS suite of products as well as Autodesk AutoCAD and AutoCAD Map in a Windows environment. Experience in database administration, relational database design, development, and implementation. Working knowledge of ArcSDE, ArcIMS, MapObjects, and ArcGIS data model design.

**Nature of Contact with Other People:** The GIS Specialist will act as the geographic information expert for the City of West Sacramento. The GIS Specialist provides oral and written progress reports and updates to superiors and oversight committees. The position requires an extensive amount of communication at all levels of the City.

## GIS Intern

**Department:** Information Technology

**Supervisor's Title:** Information Technology Manager; GIS Specialist

**Definition:** Under general direction, assists GIS Specialist in the implementation, design and support of the City of West Sacramento's Geographic Information System (GIS).

**Essential/Marginal Functions**: Essential: Collects data through a combination of field investigation, aerial photography and other sources; inputs and updates current city data sets; inputs, queries, and manipulates data using ESRI ARC GIS 8.3 – 9.0 and AutoCAD Map; performs research and analysis for municipal projects using GIS software, spreadsheets, word processing and other software; assists with GIS operating maintenance; inputs, maintains and expands city's GIS dataset (DWG, Shapefiles, SQL data); provides technical support to departments; Marginal: Performs other administrative tasks and duties as assigned.

**Qualifications**: Knowledge of: Basic operation of computer systems and related equipment; GIS software, specifically ESRI ARCGIS 8.3-9.0, ESRI ArcIMS, Cold Fusion, and Autodesk AutoCAD Map. Ability to: Plan, organize, and coordinate workload; communicate effectively, both orally and in writing; operate a personal computer; perform arithmetic computations; work independently with minimal supervision; establish and maintain cooperative working relationships with those contacted in the course of work; maintain physical condition appropriate to the performance of assigned duties and responsibilities, which may include sitting and standing for extended periods of time and operating assigned office equipment; and maintain mental capacity which allows for effective interaction and communication with others.

**Education and Experience**: Education: Freshman through Senior level standing in an accredited college or university with course emphasis in GIS, Geography or

closely related field. Experience: Any experience, including class work or field study which would provide the applicant the required knowledges and abilities. *Preference will be given to candidates with experience in using Microsoft Office (including Excel, Word, and SQL Server), desktop publishing (i.e., Adobe PageMaker, Illustrator, Photoshop) and GIS software (ESRI ARC GIS 8.3-9.0 and Autodesk AutoCAD Map).*

**Licenses and Certificates**: If required to drive, possession of a valid Class "C" California driver's license . Marginal: May assist with software programming; and perform other related duties as assigned.

**Special Conditions:** The City of West Sacramento will require documentation of a candidate's identity and authorization to work in the United States prior to finalization of employment. Employment is subject to the candidate successfully passing a fingerprint check prior to placement at the worksite. The successful candidate may be required to have a medical examination or complete a medical history.

**Hours**: Employment in this classification will not exceed one-thousand hours per fiscal year for an average of twenty (20) hours per week during the school year. The planned length of employment is at least one (1) school year. Work hours are to be coordinated with the Information Technology Manager.

Salary: Hourly pay scale: $9.00-$10.50-$12.00-$13.50-$15.00

## GIS Enterprise Staffing

Staffing issues will be critical to the success of the City of West Sacramento's enterprise-wide GIS effort. Unfortunately, staffing can also be a complex and frustrating issue. Budgetary and political realities within local governments place restraints on what can be accomplished. Ideal staffing structures are often difficult to attain. Nonetheless, there are fundamental steps that the City of West Sacramento can take to ensure a proper staffing foundation, which can be improved upon as time and necessity dictate.

The organizational structure of the GIS effort will have an impact on staffing issues. Organization structure and staffing are inherently interrelated. GIS staff allocations must be determined before specific job requirements and responsibilities can be agreed upon. Please refer to the previous section for organizational structure recommendations for GIS within the City of West Sacramento.

The size of a local government organization plays a significant role in staffing issues. The needs of a large city are different from those of a small rural town. Based on this variability in needs, this document focuses on staffing issues related to medium-sized cities, such as West Sacramento, whenever possible.

## Functional Areas

There are six functional areas in which most GIS positions can be classified: coordination, system support, application design, database support, user support, and production/data collection. Not all organizations will have staff members in every functional area, and often individual staff members will have responsibilities in two or more functional areas. Individual job descriptions are provided later in this document. The City of West Sacramento already has its own job classification structure in place, so careful consideration will be needed when assigning employees of particular functional area to the proper job classification.

Coordination: It is vital to the success of the City of West Sacramento's GIS effort to have a GIS Specialist. The GIS Specialist is responsible for all resource and project coordination as well as the effective day-to-day operation of all GIS aspects. This includes hardware and software issues, database design and maintenance, technical support, and management of the GIS Specialist. A GIS Specialist must have the technical savvy to run diverse operating systems, networks, and GIS software and the people skills to coordinate, sell, champion, teach, and referee the implementation of GIS.

System Support: System Support staff provides the necessary support to ensure that all GIS software, hardware, networks, and databases are properly implemented and working. Technical support for all GIS end-users is the responsibility of System Support staff. Systems Support within the City of West Sacramento will be provided primarily by the Information Technology Division; additional support should be provided by the GIS Specialist.

Application Development: Many larger organizations have their own GIS application development staff. Packages such as ESRI's MapObjects and ArcObjects allow for custom application development to suit individual department and enterprise-wide needs. Flagship and desktop GIS packages such as ESRI's ArcGIS allow customization of design and functionality. Recently, the development of a GIS-enabled web site has become an important goal for many cities. Primarily developed with ESRI's ArcIMS, these GIS-based web applications require staff for its creation and maintenance. It is recommended that the City of West Sacramento work with the GIS Specialist to determine which application development efforts can be implemented in-house; efforts that cannot be implemented in-house should be outsourced to a qualified GIS services vendor.

Database Support: Most GIS packages are designed to operate from commercial relational database management systems (RDBMS), such as Oracle, MS SQL Server, or MS Access. ESRI's ArcGIS uses a geodatabase model for data storage, retrieval, and editing from an RDBMS. This allows for the preferred creation of a central GIS data repository. Therefore, it is imperative that knowledgeable staff is employed to implement and maintain the effective operation of the central GIS repository. If a city is already using a specific RDBMS citywide, it makes sense to use that same RDBMS for its GIS, as it ensures compatibility and easier. Additional responsibilities of database support are the enforcement of GIS data structure and metadata standards for GIS- participating departments. No specific database support staff is recommended at this time for the City of West Sacramento. Database support tasks can be conducted by the GIS Specialist.

User Support: This is a very broad category, and encompasses both GIS-core staff and GIS-departmental staff, depending on organizational structure. Generally, GIS Analysts and Specialists fall under the User Support category. This staff provides enterprise-wide GIS activity support as well as support to departments beyond what existing staff requires. A successful GIS effort must be results-oriented. Therefore, the expertise and quality of analysis conducted by User Support staff are vital. It is recommended that the GIS Specialist (and GIS Intern) provide User Support for those departments that he/she deems appropriate. As GIS usage grows throughout the City, with departments/divisions/offices requiring more GIS Support the city will need to consider hiring additional GIS Specialists or GIS Technicians. With additional growth in GIS staff, the City will need to revise its organizational structure to eventually establish a formal GIS Section in the Information Technology Division; this section will be led by a Senior GIS Specialist (or GIS Coordinator) that will supervise GIS staff in the section, and provide coordination to GIS users in other departments/divisions.

Data Collection/Production: A great deal of time and effort is spent by most organizations to develop accurate and effective GIS datasets. This data must be maintained properly for it to retain its usefulness. This is primarily the role of GIS Technicians and GIS Specialists. As GIS develops within an organization, new data will be collected and will need to be converted to adhere to data standards. Specific tasks such as digitizing, scanning, and metadata creation are also the responsibility of GIS Technicians and/or GIS Specialists. It is recommended that the GIS Specialist and GIS Intern serve to collect, produce, and maintain GIS datasets for those departments that do not have the necessary staff to perform this task.

## Hiring vs. Retraining

A fundamental question encountered by organizations during implementation of an enterprise-wide GIS is: "When should we hire additional GIS staff, and when should we retrain existing staff to handle GIS responsibilities?" The answer to this, in large part, depends on the existing status of GIS within each organization. Larger cities will require GIS staff in several functional areas (outlined in the previous section).

There are two general categories for the hiring or retraining of staff. The first is core GIS staff. As outlined previously in this chapter, even decentralized GIS organizational structures require core GIS staff to handle non-department specific GIS issues. Many of the responsibilities of core GIS staff require specific knowledge of GIS and Information Technology issues. As a general rule, a large organization without existing staff to handle all of these responsibilities will need to hire additional staff.

Staffing issues in GIS-participating departments are more complex when compared to core GIS staff. A primary reason for implementing an enterprise-wide GIS is to facilitate and improve existing business processes. A large organization utilizing enterprise-wide GIS will have more end-users of GIS than specific GIS staff. The majority of staff within GIS-participating departments will primarily utilize GIS data browsers. Although basic GIS data browsing and querying require limited training, the functionality required for advanced spatial analysis, using robust applications such as ArcEditor or ArcView, is much more complex. Individual departments will need to have staff with appropriate knowledge to effectively operate these applications. In general, it is easier to hire a professional for the required business function (such as engineer or planner), and train them in GIS, than it is to hire a GIS-trained staff member and train them for the required business function. In addition, professionals will have more intimate knowledge of the specific objectives and goals that they wish to accomplish.

As GIS within individual departments grows, it may be found that existing staff cannot handle all of the desired GIS analyses; under these circumstances, the hiring of additional staff should be assessed.

## Position Classes

Within each functional area there can be several specific position titles. One effective method is to differentiate position classes within position titles. For example, the general position "GIS Analyst" can be differentiated into "Senior GIS Analyst" and "GIS Analyst." Additionally, there can be two classes of GIS Specialists, such as GIS Specialist I and GIS Specialist II.

The reason for creating position classes is two-fold. First, it allows for greater flexibility. As GIS technology grows, and use within the City expands, job responsibilities may change. Position classes will accommodate any changes needed to adapt to changing responsibilities. Second, position classes allow for mobility and career potential. As specific staff members

demonstrate initiative and capability, it is advantageous for an organization to offer upward mobility as an incentive to existing staff members to perform well and learn as much as possible.

## Salary Structures

Equitable and consistent salaries for GIS staff and professional staff with GIS skills are important for the success of the City of West Sacramento's GIS endeavor. Enterprise-wide GIS implementation can only be as successful as the people that supervise and operate it. Attracting and retaining qualified staff are inherently tied to the compensation that the City of West Sacramento is willing to provide. It should be noted that public sector GIS salaries traditionally have been less than those obtainable in the private sector; accordingly, every effort must be made to make the City of West Sacramento an attractive place to work.

Salaries primarily depend on two factors: market conditions and skill sets. Although every organization is unique, the City of West Sacramento must ensure that salaries for GIS staff are in line with other organizations of equal size and structure. As aforementioned, it is expected that public sector jobs will offer less compensation than the private sector; however, the difference in compensation cannot be too great if the City of West Sacramento expects to hire and retain qualified GIS staff.

Different functional areas require positions with varying skill sets. The GIS Specialist is the most important position to the success of the City of West Sacramento's GIS effort. It requires a broad knowledge of both GIS technical expertise and management skills. Proper compensation for this position should be of the highest priority. Frequent turnover in this position can have disastrous consequences to the overall success of the GIS effort.

System Support, Application Development, and Database Support positions require personnel with advanced technical capabilities. These positions require knowledge of hardware specifications, networks, programming, and database administration. These same skills are also easily transferable to the Information Technology sector, where salaries are consistently higher, both in the public and private sector. Salaries for these positions must be reasonably competitive with public sector IT positions.

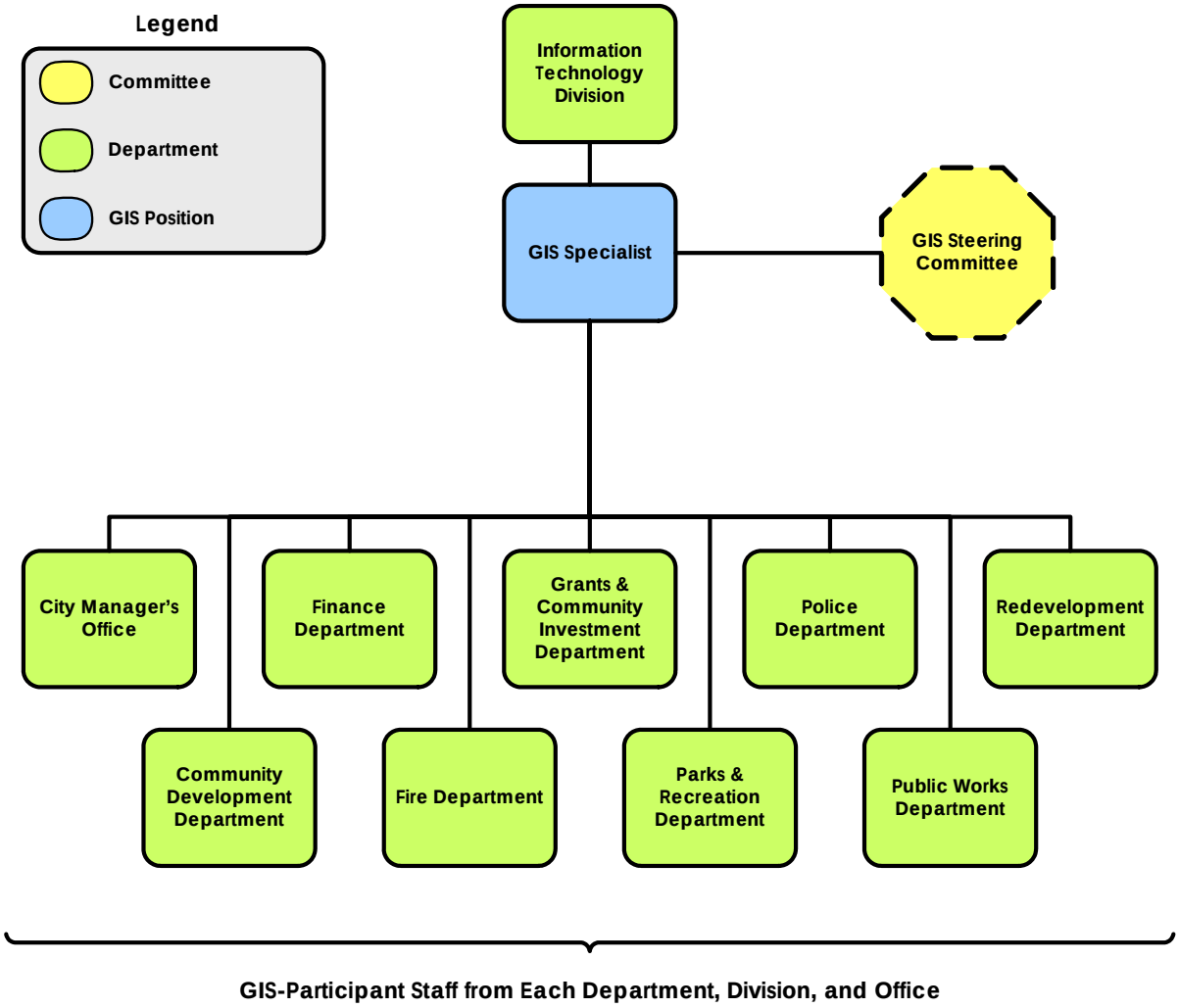
User Support positions are occupied by full-time GIS Analysts and GIS Specialists, as well as professionals with GIS skills. Full-time GIS Analysts and GIS Specialists typically have bachelor's degrees at a minimum, and often they have graduate degrees. In many cases, GIS is not their only skill set – they learned it in addition to another field of study. Salaries must be in line with professional jobs in their area of focus. For example, a GIS Analyst in Public Works should receive a similar salary to an engineer in Public Works with similar education and work experience.

Department-specific professional staff positions that require GIS usage need to be addressed separately. Once GIS has been effectively integrated into the business processes of individual departments, employees with GIS skills become more valuable. Applicants with GIS skills should receive higher compensation than comparable candidates without GIS skills. Additional compensation should be dependent on the time and finances required to train an employee without previous GIS skills. It should be noted that time spent training is time that employees are not spending on their required job responsibilities. Current professional staff members that learn required GIS skills should also be appropriately compensated. Existing employees may be hesitant to take the time to learn these skills, as it will detract from their job responsibilities in the short-term. However, if GIS is effectively integrated into business processes, the amount of time spent training will be recouped by more efficient work

facilitated by GIS. Additionally, employees become more marketable when they acquire new skill sets. In order to retain qualified staff that attains new marketable skills, it is prudent to appropriately compensate them.

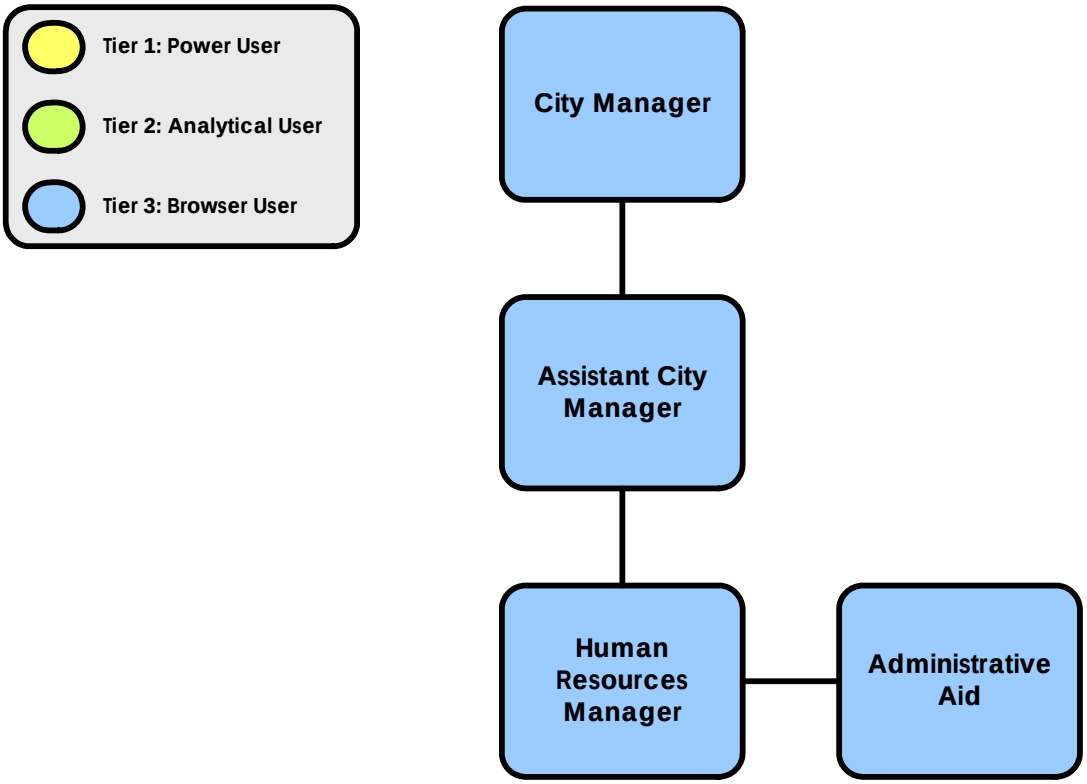
Production/Data Collection positions can be difficult to properly staff. These positions (primarily filled by GIS Technicians) are primarily at the lower end of the GIS hierarchy. Nonetheless, qualified GIS Technicians are essential to GIS efforts. The work of a GIS Technician can be repetitive and uninteresting at times. The key to ensuring job satisfaction is to assign a variety of responsibilities, so that less satisfying tasks are interspersed with more challenging tasks. Effective production and data collection work requires knowledgeable employees. Although the manual tasks of digitizing, scanning, or GPS data collection are not terribly difficult during the actual performance of the task, prerequisite knowledge for proper setup, techniques, and post-processing is important. The City of West Sacramento should continue to utilize university students as interns or in co-op positions to supplement the work performed by the GIS Specialist. This is mutually beneficial, as university students with GIS education have the background knowledge to successfully complete tasks, yet they are willing to accept lower salaries in return for gaining experience.

# City of West Sacramento
# Recommended GIS Organizational Structure



## Multi-Tier GIS Application Use within the Human Resources Department

The following chart describes the recommended GIS application use by the Human Resource Department. A Tier 1 user is a power GIS user who should have access to a fully functioning GIS toolset. A Tier 2 users focus is data analysis in addition to general browsing capabilities. A Tier 3 user requires only general browsing GIS data functions. The Human Resource Department will consist of Tier 3 users.




***Human Resources Multi-Tier GIS Application Use***

# Parks and Recreation Department

## Personnel and Duties

The Parks and Recreation Department employs twenty-three full-time staff members, including:

- Parks and Recreation Director (1)
- Superintendent Community Services (1)
- Parks & Grounds Superintendent (1)
- Community Services Manager – Enterprise Zone (1)
- Office Manager – PC&S (1)
- Recreational Supervisors (5)
- Park Maintenance Workers (10)
- Secretary (1)
- Senior Clerk (1)

In addition, the Department employs between 87-105 part-time workers, as well as an intern in the Enterprise Zone Program.

The City of West Sacramento Parks and Recreation Department has several areas of responsibility:

- Recreation
- City Tree Program
- Facility Maintenance
- Park and Open Space Maintenance
- Park and Open Space Development
- Special Park Events
- Community Services
- Special Programs
- Park and Facility Administration

Parks Division

This division oversees the maintenance of 140+ acres of developed city parks. Park workers are dedicated to maintaining the parks to the highest standard: keeping them clean, safe, and attractive. Each park is unique in its amenities. Some of these include: baseball, softball, and soccer fields, picnic areas, open grassy areas, tot lots, and a boat ramp, just to name a few. The city tree program is also within this division and is responsible for the planting and care of street trees, the Trees for Tomorrow grant program, which provides free trees and education to local schools, churches and other community based organizations, and tree mitigation and abatement of hazard trees.

Recreation Division

This division provides community members with a wide variety of recreation and leisure opportunities. These opportunities include: aquatics, children's programs, teen programs (Club West Teen Center), youth and adult sports, and activities for senior citizens (West Sacramento Senior Citizen Center).

Community Services Division

This division includes Special Programs, such as special events, special interest classes, and facility rentals. This division also coordinates all community group meetings. It also includes clerical staff at the main office and general administration.

The Department currently does not utilize GIS. GIS users in the Parks and Recreation Department will be Level 3 GIS Users (see Chapter 2: GIS Organizational Structure and Staffing for more information on Level 3 GIS Users).

## Hardware and Software

The Parks and Recreation Department currently has 23 PCs.

All Parks and Recreation Department PCs have either the Windows XP or Windows 2000 operating system (citywide standard).

The Parks and Recreation Department uses the following software applications:

1. MS Office
2. MS Visio
3. MS Project
4. Intranet Registration System (developed in-house)

## GIS Needs and Duties

Based on this needs assessment several GIS needs have been identified for the Parks and Recreation Department, including:

- Mapping and spatial analysis of parks and recreation data
- Mapping and spatial analysis of street tree data
- Field access to geo-spatial data
- GIS interface to irrigation control system
- GIS-based work order Management
- Public Access to geo-spatial parks and recreation data, including online reservations/registrations

### Mapping and Spatial Analysis of Parks and Recreation Data

The Department will benefit, directly and indirectly, from integration of GIS-based applications for mapping and analysis of parks, street trees, facilities, and trails and paths.

The Parks and Recreation Department can utilize GIS to assist in several tasks, including:

- Facilities mapping and management
- City assets mapping and analysis
- Street tree mapping and analysis
- Proposed park and facilities location analysis
- Program and facility registration mapping and tracking
- Park maintenance work orders and inventory mapping and analysis (long-term)
- Statistical analysis for budgetary preparations
- Using maps to train personnel

In addition to mapping and spatial analysis capabilities, the Department may be able to enhance several of its existing applications by integrating them with GIS software. These applications include an irrigation management application (United Green Tech) and an online registration application. It is recommended that the Department work with the GIS Specialist and Information Technology Division to integrate these applications as appropriate. Integrated mapping and analysis will enhance these applications.

It is recommended that Parks & Recreation personnel utilize an Intranet GIS data browser to conduct basic spatial analysis and produce maps. This Intranet browser will be based on the enterprise-wide Intranet GIS data browser procured by the City. More information on the

Intranet GIS data browser is provided in the Enterprise-Wide Applications section of this chapter. For more advanced analysis and other tasks such as data creation, the Parks & Recreation Department should work with the GIS Specialist, who can use advanced GIS software such as ArcView or ArcInfo to conduct many of these tasks; the GIS Specialist may also be called upon to create other cartographic products for the Parks & Recreation Department.

***Figure P-1.1: A parks system map provides basic information about parks in a specific jurisdiction***

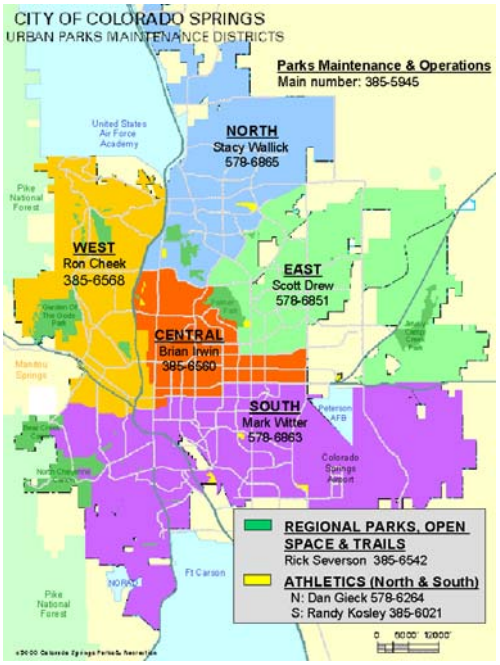



***Figure P-1.2: An urban parks maintenance districts map for the City of Colorado Springs, CO***

<u>*Parks Master Plan*</u>

The City contracted a consultant that developed the City of West Sacramento Parks Master Plan (finalized in September 2003). This document includes a needs assessment and an action plan that provides specific recommendations. This plan details a variety of information about the City's parks and facilities as well as recreation activities and programs.

GIS-based mapping and spatial analysis can be used to address or contribute to several of the goals and objectives specified in the plan, including:

| ***Goal or Objective*** | ***How GIS Can Be Used*** |
|---|---|
| Expand existing parks where feasible to provide additional acreage | Map and analyze existing park boundaries in relation to City-owner property, including vacant land and/or under-utilized land |
| Acquire and develop parks to meet the standard of 2 acres of neighborhood park and 3 acres of community park per each 1000 residents | Map and analyze existing/proposed parks (and corresponding attributes) in relation to demographics |
| Acquire and develop a central park to serve the entire city | Spatial analysis to determine optimal location; statistical projections; modeling |
| Build new community centers, senior centers, gymnasiums, teen centers and indoor soccer facilities to support the demand for recreation programs and classes | Spatial analysis for site selection; demographic analyses |

| | |
|---|---|
| Acquire and develop recreation corridors located along watercourses and railroad right-of-ways to link the park system and provide additional recreation opportunities | Map existing parks; use buffers and other spatial analyses with watercourses and railroads layers; spatial analysis to determine additional area |
| Locate new parks to take advantage of the city's natural resources, including the river and other watercourses | Spatial analysis to determine optimal location; statistical projections; modeling |
| Provide improved river access for boating and fishing | Determine optimal access points based on other factors, including infrastructure, environmental impact, proximity to population, and environmental features |
| Develop open space areas to protect significant wetlands and riparian forests, and to provide passive recreation opportunities | Spatial analysis to determine optimal location; statistical projection; wetlands and riparian forest environmental impact modeling |
| Develop an inventory of all existing street trees. | Determine trees requiring immediate removal, or other maintenance. Track maintenance for future cyclical pruning and other maintenance |

In addition to the potential mapping and spatial analysis opportunities listed above, there is also potential for additional mapping/attribution of park assets and infrastructure based on information provided for each park in the study. For example, a parks layer could be enhanced by adding attributes that specified the park type, total acreage, number of soccer fields, programmed activities (see Figure P-1.3). This information would also prove useful for conducting an audit and developing an inventory of park assets to be mapped (e.g., soccer fields).

Summerfield Park

**Type:** Neighborhood Park
**Location:** Linden Avenue near Diane Drive
**Neighborhood Planning Area:** Southport D1
**Size:** 8.9 acres

**Inventory**
Soccer field (2)
Basketball (1 full court)
Restrooms (portables)
Baseball backstops on turf area (3)
Dog run (fenced)
Trash receptacles and recycling bins
Play area – tot lot (1 structure, 1 swing)

**Programmed Activities**
Youth soccer
Little league practice

***Figure P-1.3: Example of a Park/Recreation Facility Detail from the Parks Master Plan***

It is recommended that the GIS Specialist work with the Department to determine an optimal strategy for GIS-based mapping and analysis in support of the Parks Master Plan.

Field Access to Geo-Spatial Data

Parks and Recreation personnel identified a need for field access to maps and GIS data. At present, field personnel in each division rely on hard copy maps provided on an ad-hoc basis by the Community Development Department. There are two methods for Parks and Recreation personnel to access spatial information in the field:

I. Map Books
II. Mobile Computers

Map books are recommended as a basic means of providing field personnel with access to updated and accurate maps. Once designed and developed, these map books can provide both short and long-term access for a variety of staff (including part-time workers). Mobile computers, specifically hand-held computers, are recommended as a more sophisticated means of providing field personnel with access to dynamic mapping and basic spatial analysis capabilities. Mobile computers are recommended for use in the long term, as field personnel become more familiar with GIS and the need for field-based GIS becomes more prevalent within the Department.

*I. Map Books*

The most cost effective solution for access to spatial information in the field is via map books. Map books can be generated for all Parks and Recreation staff. Each page can display a different section of the City or region. The location of pertinent features, such as parks and facilities can be displayed on top of base map information, such as labeled streets, tax parcels, and aerial photography. Map books represent an effective means of referencing the location of all pertinent features. As features are changed or added, new map books can be generated to reflect these changes.

*II). Mobile Computers*

A more advanced method for accessing spatial data in the field is through the use of mobile computers, including notebook computers, tablet PCs and hand-held computers. A GIS data browser, such as ESRI's ArcPad, can be loaded on hand-held computers, allowing the same capabilities offered by map books, but also the ability to query attributes, such as parks, facilities, assets, and trails; link to GPS receivers, and more.

It is recommended that hand-held computers be purchased for field staff use. A GIS data browser, such as ArcPad, should be loaded onto each hand-held computer. One (1) hand-held computer is recommended for Year 2; an additional two (2) hand-held computers are recommended for Year 3.

It is recommended that the Parks and Recreation Department have complete and accurate map books created in Year 1 of this three-year phased GIS implementation. Preliminary GIS access via mobile (hand-held) computers is recommended for Year 1. Comprehensive GIS access (all users) via mobile (hand-held) computers is recommended for Year 2.

☑ GIS Interface to Irrigation Control System

An opportunity exists for the integration of the United Green Tech irrigation control system (ICS) with a GIS Interface. The Parks Division recently procured Green Tech's ICS, which enables the Division to manage and monitor irrigation activity throughout the City's park network. ICS components are controlled via a satellite system that relays information from antennas to personal computers. The ICS should be mapped by conducting GPS field work to capture the location of sprinkler heads, irrigation lines, control modules, and other parts of the system. Feature data should be obtained via GPS and then converted to GIS data layers that can then be linked to the ICS database. The GIS Specialist can utilize extract/transform/load (ETL) applications to perform this task. Derivative GIS data sets may eventually be able to be linked to the ICS itself, providing full integration of mapping capabilities with real-time irrigation system control.

☑ GIS-Based Work Order Management

At present, the Department does not utilize an integrated work order system. Most work order requests are handled via digital documents that are subsequently archived as flat files. Although not an immediate need, there is a potential for Parks and Recreation personnel to utilize a GIS-based work order management system that will enable staff to track park assets and corresponding work orders. Subject to an increase in work orders and demand for services, it is recommended that the Parks and Recreation Department work with the GIS Specialist to implement an integrated GIS-based work order system that will allow for mapping, tracking, and analysis of work orders. Work order information should be stored in a database (such as SQL Server) that will allow for easy integration of work order and asset information as layers in a GIS data browser (such as an Intranet GIS data browser or a data browser on hand-held computer).

☑ Public Access to Geo-Spatial Parks and Recreation Data, Including Online Reservations/Registrations

A key GIS integration effort that the Department should undertake with assistance from the GIS Specialist and the Information Technology Division is the integration of the existing online activity registration application with a GIS interface. The current application allows citizens to log in to the City's web site and register online for various activities (see Figure P-1.4). This application also provides Recreation Division staff with an Intranet interface to view registration information.

Because most registration information will have a geographic component to it (such as address, facility, park, etc.), it is viable to produce GIS data layers from this data. A public mapping interface can be provided for the public, allowing citizens to use a map interface to view and register for programs and facilities. In addition, GIS data layers derived from the registration information can be used for mapping and analysis of registration trends and demographics via an Intranet GIS data browser as well as other GIS applications.

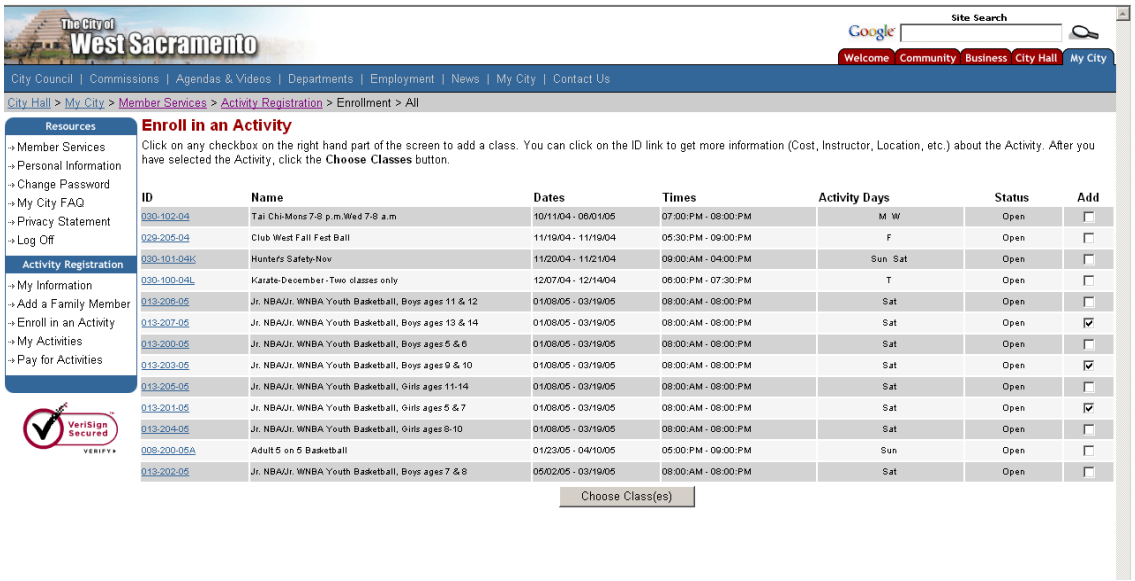



***Figure P-1.4: Activity registration interface available on the City web site***

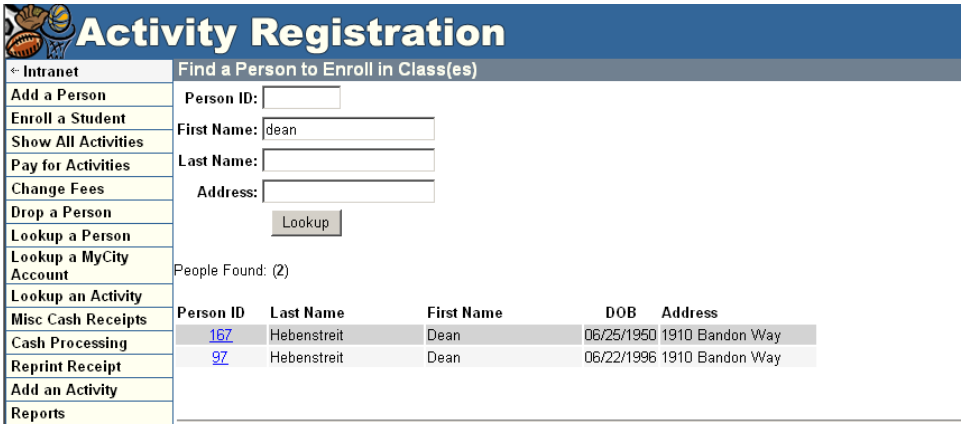



***Figure P-1.5: Intranet application for viewing registration information***

In addition to the GIS interface for activity registration, the Department should coordinate with the GIS Specialist to integrate departmental GIS data into the Internet-based mapping application to be developed by the City. In addition the Department should identify additional functionality that may be required in addition to the City's base enterprise offering.

More information on Internet GIS data browsers can be found in the Enterprise-Wide Applications section of this chapter.

## GIS Data Layers

The Parks and Recreation Department will benefit from access to several other departmental GIS data layers. It is expected that once all departmental data is integrated, consolidated, and centrally stored, that staff will have access to **all** non-classified GIS data layers from other City departments.

Department personnel expressed that access to the following GIS data layers would be beneficial:

| *Data Layer* | *Creation Methodology* | *Recommended Update Division or Individual* | *Existing or Recommended?* |
|---|---|---|---|
| **Address Points** | Extract, cleanse, geocode, and map from Springbrook; georeference based on aerial photography and GPS field work | Automated; GIS Specialist; Drafting Services Section | Recommended |
| **Aerial Photography** | Fly-over with control points | GIS Data Services Vendor | Recommended |
| **Bare Spots - Grass (Parks)** | GPS field work | GIS Specialist | Recommended |
| **Bicycle/Pedestrian Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Buildings with Site Plans** | Manually digitize polygons from plans and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Census Data** | Download from Census Bureau | GIS Specialist | Recommended |
| **City-owned Property** | Extract, cleanse, geocode, and map from Yolo County tax roll; other map sources as required | Automated | Recommended |
| **Crime Data** | Extract, cleanse, and automatically map from Police VisionAIR database | Automated | Recommended |
| **Easements** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Facilities** | Digitize on screen; aggregate layers as needed | Drafting Services Section | Existing |
| **Fire Hydrants** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **General Plan** | Digitize features from aerial photographs and existing data layer | Drafting Services Section | Recommended |
| **Hazardous Materials** | GPS data collection for location; extract from FirePoint or other database once data is entered | GIS Specialist; YCCESA | Recommended |
| **Impervious Surfaces** | Digitize polygons from aerial photographs; derive polygons by raster analysis of remotely-sensed data | Drafting Services Section; GIS Specialist | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Irrigation lines** | Digitize from as-built; GPS field work (may be available from GreenTech system) | Drafting Services Section; GIS Specialist | Recommended |
| **Irrigation sprinkler heads** | GPS field work (may be available from GreenTech system) | Drafting Services Section; GIS Specialist | Recommended |
| **Land Use** | Digitize polygons from aerial photographs and existing maps; existing CADD data | Drafting Services Section | Existing |
| **Levees** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Lighting and Landscape Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Major Intersections** | Use street centerline layer as source | Drafting Services Section | Recommended |
| **Oak Trees (Heritage)** | GPS field work; validation may be possible using aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Parcels** | Acquire from Yolo County | Yolo County ( and GIS Data Services Vendor) | Recommended |
| **Park benches** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park Facilities** | Query from address point layer; attribute as needed; digitize from base map data; GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park lights** | Extract, cleanse, and map based on Excel spreadsheet | Drafting Services Section; GIS Specialist | Recommended |
| **Park signs** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park tables** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park trash receptacles** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park tree canopies** | Digitize from aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Parks** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Port** | Digitize features from aerial photographs and other maps | Drafting Services Section; GIS Specialist | Recommended |
| **Reclamation District Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Schools** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Sewer Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Storm Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Streets** | Derived from aerial photography; GIS Consortium | Drafting Services Section | Existing |
| **Street Trees** | GPS field work; validation may be possible using aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Telecommunication Facilities** | Aggregate from telecommunications | GIS Specialist; Automated | Recommended |
| **Trees (Parks)** | Digitize from aerial photographs and existing maps | GIS Specialist | Recommended |
| **Water Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Waterways** | Digitize polygons from aerial photographs and existing maps | Drafting Services Section; GIS Specialist | Recommended |
| **Zoning** | Based on existing maps; General Plan | Drafting Services Section | Existing |

Additional layers may be required as the department increases its GIS utilization and incorporates additional field data.

## GIS Applications

### Intranet GIS Data Browser

An Intranet GIS data browser has been recommended for use by Department personnel. A full description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### Internet GIS Data Browser

An Internet GIS data browser has been recommended to provide citizens with access to the City's geo-spatial data. Leveraging the City's existing ArcIMS platform, the City will need to develop an enterprise-wide Internet GIS data browser to provide the public with access to geo-spatial economic and property data. A description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### Online Registration and Mapping

As aforementioned, it is recommended that the Recreation Division work in conjunction with the GIS Specialist and Information Technology Division to integrate GIS functionality with the existing web-based activity registration application. Registration data should be converted to one or more GIS layers that can be used to map and analyze registration activity and demographics.

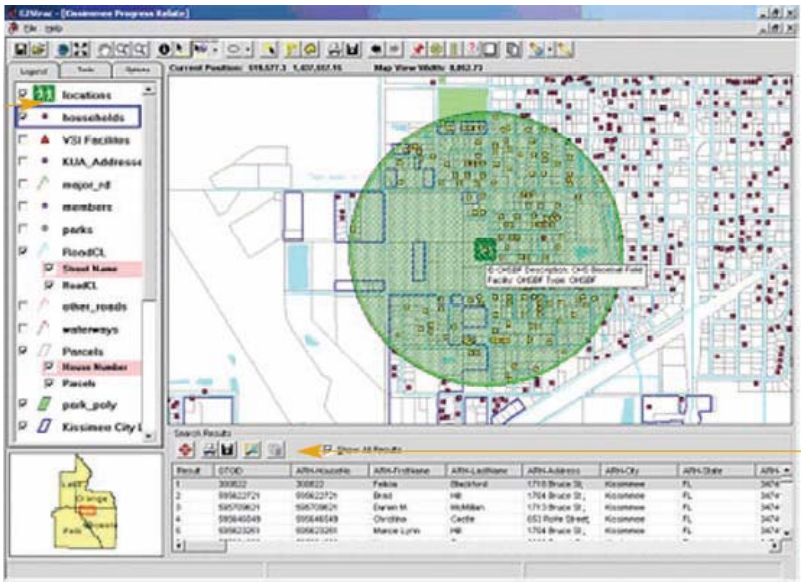



***Figure P-1.5: A spatial analysis can determine registration proximity relative to a given facility or park.***

## ArcPad 6.0

ArcPad software is an easy-to-use, lightweight, low-cost solution for mobile mapping and geographic information systems. ArcPad enhances portable touch screen computers with intuitive mapping, GIS, and GPS functionality. ArcPad makes field data collection fast and easy, improves data accuracy, and provides immediate data availability and validation. It is recommended that ArcPad technology be utilized in the Parks and Recreation Department. ArcPad will enhance and streamline field activities related to parks and facility maintenance, as well as asset and infrastructure management.

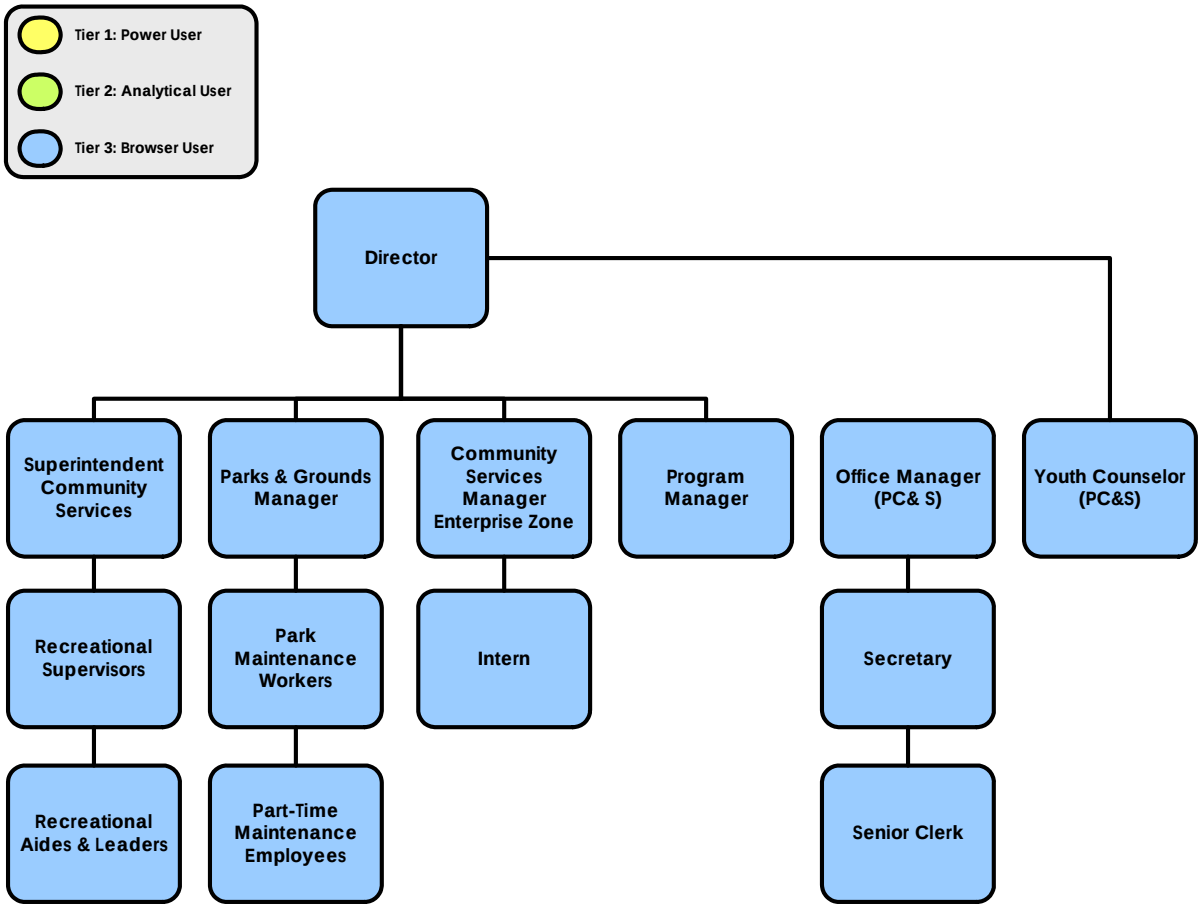
With ArcPad 6.0, Parks and Recreation personnel can:

- Use existing data - ArcPad supports industry-standard vector and raster image display.
- Add data from the Internet - Data can be provided from the Internet via wireless technology.
- Move around the map - ArcPad includes a number of map navigation tools including zoom and pan, spatial bookmarks, and center on the current GPS position.
- Query data - Identify features, display hyperlinks, and locate features.
- Measure distance, area, and bearings on the map.
- Navigate with GPS - Connect a GPS and with ArcPad.
- Edit data - Create and edit spatial data using input from the mouse pointer, pen, or GPS.

Extract, convert, and project existing data using ArcGIS Desktop

## Multi-Tier GIS Application Use within the Parks & Recreation Department

The following chart describes the recommended GIS application use by the Parks and Recreation Department. A Tier 1 user is a power GIS user who should have access to a fully functioning GIS toolset. A Tier 2 users focus is data analysis in addition to general browsing capabilities. A Tier 3 user requires only general browsing GIS data functions. The Parks and Recreation Department will consist of Tier 3 users.




***Parks and Recreation Department Multi-Tier GIS Application Use***

# Police Department

## Personnel and Duties

The Police Department, headed by the Chief of Police, is charged with maintaining public order, deterring law violations, protecting life and property, and apprehending criminal offenders. The Department is organized into four Offices, including:

- Office of Administration
  - Personnel/Training
  - Professional Standards
- Office of Operations
  - Watch Teams
  - Traffic Unit
  - Parking Enforcement
  - Vehicle/Equipment Maintenance
- Office of Criminal Investigations
  - General Investigations
  - Special Investigations
  - Crime Scene Investigations
  - Property Evidence
  - Crime Analysis Unit
  - Crime Prevention
  - Code Enforcement
  - Public Information
- Office of Support Services
  - Records Division
  - Information Center
  - Police Chaplain Program

This organizational structure enables the Department to effectively manage a broad spectrum of law enforcement services for the community.

The Police Department strives to deliver high quality Police service to the residents and visitors of the community. The prevention of crime is the highest operational priority; and, the department places its highest value on the preservation of human life, the protection of property and service to mankind. The Police Department maintains a 24-hour per day patrol of the City. The City of West Sacramento Police Department is a full service law enforcement agency emphasizing community policing. The City contracts its dispatch services through Yolo County Communications (YCCESA) in Woodland, California.

At present, the Department has one staff member (Crime Analyst) that directly uses GIS. The Crime Analyst uses GIS for mapping and some crime analysis; the core GIS application used by the Crime Analyst is ESRI's ArcView. The majority of GIS users in the Police Department will be Level 3 GIS Users; however, some GIS use within the Department will involve more complex GIS data analysis, mapping, and some geo-spatial data creation, such as that of Level 2 GIS Users (see Chapter 2: GIS Organizational Structure and Staffing for more information on Level 2 & Level 3 GIS Users).

The City of West Sacramento Police Department responded to a total of 1,975 Part-One crimes in 2003.

## Hardware and Software

The Police Department currently has desktop, notebook, and mobile PCs. All Police Department PCs have either the Windows XP or Windows 2000 operating system (citywide standard). Mobile computers are mounted in patrol vehicles.

The Police Department uses the following primary software applications:

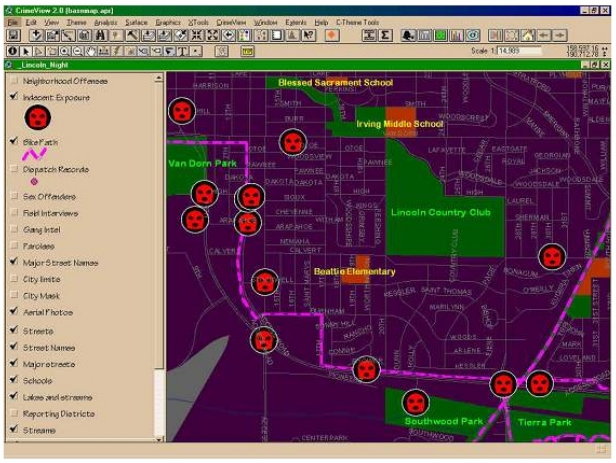
1. MS Office
2. VisionAIR
3. PRC CAD (through YCCESA)
4. ArcView
5. CrimeView (to be implemented in the near future)
6. Permits Plus (Accela)

A comprehensive list of software resources for all City of West Sacramento departments is provided in Appendix V: Existing Software Resources.

GIS applications used by the Police Department include CrimeView and ArcView.

### CrimeView

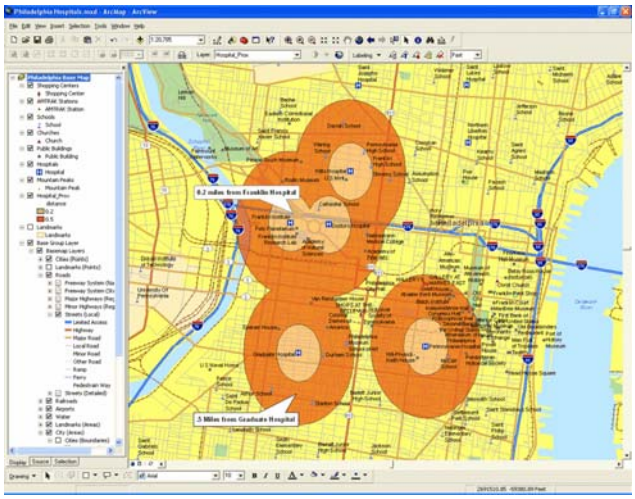
The Omega Group's CrimeView is an extension used in conjunction with ArcView to perform crime analysis. CrimeView allows users to query various types of incidents and display analyses in a map-based context.




***CrimeView Interface***

### ArcView

ArcView is used extensively to perform various spatial analyses in support of crime analysis. The department also uses ArcView to generate cartographic products for use by administrative and field staff.



***ESRI's ArcView***

The Police Department uses VisionAIR as its Record Management System (RMS) and PRC CAD for its Computer Aided Dispatch (CAD) system (through YCCESA). Microsoft Access-based applications are also used for several in-house databases.

VisionAIR offers a variety of products for use by public safety agencies. VisionAIR's VisionRMS provides a means for management of vital, agency-specific records, including incidents, arrests, property, field interviews, and warrants. A key opportunity exists for integration of the VisionAIR database with standalone and Intranet GIS data browsers. In addition, comprehensive GIS Integration with the County's CAD system will allow the Police Department to access real-time incident and call for service information in a spatial context. At present, the Crime Analyst manually extracts a limited amount of data from the RMS database; this extraction process involves address matching some incident data to the City's street centerline layer. The Crime Analyst has limited access to other digital layers maintained by the City. No information is currently extracted from the CAD system.

The Code Enforcement section utilizes Permits Plus to track various types of violations, including substandard housing and business licenses. Permits Plus is also used to track work orders for violations. Permits Plus is also used by other departments/divisions, including the Building Inspection Division. Additional information, such as patrol reports is obtained from VisionAIR. Some case tracking is also performed in Microsoft Excel. As with VisionAIR and the County's CAD system, much of the information stored in Permits Plus and Excel can be extracted and integrated with GIS applications, such as an Intranet GIS data browser.

In addition to VisionAIR and Permits Plus, the Department utilizes Crossroads software to track and analyze traffic accidents. The information maintained in the Crossroads database can be spatially enabled and converted to a GIS layer, allowing for GIS-based mapping and spatial analysis of traffic accidents.

Making quick and accurate decisions is critical in policing—GIS can assist in making these decisions. Cities throughout the world are finding that GIS can save lives, time and money. The use of GIS has been heralded as having contributed to the nationwide drop in the crime rate over the past few years. GIS can help depict patterns in criminal behavior that are impossible to visualize with traditional methods.

## GIS Needs and Duties

The Police Department has great potential for implementation of GIS and complementary technologies throughout the Department. From crime activity mapping, to patrol vehicle tracking, to reverse 911 notifications, the Department can leverage and integrate existing investments in its technology infrastructure to develop a best-of-class GIS.

Police departments throughout the country have implemented GIS in varying capacities—the City of West Sacramento Police Department is well positioned to implement GIS in a highly sophisticated capacity. Key to this effort will be the implementation of mapping and spatial analysis applications throughout the various divisions and sections of the Department as well as dynamic, real-time access to data for field personnel. Access to information should be provided by several user-friendly applications.

Based on this needs assessment, the Police Department has several GIS needs, including:

- Mapping and spatial analysis of criminal activity, incidents, and accidents
- Field access to geo-Spatial data
- Reverse 911

- Automatic vehicle location (AVL)
- Code enforcement tracking and analysis
- Public access to geo-spatial police Data
- Formal GIS training for Police Department staff

It is recommended that the Crime Analyst continue to use software such as ArcView and CrimeView to conduct spatial analyses and produce maps. For advanced GIS support, the Police Department should work with the GIS Specialist, who can use robust GIS software such as ArcEditor or ArcInfo to conduct additional mapping and analysis tasks; the GIS Specialist may also be called upon to create additional cartographic products for the Police Department.

It is also recommended that the Department implement an Intranet GIS data browser, as well as a desktop GIS data browser, to provide staff with access to mapping and spatial analysis functionality. This GIS data browser should include the ability for staff to view updated Department-specific information as well as the City's base GIS data layers.

Crime Scene Investigation Unit

In addition to the general recommendations for the Department as a whole, this needs assessment provides specific recommendations for the Crime Scene Investigation (CSI) Unit. It was identified that the CSI Unit has great potential for utilization of GIS in support of investigative operations.

Recommendations for the CSI Unit include:

- User Friendly Tools for Inventory and Analysis of Evidence
    - Field hand-held GPS and GIS technology (see Field Access to Geo-Spatial Data below)
    - User-friendly and intuitive GIS software (see GIS Applications below)
    - Integration of crime scene information (see GIS Data Layers below)

- GIS Data Layers and Information for CSI (see GIS Data Layers below)
    - Surrounding jurisdictions
    - Lighting base map
    - Vegetation Coverage
    - Waterways
    - Aerial photography

The recommendations listed above are addressed below in specific sections of the document. In addition to the aforementioned recommendations, it is also recommended that a Pilot Project be implemented to establish a foundation for utilization of GIS in support of CSI operations.

The recommended Pilot Project for the CSI Unit is based on two phases:

Phase I: Design and Development of Project

- Identify project goals
- Assign resources
- Design information technology infrastructure and standards
- Develop and implement technology infrastructure, including hardware, software, data models, and network

Phase II: Conduct Pilot Project

- Populate database

- Field use of GPS and GIS technology
- Training, as needed
- Assign Resources

This pilot project is aimed at establishing the environment, methodology, and processes that will allow the CSI Unit to utilize GIS in support of GIS operations. Subject to successful implementation and assessment of the Pilot Project, the Unit will be able to leverage investments in GIS and complementary technologies to integrate additional GIS software and hardware that will continue to improve and enhance operations. It is recommended that the CSI Unit work with the GIS Specialist (and an outside consultant, if needed) to design and develop the pilot project.

Mapping and Spatial Analysis of Criminal Activity, Incidents, and Accidents

As aforementioned, the Department's current mapping and spatial analysis capabilities are solely provided by the Crime Analyst. A key need for the Department is to provide organization-wide access to GIS-based mapping and spatial analysis. Users in every section will benefit from access to the City's base data as well as department-specific information. Upon implementation of an enterprise GIS, the Police Department will be able to conduct the following types of mapping and analysis:

- Incident analysis
- Calls for service
- Pin mapping
- Hot spot analysis
- Court case support
- Logistical support
- Tracking drug free zones around schools
- Creation of new Police beats or response areas
- Optimal sitting of facilities
- Optimal routing
- Viewing aerial imagery for drug raids and traffic accident analysis
- Mapping the location of registered sex offenders
- Laptop access with an easy-to-use data browser
- Notification of voluntary evacuation during storm events
- Tracking all outstanding warrants and served warrants
- Historical mapping of all cancelled warrants
- Traffic collision intersection studies
- Crime scene diagrams
- Traffic collision diagrams
- Gang territories

Much of the information used by Department staff will come from the VisionAIR database as well as from database extracts from the PRC CAD. Incident information, as well all other crime information maintained in the VisionAIR database, should be spatially enabled. Data extracted from the PRC CAD system, such as calls for service, should be spatially enabled and maintained as updated as possible. By spatially enabling these databases, the Department will establish a solid foundation for mapping and analysis efforts.

The Crime Analyst will be the Department's lead GIS user, although other staff members in various sections will also be able to perform conduct some mapping and analysis tasks utilizing an Intranet GIS application. As aforementioned, various tiers of GIS applications are recommended for the Department to meet its GIS needs. An Intranet GIS data browser

should be made available to all staff—this application will enable staff to perform basic PIN mapping.

A desktop GIS data browser is recommended for use by personnel that wish to conduct more complex PIN mapping and analysis (see Figure PD-1.1); this application will provide access to data extracts from the VisionAIR and PRC CAD databases, as well as base map information such as streets, parcels, and aerial photography.

Field personnel, such as Criminal Investigation Services and Code Enforcement, should also have hand-held computers with GIS data browsers (see figure PD-1.2). GPS units can be used in conjunction with ArcPad, allowing units to capture and link spatial data to other data collected in the field.

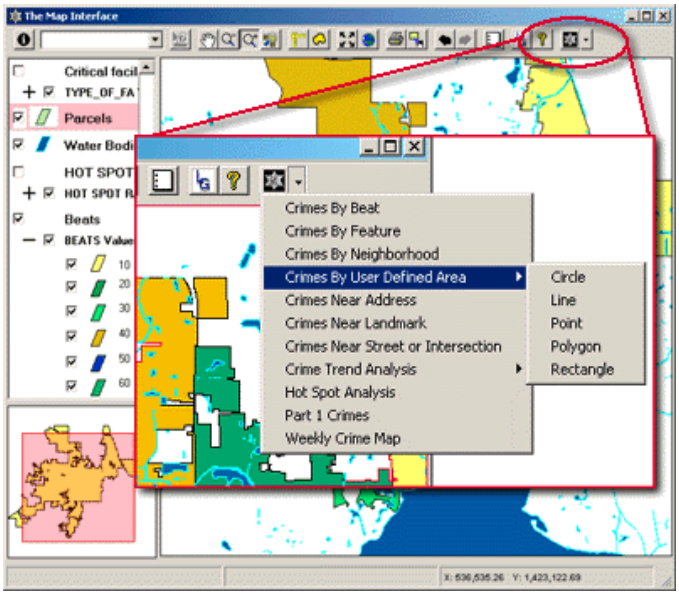



***Figure PD1.1 a desktop GIS browser with PIN mapping capabilities***

***Figure PD-1.2 ESRI's ArcPad application can provide field personnel with access to GIS data***

Police staff identified that inquiries by the citizens, both by telephone as well as in person, could be addressed by providing public mapping application. The addition of public touch screen kiosks and an Internet mapping application will also provide the public with the ability to map and analyze non-sensitive crime and police information (see Figure PD-1.3).

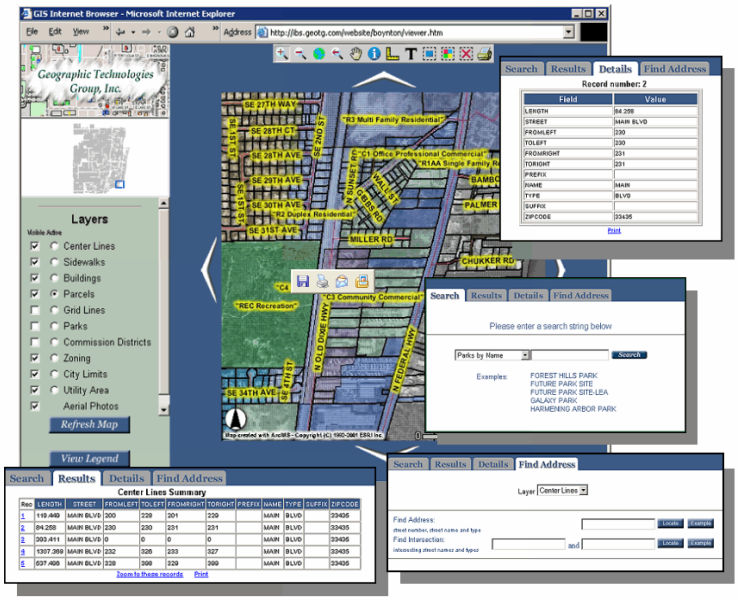
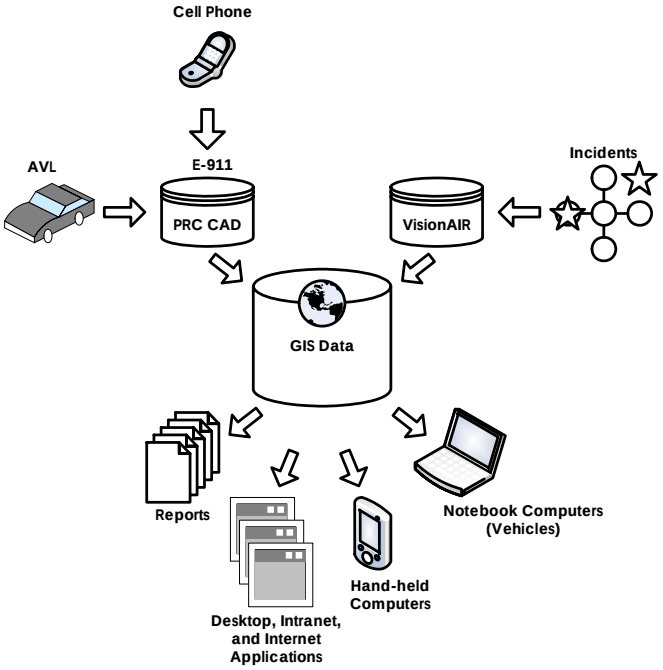



*Figure PD-1.3 an Internet mapping application provides citizens with access to crime data and maps via a web browser.*

*Figure PD-1.4 A public touch screen kiosk can be used to provide the public with access to crime statistics and maps*

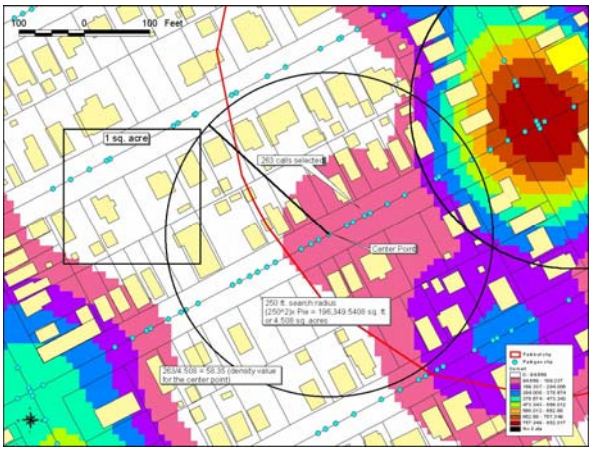
There is great potential for data integration and dissemination within the Police Department. Several existing and potential data threads will enable the Police Personnel to have access to a variety of geo-spatial information. This information should include E-911 and CAD data in a real-time basis.

A key element of the Department's GIS effort is providing field personnel with access to GIS applications—GIS data layers should be loaded to mobile computing resources, allowing staff to quickly access base and police-specific information.




*Police Department GIS Data Threads*

The following are some examples of the type of advanced GIS analysis that can be conducted for the Police Department:




A **Hot Spot Analysis** will look at part-one crimes for a week and look at the same week from the previous year. If a significant increase in crime has occurred, the Police Department can focus resources on trouble spots.

***Figure PD-1.5: Example of Hot Spot Analysis***

A **Traffic Collision Analysis** will look at collisions in specific areas, including date/time and number of accidents. Specific trends for collision-prone areas can be derived and mapped. Features such as signage, street and pavement conditions, and traffic counts can be used to determine traffic collision-prone areas.

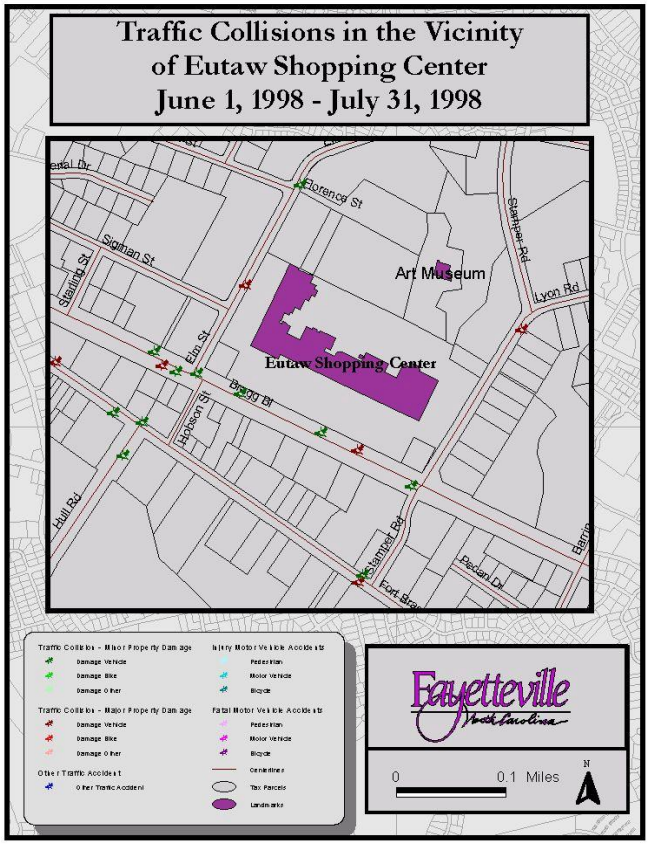



***Figure PD-1.6: Example of Traffic Accident Mapping***

One of the challenges the Crime Analyst has encountered is poor geocoding rates for the VisionAIR RMS data. It is expected that the poor geocoding rates are due to incorrect or inaccurate address entries made by RMS as well as an incomplete street centerline layer. At present, the Department has acquired an updated street centerline layer that may improve some, but not all, of the geocoding match rates. It is recommended that the Police Department work in conjunction with the GIS Specialist to device strategies to prevent incorrect or inaccurate address entry; additionally, a data entry standard should be established. It is recommended that Information Technology personnel assist with this effort.

Case Study: Lincoln, Nebraska, Police Make Connections through Geographic Location

The Lincoln Police Department (LPD) uses CrimeView, an ArcView extension, to convert tabular data into geographic visual displays that can generate discussion of current trends, known offenders, suspects, specific crimes, and intelligence. Such crime incident maps graphically reveal where specific kinds of offenses have been concentrated. LPD then strategically deploys officers to target these crime pattern areas.

With a metropolitan police department of more than 300 sworn officers and more than 100 civilian employees serving a city with a population in excess of 225,000, it would be understandable if police managers focused on administrative matters such as budget, personnel, local politics, equipment purchases, and revision of department procedures and policies. However, "Police work is about solving crimes, preventing crimes, and protecting the quality of life in neighborhoods," says Tom Casady, chief of police, Lincoln, Nebraska. As far as Chief Casady is concerned, the mission of the Lincoln Police Department (LPD) is crime prevention and reduction, and a focus on these issues by management is essential to success.

Chief Casady believes that maintaining focus on the mission requires that the crime fighting expertise and knowledge of his officers be systematically applied to the analysis of crime data. LPD has long believed that its officers on the streets are the best at investigating and clearing cases. As the chief puts it, "He or she is the one who knows the local places and is out there mixing it up with the victims, offenders, convenience store clerks, cab drivers, and street kids." Therefore, when it comes to focusing on crime analysis, the officer "is the one who needs to know that the offense he or she just worked is related to several other reports."

However, while LPD has an extensive records management system (RMS) that provides volumes of available data, the problem has been almost too much data, making it difficult to piece any of it together into discernible crime patterns. Chief Casady began looking for an analytical tool that would allow his officers and crime analysts to easily navigate the rich, yet formidable, database.

Recognizing that the basic component of crime data is geographic location, Chief Casady knew that he needed a GIS application to serve as the starting point for analysis of the crime data. In 1998, Chief Casady instituted monthly meetings of his officers to analyze the data by tapping into existing shared and common ArcView files that were already available from the Planning and Engineering Departments on the city and countywide network server.

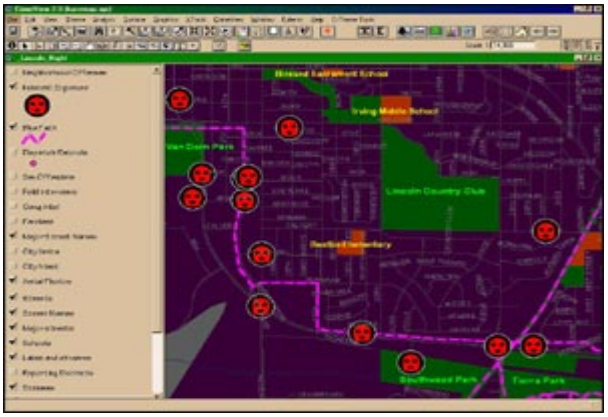
The meetings became known as ACUDAT, an acronym for Analyzing Crime Using Data About Trends. At the ACUDAT meetings, attended by commanders, supervisors, detectives, investigators, and officers, discussion of current trends, known offenders, suspects, specific crimes, and intelligence was initiated by looking at the computerized interactive crime incident map produced from the queries submitted by police staff to the ArcView software. The crime incident maps graphically revealed where specific kinds of offenses were

concentrated. LPD then strategically deployed officers to target these crime patterns and successfully interrupt them through both investigative and preventative measures.

Officers can now see clearly the connections that may have escaped their attention until they see adjacent icons on a GIS crime incident map.
The early successes of crime mapping analysis encouraged LPD to find ways of doing a lot more of it more quickly with even more detailed accuracy. In March 1999, while attending a crime mapping conference, Chief Casady found (and implemented soon thereafter) what his department was looking for: CrimeView, a GIS application created by The Omega Group, Inc.

Chief Casady explains that computerized crime mapping is a "great way to process a large amount of data visually that would be difficult to conceptualize in tabular form alone." Now officers began to link cases that would have been hidden-submerged among the 400 or more incidents LPD handles daily.

For example, officers at the ACUDAT meetings have linked suspects from different types of sexual offense reports such as indecent exposure and sexual assault on a child that occurred in the same vicinity. This connection may have previously escaped officers' attention until the two crimes appeared as adjacent icons on a GIS crime incident map.



Although the monthly ACUDAT meetings provide a focal point for discussing crime trends, the key is to get the officers to frequently interact with the crime data. To further employee access, LPD incorporated CrimeView Internet (CVI), a browser-based application using ESRI's ArcIMS server software that allows officers at multiple and remote locations to conduct crime mapping analysis without using the desktop version. With CVI, officers independently and immediately received answers to their questions.

The street officers were no longer reliant on the analysts in the department's Crime Analysis Unit. LPD officers are now able to produce their own up-to-the-minute relevant crime maps without the delay of submitting a request and waiting for a crime map to be created for them--a map that may be obsolete by the time they receive it. In essence, the LPD officer has become his or her own crime analyst in many situations, and the crime analysis staff is freed for more demanding and complex analyses.

When officers make arrests on the streets of Lincoln, they are often asking themselves, "Do we have any similar offenses and where?" This information is immediately available to officers during post arrest interrogation and follow-up.

"The ability to locate similar offenses quickly at any time of day or night can be quite valuable in leveraging a single case into a multiple clearance," says Casady. For instance, by running GIS queries using keywords related to specific aspects of the modus operandi, LPD officers have been able to clear additional cases during the suspect interview.

LPD officers use crime maps to provide information to community and neighborhood groups about crime trends. For several years, LPD has provided weekly crime maps to the Lincoln Journal Star for printing in the paper. Recently, LPD took the next step in its partnership with its community by providing city of Lincoln citizens' public access to The Omega Group's CrimeView Community, based on ESRI's ArcIMS Web server software. After its debut, LPD's Internet site reached a new plateau, receiving more than 100,000 hits per month. Using this site, citizens learn about what kind of crime is going on in their neighborhoods on a real-time basis. The availability of this information has reinforced LPD's community-based policing efforts.

Chief Casady believes that crime mapping technology empowers officers' investigative and preventative efforts, and thus is a basic police tool that helps officers carry out the department's mission. He reminds everyone that the officer is the crime fighting expert. It's his or her training and experience that ultimately solves cases and interrupts crime trends. However, crime mapping provides a powerful lens that maximizes the effectiveness of the officer's street-trained eyes.

**Case Study Courtesy of ESRI ArcNews Magazine*

Field Access to Geo-Spatial Data

An advanced method for accessing spatial data in the field is through the use of mobile computers, including notebook computers, tablet PCs and hand-held computers. A GIS data browser can be loaded on mobile computers, allowing the same capabilities offered by map books, coupled with the ability to conduct address searches; query attributes of all information, such as schools, types of hazardous material stored at a location; link to digital site plan images, and more.

The Police Department indicated a need for notebook computers to assist with crime mapping and automated vehicle location (AVL). At present, the Police Department has notebook computers in all patrol vehicles. These notebook computers will serve as the foundation for field access to GIS data. At present, vehicles have a mapping application that has limited functionality as well as inaccurate data. It is recommended that the application and data should be replaced with a more sophisticated application and base map data maintained by the Drafting Services Section and GIS Specialist.

***Figure PD-1.7: A hand-held computer with ESRI's ArcPad***

In coordination with the GIS Specialist and the Information Technology Division, these notebooks should be configured with a GIS data browser that includes AVL and routing functionality. All relevant layers, including base map layers and aerial photography should be available for display in the GIS data browser. It should be noted that highly accurate geo-spatial data is required for the successful implementation of such as solution, given that patrol personnel will rely on this information to make tactical decisions.

In addition to the notebook computers in patrol vehicles, other mobile computing resources should be procured and configured with GIS data browsers. Staff in the Code Enforcement

and CSI should have hand-held computers with ESRI's ArcPad (see Figure PD-1.7). An exciting opportunity lies in the use of integrated GPS/hand-held computers, which provide a user-friendly means of acquiring GPS data on the same computer that hosts a GIS application—such a configuration would be optimal for use by the CSI Unit. It is recommended that the CSI Unit utilize GPS/hand-held computers to capture a geo-spatial inventory of crime scene information.

Other mobile computers, such as tablet PCs or ruggedized notebook computers should be procured, centrally stored, and accessible to various field personnel as shared resources. All mobile computers should be configured with the aforementioned GIS data browser.

It is recommended that the Police Department have a GIS data browser in patrol vehicles in Year 1 of this three-year phased GIS implementation. An initial set of ruggedized notebook computers and hand-held computers configured with a mobile GIS data browser should also be acquired in Year 1 to determine their viability for field access to spatial data; subsequent to successful utilization of field computers, the Department should continue to procure additional ruggedized notebooks and hand-held computers during Years 2 and 3. GIS access via mobile computers is also recommended for Years 1, 2 and 3.

Reverse 911

GIS has proven to be a valuable technology for community alerting mechanisms, such as Reverse 911. Reverse 911 is inherently a GIS application as spatial selection and analysis are fundamental for the effective utilization of Reverse 911. Reverse 911 is a requirement of the city's technology strategy plan; it is recommended that the city implement a GIS-based Reverse 911 solution.

The uses of GIS-based Reverse 911 applications include:

- Emergency Evacuations
- Missing Person Alerts
- Crime Prevention Safety Tips
- Public Service Announcements
- Citizen Surveys
- Business Crime Alerts
- Investigation Assistance
- Sexual Offender and Predator Notices
- Search and Rescue Operations
- Neighborhood Watch Meeting Notices

GIS-based Reverse 911 applications include functionality to select target audiences for distribution of messages based on spatial queries, tabular queries, user-defined areas, buffers, and existing data layers. A key need identified by the Department is notification of incidents/events to neighborhood watch groups. Using a GIS-based Reverse 911 application, the Department could use spatial analyses to determine appropriate contact information for selected neighborhood watch groups in the vicinity of an incident of event (see Figure PD-1.8). The Department should utilize a Reverse 911 application that can be easily and effectively integrated with the City's GIS, including the Intranet and desktop mapping applications referenced above.

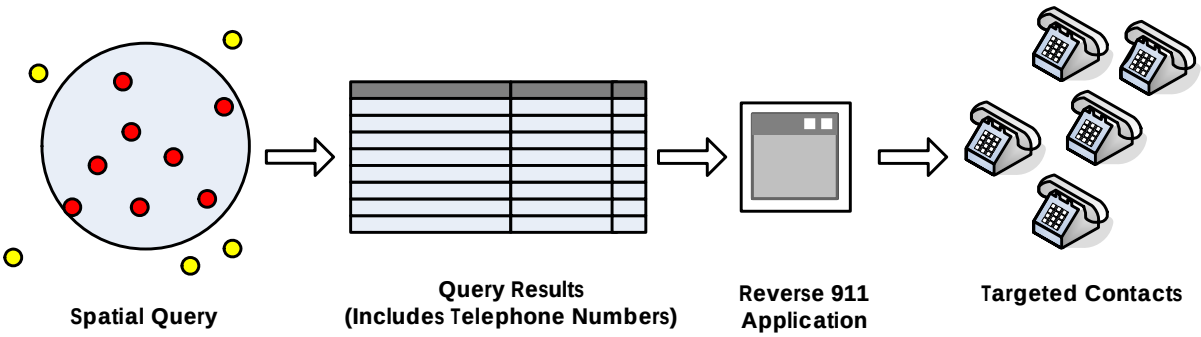



***Figure PD-1.8: GIS-based Reverse 911 Workflow***

## Automated Vehicle Location (AVL)

Many police departments are implementing Automated Vehicle Location (AVL) systems to monitor via GPS the location of public safety vehicles. AVL can also be used for any City vehicle. Knowing the location of police vehicles will allow dispatchers to more efficiently allocate resources and improve response times. Additionally, the location of personnel in danger can be tracked. It has been said that if AVL can save the life of one officer, it is worth the investment.

The Police Department should coordinate with the Fire Department and YCCESA to conduct a review of available AVL systems. AVL will be tightly integrated with the Computer-Aided Dispatch application implemented by YCCESA as well as the City's other GIS infrastructure and database systems (see Figure PD-1.9)

The Department should use AVL in conjunction with existing mobile computing equipment to ensure that this information can be viewed in data browsers in the field as well as in operations offices. Mobile computers configured with a GIS Data browser should have routing capabilities, in order to enable dispatched units to quickly and efficiently respond to calls for service.

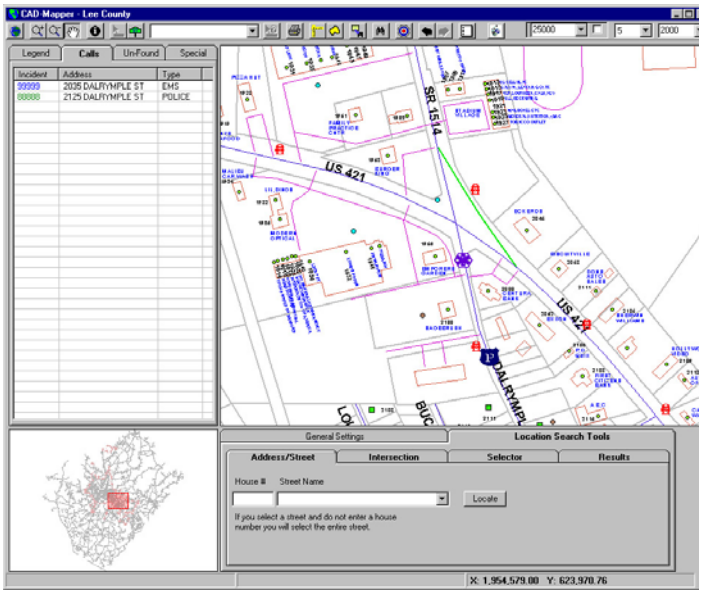



***Figure PD-1.9: Example of a mapping interface that displays CAD information and AVL***

## Code Enforcement Tracking and Analysis

Code Enforcement personnel identified the need to map calls for service in given areas, which will lead to analysis and efficient deployment of resources. In addition, trends or specific complaints related to code enforcement issues can be assessed, and the information can be used to prioritize the work load. At present, Code Enforcement maintains a Microsoft Access database file which is in the process of being decommissioned. All new data for code enforcement is entered into the Permits Plus (the primary database used by the Section). A variety of information is maintained for each case, including case and complaint types, case category or priority, property locations, property owner information,

vehicle registration and owner information. Utilizing the aforementioned GIS data browser, staff in Code Enforcement will be able to conduct many of these mapping and analysis tasks. It is recommended that Code Enforcement personnel work with the Crime Analyst and GIS Specialist to conduct any complex analysis and/or data production that may be needed to support this effort.

In addition to mapping and analyzing code enforcement service calls, Code Enforcement personnel identified the need to link to the County Assessor's parcel information, to include mortgagee and note holder information. It is recommended that the Section work with the GIS Specialist to determine an optimal strategy for obtaining, configuring, and linking the deed information to the City's parcel layer. Code Enforcement personnel identified MetroScan, a third party provider of tax/assessment data, as a potential alternative for acquisition of this information.

☑ Public Access to Geo-Spatial Police Data

The Police Department expressed the need to disseminate spatial information to the public by providing a mapping application that will enable the city's citizens to view and analyze criminal and incident information. As aforementioned, the mapping application should incorporate the ability for the public to view criminal and incident data, including crime hotspots and sexual offender locations.

As part of the City's objective to provide an Internet GIS data browser, the department should coordinate with the GIS Specialist to integrate departmental GIS data into the Internet-based application. In addition the Department should identify additional functionality that may be required in addition to the City's base enterprise offering.

More information on Internet GIS data browsers can be found in the Enterprise-Wide Applications section of this chapter.

In addition to an Internet GIS data browser, it is recommended that the Department procure a public access kiosk. The kiosk will provide citizens basic mapping and query functionality in an easy-to-use, intuitive interface. It is expected that the kiosk will reduce the amount of inquiries that need to be addressed in person by Police personnel.

☑ Formal GIS Training for Planning Division Staff

Several departments/divisions, including the Police Department, will benefit from formal training in GIS. It is recommended that the Crime Analyst receive formal training in ArcGIS. More information on training opportunities can be found in Chapter 9: GIS Training and Education.

## GIS Data Layers

The Police Department will benefit from access to several other departmental GIS data layers. It is expected that once all departmental data is integrated, consolidated, and centrally stored, that staff will have access to **all** non-classified GIS data layers from other City departments.

Department personnel expressed that access to the following GIS data layers would be beneficial:

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Address Points** | Extract, cleanse, geocode, and map from Springbrook; georeference based on aerial photography and GPS field work | Automated; GIS Specialist; Drafting Services Section | Recommended |
| **Aerial Photography** | Fly-over with control points | GIS Data Services Vendor | Recommended |
| **Bad Bridges** | GPS data collection and integration with existing information | Fire Department; GIS Specialist | Recommended |
| **Bicycle/Pedestrian Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Building Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Buildings with Site Plans** | Manually digitize polygons from plans and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Census Data** | Download from Census Bureau | GIS Specialist | Recommended |
| **City-owned Property** | Extract, cleanse, geocode, and map from Yolo County tax roll; other map sources as required | Automated | Recommended |
| **Commercial Addresses** | Extract, cleanse, geocode, and map from Springbrook | Automated | Recommended |
| **Crime Data** | Extract, cleanse, and automatically map from Police VisionAIR database | Automated | Recommended |
| **Critical Facilities** | Manually digitize points from aerial photography and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Day Care Facilities** | GPS field work. | GIS Specialist; Redevelopment Agency | Recommended |
| **Easements** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Entrapment Areas** | Manually digitize polygons from aerial photography and other imagery | GIS Specialist | Recommended |
| **Facilities** | Digitize on screen; aggregate layers as needed | Drafting Services Section | Existing |
| **Fire Hydrants** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Fire Incidents** | Extract, cleanse, geocode, and map from FirePoint or in-house database | Automated | Recommended |
| **Fire Inspections** | Extract, cleanse, geocode, and map from FirePoint or in-house database | Automated | Recommended |
| **Fire Investigations** | Extract, cleanse, geocode, and map from FirePoint or in-house database | Automated | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **General Plan** | Digitize features from aerial photographs and existing data layer | Drafting Services Section | Recommended |
| **Hazardous Materials** | GPS data collection for location; extract from FirePoint or other database once data is entered | GIS Specialist; Fire HAZMAT Manager | Recommended |
| **Jurisdictions (Adjacent)** | Digitize polygons existing maps; existing CADD data; acquire data from other organizations | GIS Specialist; Drafting Services Section | Recommended |
| **Land Use** | Digitize polygons from aerial photographs and existing maps; existing CADD data | Drafting Services Section | Existing |
| **Levees** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Licensed and Unlicensed Businesses** | Extract, cleanse, geocode, and map from in-house database | Automated | Recommended |
| **Liens** | Extract, cleanse, geocode and map from Springbrook | Automated | Recommended |
| **Liquor Licenses** | Acquire from state ABC database; geocode and georeference using base layers | GIS Specialist; Drafting Services Section | Recommended |
| **Major Intersections** | Use street centerline layer as source | Drafting Services Section | Recommended |
| **Neighborhood Watch Areas** | Digitize from base map data; GPS field work (if needed) | GIS Specialist; Drafting Services Section | Recommended |
| **Parcels** | Acquire from Yolo County | Yolo County ( and GIS Data Services Vendor) | Recommended |
| **Parks** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Parolees** | Extract, geocode, and map from Parole download (available from California Department of Corrections) http://www.corr.ca.gov/ | Automated | Recommended |
| **Police Beats** | Digitize from base map data; other map sources as needed | GIS Specialist; Crime Analyst | Recommended |
| **Police Department Special Projects** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Police Station Location** | Manually digitize points from aerial photography and address sources | GIS Specialist; Drafting Services Section | Recommended |
| **Port** | Digitize features from aerial photographs and other maps | Drafting Services Section; GIS Specialist | Recommended |
| **Schools** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Sewer Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Sexual Offender Locations** | Extract, cleans, and automatically map from VisionAIR; Megan's Law Database | Crime Analyst & GIS Specialist | Recommended |
| **Storm Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Streets** | Derived from aerial photography; GIS Consortium | Drafting Services Section | Existing |
| **Telecommunication Facilities** | Aggregate from telecommunications | GIS Specialist; Automated | Recommended |
| **Traffic Accidents** | Extract, cleanse, geocode, and map from Crossroads database | GIS Specialist; Engineer; (Crime Analyst) | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Traffic Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Traffic Calming Devices** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Traffic Counts** | Extract, cleanse, geocode and map from Access database | GIS Specialist | Recommended |
| **Traffic Signals** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Transit Routes** | Derive from street centerline layer; acquire from SACOG? | Drafting Services Section | Recommended |
| **Truck Routes** | Derive from street centerline layer | Drafting Services Section | Recommended |
| **Vacant Properties** | Query from parcel layer; other sources as needed | GIS Specialist (eventually automated) | Recommended |
| **Water Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Waterways** | Digitize polygons from aerial photographs and existing maps | Drafting Services Section; GIS Specialist | Recommended |
| **Zoning** | Based on existing maps; General Plan | Drafting Services Section | Existing |

Additional layers may be required as the Department increases its GIS utilization and incorporates additional field data.

In addition to the layers listed above, the CSI Unit identified the need to link various types of multimedia crime scene information to crime incidents, including photographs, video, and sketches (scanned).

## GIS Applications

### Internet GIS Data Browser

An Internet GIS data browser has been recommended to provide citizens with access to the City's geo-spatial data. Leveraging the City's existing ArcIMS platform, the City will need to develop an enterprise-wide Internet GIS data browser to provide the public with access to geo-spatial property data. A description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### Intranet GIS Data Browser (including PIN Mapping)

An Intranet GIS data browser has been recommended for use by Police personnel. The Intranet GIS data browser should provide PIN mapping functionality for the all Department personnel. This application will provide the ability to map and analyze all data extracted from VisionAIR and PRC CAD. This application will serve as the primary enterprise-wide GIS application for the Police Department, and should be made available to all personnel throughout the Department. A full description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### GIS Data Browser (including PIN Mapping)

A standalone (desktop) GIS data browser is recommended as a more robust crime analysis application for Department personnel that will engage in mid-level crime analysis, including the CSI Unit. The GIS data browser should include much of the same functionality as that

provided by the Intranet GIS data browser, but it should include additional functionality including more detailed reporting, additional crime mapping tools (including crime trend analyses) and the ability to read data files on a local drive (for mobile computers, such as those in patrol vehicles).

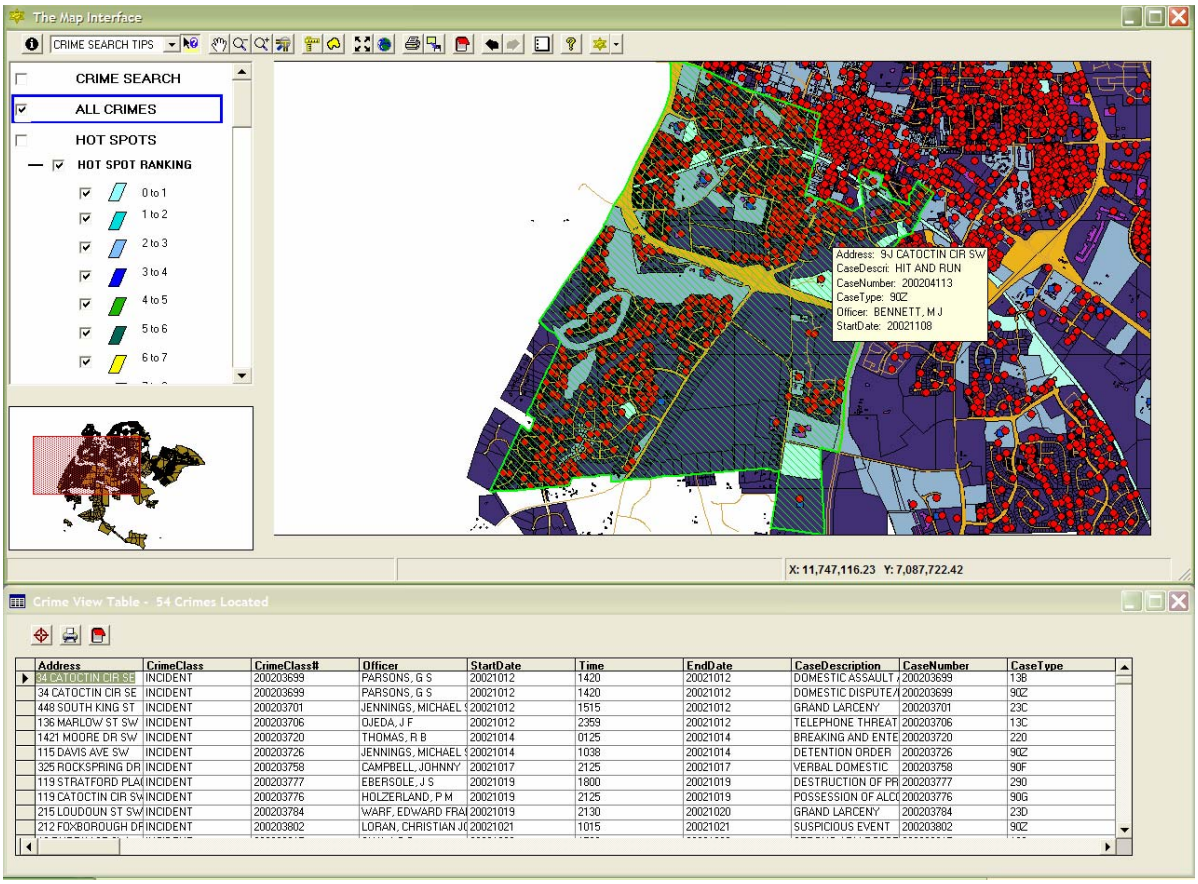



***Figure PD-1.10: Sample Crime Mapping Interface***

## Mobile GIS Data Browser (including AVL integration and routing)

A mobile GIS data browser is recommended for use in patrol vehicles. This application should integrate with existing AVL hardware in the patrol vehicles, thereby allowing existing investments in hardware to be leveraged for improved functionality with the new data browser. The mobile GIS data browser should also include routing functionality that will allow quick and effective determination of optimal routes to a service call location. The application should integrate with the aforementioned GIS data browser, providing field personnel with a familiar user interface, functionality, and available data.

## ArcGIS 9

ArcView 9 is recommended for use by Police Department personnel. A description of this application is provided in the Enterprise-Wide Applications section of this chapter. One (1) license of ArcView is recommended for use by the crime analyst. The Crime Analyst should continue to utilize ArcView in conjunction with CrimeView to perform sophisticated crime analyses.

## Reverse 911

GIS has proven to be a valuable technology for community alerting and public outreach, such as Reverse 911. Reverse 911 is inherently a GIS application as spatial selection and analysis are fundamental for the effective utilization of Reverse 911. Reverse 911 is a requirement of the City's technology strategy plan; it is recommended that the Police Department leverage the GIS-based Reverse 911 solution that the City decides to implement. Although some Reverse 911 applications require significant investments in communications infrastructure, several emerging solutions, such as Code Red (see below), utilize the Internet and hosted infrastructure, thereby eliminating the need for investment and configuration of communication infrastructure on-sight.

The uses of GIS-based Reverse 911 applications include:

- **Emergency Evacuations**
- **Missing Person Alerts**
- **HAZMAT Emergency**
- **Crime Prevention Safety Tips**
- Public Service Announcements
- Citizen Surveys
- Utilities Service Alerts
- Investigation Assistance
- **Prison Escape Alerts**
- **Sexual Offender and Predator Notices**
- **Parolee and Juvenile Check-ups**
- **Search and Rescue Operations**
- **Neighborhood Watch Meeting Notices**

Several effective GIS-based Reverse 911 applications are currently available on the market. It is recommended that the City procure and implement a solution that integrates GIS technology with the telecommunications capability of the Internet. Listed below is GTG's recommended Reverse 911 application.

### *CodeRED™ Emergency Telephone Calling System*

The CodeRED™ Emergency Telephone Calling System is a high-speed telephone communication service available for emergency notifications. CodeRED™ utilizes Internet mapping capability for geographic targeting of calls, coupled with a high speed telephone calling system capable of delivering customized, pre-recorded emergency messages at the rate of up to 60,000 calls per hour. CodeRED™ subscribers control their emergency broadcasts from anywhere in the world via a secure Internet Portal.

More information can be found at http://www.coderedweb.com

## ArcPad 6.0

ArcPad software is an easy-to-use, lightweight, low-cost solution for mobile mapping and geographic information systems. ArcPad enhances portable touch screen computers with intuitive mapping, GIS, and GPS functionality. ArcPad makes field data collection fast and easy, improves data accuracy, and provides immediate data availability and validation. It is recommended that ArcPad technology be utilized in the Police Department. ArcPad will enhance and streamline field survey activities related to inspections.

With ArcPad 6.0, Police personnel can:

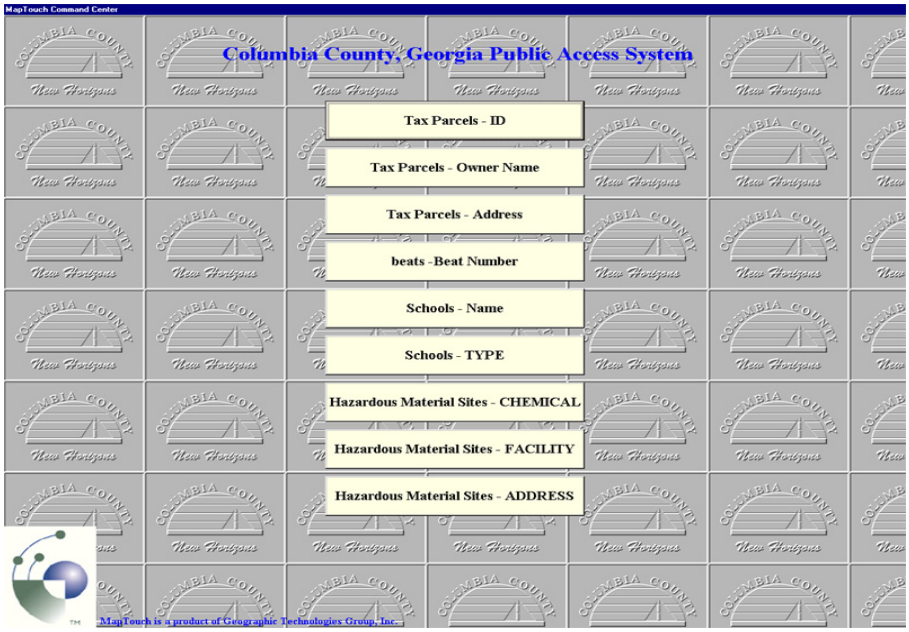
- Use existing data - ArcPad supports industry-standard vector and raster image display.
- Add data from the Internet - Data can be provided from the Internet via wireless technology.
- Move around the map - ArcPad includes a number of map navigation tools including zoom and pan, spatial bookmarks, and center on the current GPS position.
- Query data - Identify features, display hyperlinks, and locate features.
- Measure distance, area, and bearings on the map.
- Navigate with GPS - Connect a GPS and with ArcPad.
- Edit data - Create and edit spatial data using input from the mouse pointer, pen, or GPS.

Extract, convert, and project existing data using ArcGIS Desktop

## Public Access Kiosk Application

Many public access attempts required the user to use a mouse and keyboard and have an understanding of how to use a Windows based application. These expectations eliminate 70% of potential users. The Internet has become one medium of disseminating data to the public. However, there is still a need to have public access to data physically at an organization's buildings. Many people come to a facility, such as the Police Department office, with specific questions about crime and areas serviced. A well-written public access application will allow a user to find the answers for themselves.

To be effective, a public access application must be easy to use. For many users, this means an application that does not require use of a mouse or keyboard. Touch screen monitors have enabled applications that do not require a mouse and keyboard to become a reality. A touch screen kiosk application should be implemented utilizing Tier 3 (MapObjects) software. Buttons and slider bars must be large so that they are easily selected by touching the screen.




***Sample Introduction Screen for Touch Screen Kiosk***

This application should be flexible so that it can be used at other facilities/sites to provide public access with other data sets. Once the public access application is written it should allow for quick changes and customization.

The public access application should target the following goals:

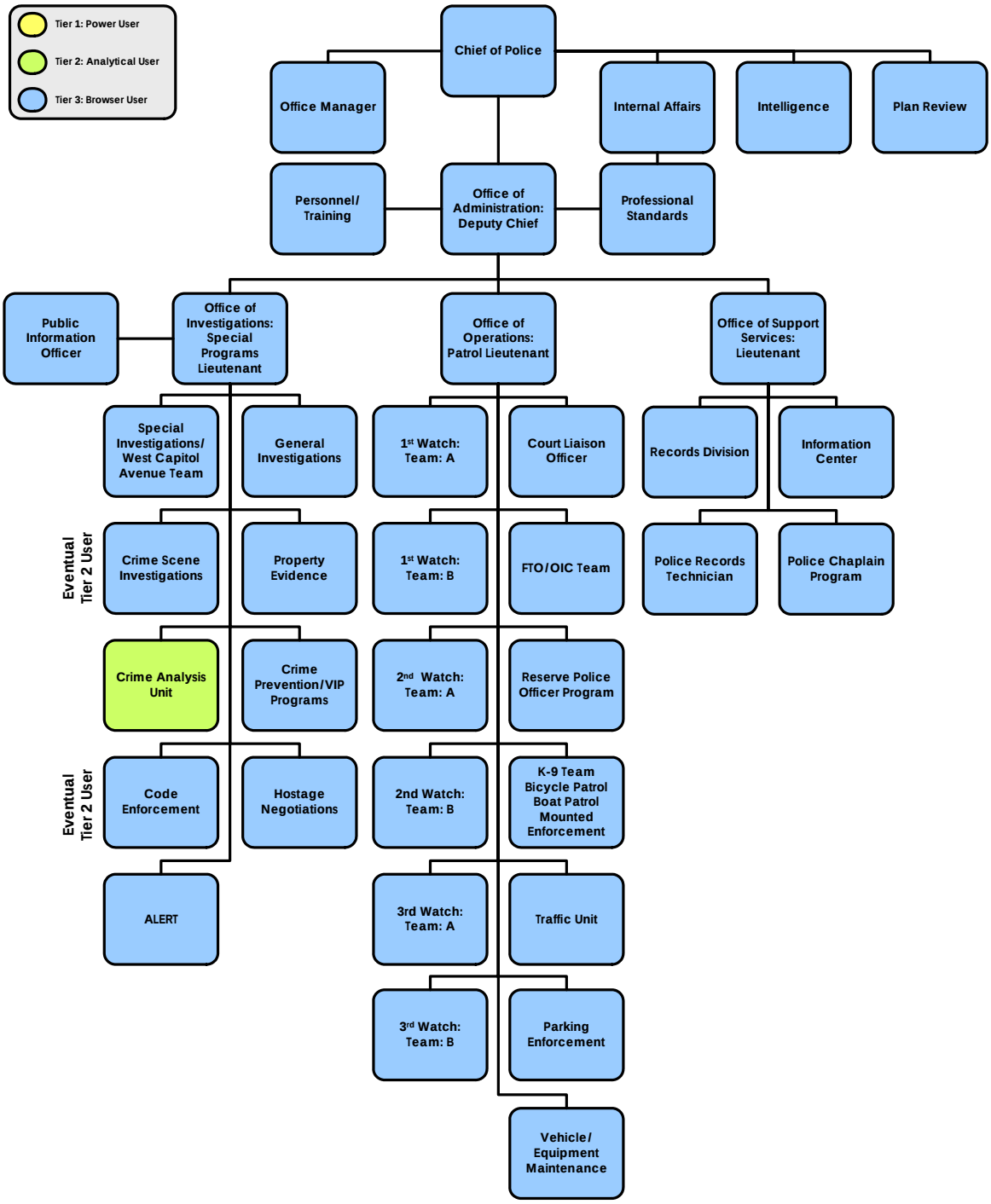
- Configurable for at least 10 preset queries
- Extremely user friendly — no keyboard, no mouse
- Designed with the latest GIS technology — ESRI MapObjects™ in conjunction with Visual Basic™
- Must have an administration package for complete control of layers, colors, and data
- Network ready for automatic update of configuration and setup files
- Easy to customize data setup and query configuration
- Supports imagery and ortho-photography
- Easy and quick setup

The kiosk application should be very streamlined, offering only the essential GIS functionality such as; printing, pan, zoom in, zoom out, identify, and turning layers on and off.

***Kiosk Application with Key GIS Functions***

## Multi-Tier GIS Application Use within the Police Department

The following chart describes the recommended GIS application use by the Police Department. A Tier 1 user is a power GIS user who should have access to a fully functioning GIS toolset. A Tier 2 users focus is data analysis in addition to general browsing capabilities. A Tier 3 user requires only general browsing GIS data functions. The Police Department will consist of Tier 2 and Tier 3 users.




***Police Department Multi-Tier GIS Application Use***

# Public Works Department

## Personnel and Duties

The Public Works Department employs fifty-four staff members, including:

- Public Works Director (1)
- Deputy Director (1)
- Wastewater Treatment Plant Superintendent (1)
- Water Treatment Plant Superintendent (1)
- Street Maintenance (6)
- Equipment & Vehicle Maintenance (2)
- Backflow (1.5)
- Sewer & Water Maintenance (9.5)
- Water Plant Operation (9)
- Water Laboratory (1)
- Pretreatment (2.5)
- Water Plant Maintenance (2)
- Wastewater Plan Operation (7)
- Wastewater Laboratory (3)
- Wastewater Plant Maintenance (2.5)
- Administrative Analyst (1)
- Secretary (1)
- Senior Clerk (2)

The Public Works Department is responsible for the operation, maintenance, and management of the City's infrastructure. The Department is made up of four divisions:

- **Administration**
  Under the guidance of the Director of Public Works, the Public Works Administration Division provides direction, control, and administrative support to all operating activities of the Public Works Department.

- **Water Treatment**
  The Water Treatment Division is an operating activity of the Department of Public Works, responsible for providing potable water to residential, commercial, and industrial customers in West Sacramento. The Division operates and maintains three treatment plants. Other functions of the Water Treatment Division include the operation and maintenance of distribution reservoirs and pumping stations.

- **Wastewater Treatment**
  The Wastewater Treatment Division is responsible for the operation of the Wastewater Treatment Plant. The 7.5 million-gallon-per-day wastewater plant treats residential, commercial, and industrial wastewater. The Plant also operates and maintains nine sewer pump stations located throughout the City.

- **Utilities & Street Maintenance**
  The Utilities & Street Maintenance Division is responsible for repair and maintenance of the City's transportation infrastructure (approximately 130 miles of city streets and rural roads) as well as six storm water pump stations. The Division also supports the Police and Fire departments in safety related functions, including street closures and hazardous material cleanup.

The complexity and cost of managing the vast amounts of infrastructure, which the City of West Sacramento Public Works Department manages, has greatly increased the demand for geographic information systems and global positioning system technology. The Public Works Director and key personnel understand that it is becoming essential to have an up-to-date and accurate digital representation of infrastructure within the City. The City is experiencing a steady population growth and with it increased pressure for the efficient and effective management of its infrastructure. The Public Works Department manages the physical infrastructure essential to social and economic development, which is indispensable to community, commerce and industry.

The Department currently does not utilize GIS, although some mapping support is provided by the Community Development Department (primarily the Drafting Services Section). GIS users in the Public Works Department will be Level 3 GIS Users initially; some users within the Department will eventually become Level 2 GIS Users (see Chapter 2: GIS Organizational Structure and Staffing for more information on Level 2 and Level 3 GIS Users).

## Hardware and Software

The Public Works Department currently has approximately 32 PCs.

All Public Works Department PCs have the Windows XP or Windows 2000 operating system (citywide standard).

The Public Works Department uses the following software applications:

1. MS Office
2. Industrial Pre-Treatment
3. PMC for preventative maintenance
4. Pre-Wins
5. RS View – for the SCADA system in water treatment plant
6. Crystal Reports

## GIS Needs and Duties

It should be noted that the Public Works Department has the potential to be a major data generator. Establishing a process of automated data capture and the effective use of GIS will be critical to the success of an enterprise-wide implementation of GIS. Data can be gathered about infrastructure repair, replacement and construction. Maintenance and construction data about street improvements – including pothole patching, and ditch and culvert cleaning, are a few examples of tasks that would benefit from the application of desktop and portable GIS.

An important element in the City of West Sacramento's GIS initiative is the streamlining of data flow between the Public Works Department (major data generator) and the other departments (major custodians of data and information).

Based on this needs assessment, the Public Works Department has several GIS needs, including:

- Mapping and spatial analysis of facilities and infrastructure
- Field access to geo-spatial data
- GIS-based work order management
- Utility geodatabase geometric networks for water, sanitary sewer, and storm water utilities
- Water distribution, wastewater, and storm water modeling and monitoring

- Public access to geo-spatial public works data
- GIS-based public notification for emergencies and maintenance

Collaboration with several departments/divisions will be instrumental in establishing GIS as a complementary technology used to meet Public Works objectives. Initial efforts should be aimed at increasing GIS awareness within the Department, allowing staff from all four divisions to become familiar with the efficiencies that can be gained through the use of GIS for mapping, analyzing, and tracking information.

Mapping and Spatial Analysis of Facilities and Infrastructure Data

Mapping and spatial analysis are key tasks that will enable the Department to improve management, operations, administration, and maintenance of the City's infrastructure. Public Works departments throughout the country have realized significant gains in both time and efficiency by using GIS.

The Public Works Department can utilize GIS to assist in several tasks, including:

- Transportation infrastructure mapping and analysis
- Wastewater and storm water system mapping and analysis
- Water system mapping and analysis
- Water quality data mapping and analysis
- Inventory mapping and analysis
- Project activity mapping
- Cost-Benefit analyses
- Work order tracking, mapping, and analysis
- Mobile infrastructure tracking, mapping, and analysis
- Routing, scheduling, and districting
- Production of maps for public meetings and exhibitions
- Statistical analysis for budgetary preparations

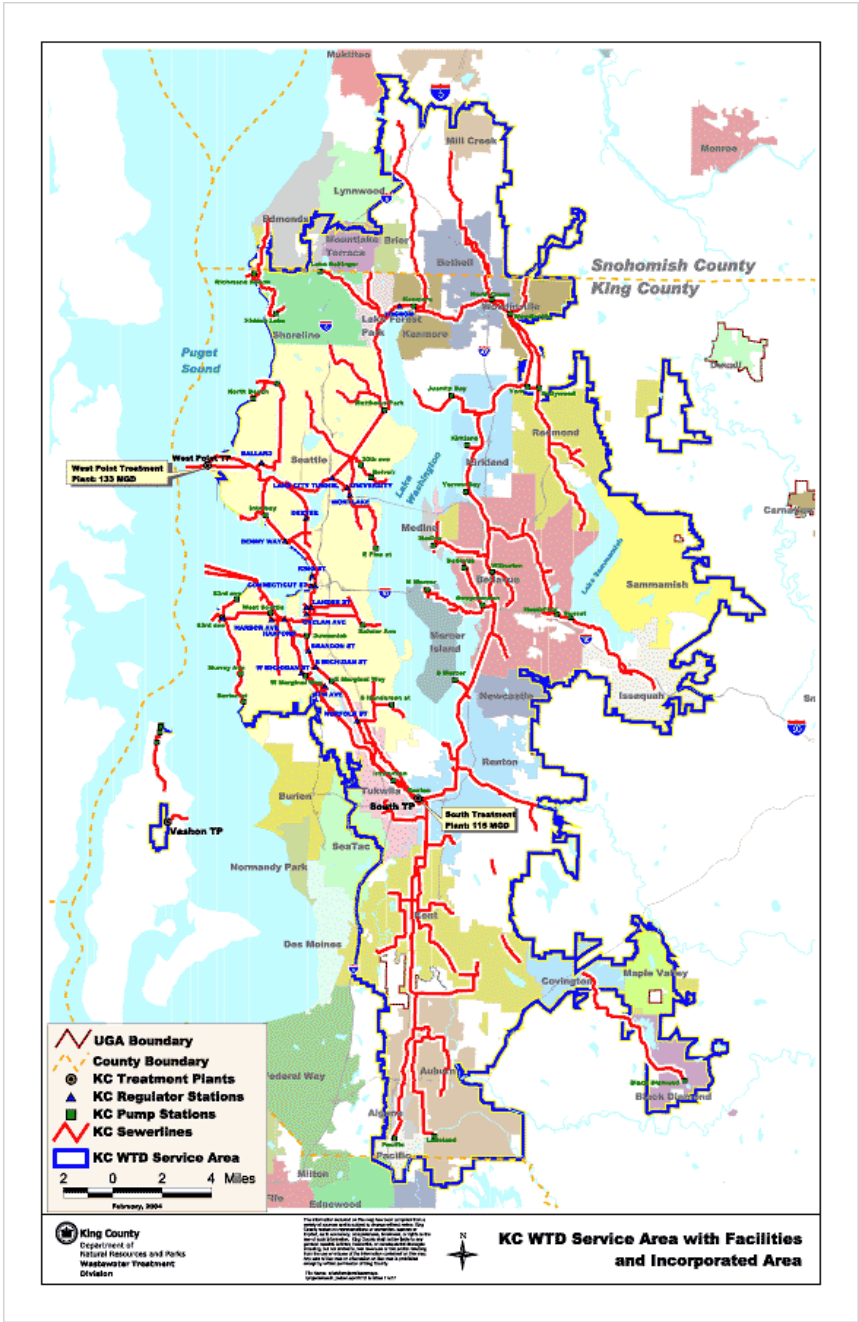



***Figure PW-1.1: King County, WA uses GIS to map and analyze its Wastewater Treatment Division Service Area in relation to sewer conveyance lines, pump stations, regulator stations, and treatment plants.***

It is recommended that Public Works personnel utilize an Intranet GIS data browser to conduct basic spatial analysis and produce maps. This Intranet browser will be based on the enterprise-wide Intranet GIS data browser procured by the City. More information on the Intranet GIS data browser is provided in the Enterprise-Wide Applications section of this chapter. For more advanced analysis and other tasks such as data creation, the Public Works Department should work with the GIS Specialist, who can use advanced GIS software such as ArcView or ArcInfo to conduct many of these tasks; the GIS Specialist may also be called upon to create cartographic products for the Public Works Department. The

Department will rely on the Community Development Department (Drafting Services Section) and the GIS Specialist for data creation and maintenance (see GIS Data Layers below for more information).

The Department also indicated interest in routing analyses and functions available via GIS. Routing analyses can be performed using ESRI's Network Analyst in conjunction with ArcGIS.

With ArcGIS Network Analyst the Public Works Department can conduct:

- Drive-Time Analysis
- Point-to-Point Routing
- Route Directions
- Service Area Definition
- Shortest Path
- Optimum Route
- Closest Facility
- Origin Destination Matrix

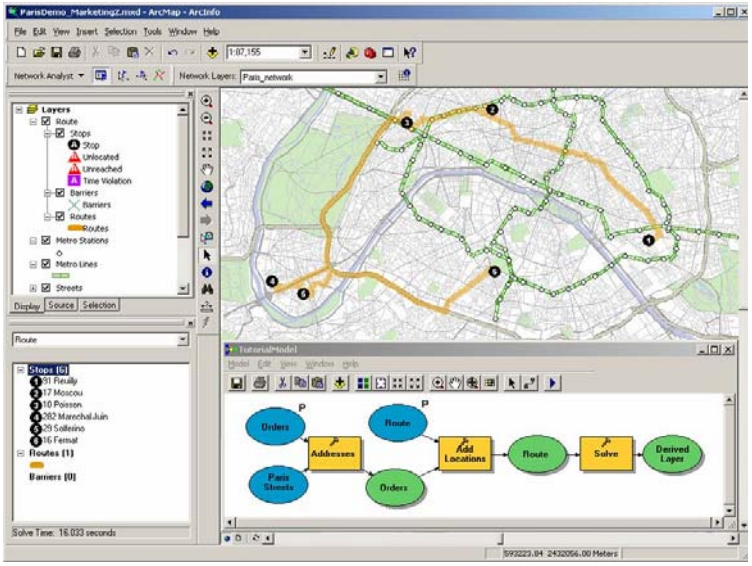


***Figure PW-1.2: ArcGIS Network Analyst***

An additional geo-spatial data issue that needs to be addressed is the consolidation and synchronization of databases. Public Works Department staff identified the need to ensure that geo-spatial data layers are consistent with city databases. Database normalization is needed to consolidate disparate, inconsistent data sources. It is expected that these issues will be eliminated by the consolidation, integration and centralization of data into a geodatabase.

## Field Access to Geo-Spatial Data

Public Works personnel will benefit from field access to maps and GIS data. At present, field personnel in each division rely on hard copy maps provided on an ad-hoc basis by the Community Development Department. There are two methods for Public Works personnel to access spatial information in the field:

I. Map Books
II. Mobile Computers

Map books are recommended as a basic means of providing field personnel with access to updated and accurate maps. Once designed and developed, these map books can provide both short and long-term access for a variety of staff (including part-time workers). Mobile computers, specifically hand-held computers, are recommended as more sophisticated means of providing field personnel with access to dynamic mapping and basic spatial analysis capabilities. Mobile computers are recommended for use in the long term, as field personnel become more familiar with GIS and the need for field-based GIS becomes more prevalent within the Department.

*I. Map Books*

The most cost effective solution for access to spatial information in the field is via map books. Map books can be generated for all Public Works staff. Each page can display a different section of the City or region. The location of pertinent features, such as signs, water, sanitary sewer, and storm water infrastructure, can be displayed on top of base map information, such as labeled streets, tax parcels, and aerial photography. Map books represent an effective means of referencing the location of all pertinent features. As features are changed or added, new map books can be generated to reflect these changes.

*II. Mobile Computers*

A more advanced method for accessing spatial data in the field is through the use of mobile computers, including notebook computers, tablet PCs and hand-held computers. A GIS data browser, such as ESRI's ArcPad, can be loaded on hand-held computers, allowing the same capabilities offered by map books, but also the ability to query attributes, such as streets, infrastructure, and facilities; link to GPS receivers, and more. These mobile computers, configured with ArcPad, can also be used by staff to update information while working in the field (see EVMWD Case Study below).

It is recommended that hand-held computers be purchased for field staff use. A GIS data browser, such as ArcPad, should be loaded onto each hand-held computer. Initially six (6) hand-held computers are recommended for Year 2; an additional six (6) hand-held computers are recommended for Year 3.

It is recommended that the Public Works Department have complete and accurate map books created in Year 1 of this three-year phased GIS implementation. Preliminary GIS access via mobile (hand-held) computers is recommended for Year 2. Comprehensive GIS access (all users) via mobile (hand-held) computers is recommended for Year 3.

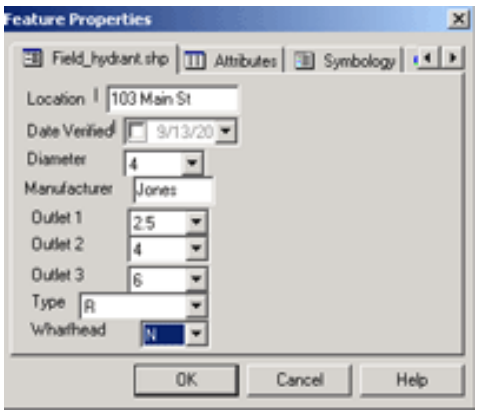
Case Study: Elsinor Valley Municipal Water District Uses ArcPad to Update Data

The Elsinore Valley Municipal Water District (EVMWD) in Southern California will update data on approximately 4,000 fire hydrants using ArcPad, a handheld computer, and a GPS unit. By using custom forms created for ArcPad, data collectors will not only verify the location of the district's hydrants but will also gather information on the make, condition, and capacity of each hydrant.

EVMWD has provided water service for the past 48 years. Located in the southwestern portion of Riverside County, the district covers a 96-square-mile area from the Temescal Valley to Murrieta and serves the cities of Lake Elsinore, Canyon Lake, and Murrieta and the unincorporated communities of Wildomar, The Farm, Cleveland Ridge, and Lakeland Village. EVMWD has approximately 28,000 water, wastewater, and agricultural services.

***EVMWD is updating data on approximately 4,000 fire hydrants using ArcPad.***

EVMWD's 125 employees maintain a water distribution system that consists of 420 miles of transmission and distribution pipelines. This system includes roughly 4,000 fire hydrants. EVMWD uses an ArcInfo-based enterprise GIS to manage this system. In 1999, the district's GIS staff began inputting fire hydrant flow tests into the GIS database and linking the results to features. During this process, staff discovered that many hydrants were not in the GIS database. These hydrants exist in an older part of the distribution system that has poorly kept records.




***A custom form was created for collecting hydrant data***

In addition to the need to simply locate all the hydrants to link the test results, the local fire authorities wanted detailed information about fire hydrants such as the type of hydrant, number of outlets, size of each outlet, and other information. A request for hydrant information originating from two sources-within EVMWD and from local fire agencies-made the GIS staff decides that it was time for a fire hydrant inventory.

The solution proposed by the staff used a Sokkia GIR 1000 GPS unit, a Compaq IPAQ PocketPC, and ArcPad from ESRI. The existing fire hydrant database, street rights-of-way, street centerlines, and miscellaneous layers are be loaded on the IPAQ and set up in ArcPad. A custom form was created for the hydrants for data collection and update. For each hydrant, the data collector refers to the hydrant database, verifies the hydrant in the field, and inputs data into the form. A hydrant that does not show up in the database is located using GPS. At the end of the day, data is downloaded from the IPAQ and the GPS receiver. Points taken with the GPS are loaded in the ArcInfo database, and attribute information is loaded into a Microsoft SQL Server database.

A pilot area study is being used to refine this method. Based on the pilot area, EVMWD will calculate the time needed to complete the fire hydrant inventory for the entire district. Staff time will be allocated, and the data collection effort will go into full swing. The data that is collected will be linked to fire flow test data and will be accessible from the various GIS interfaces within the district. Having this information readily available will save the district time and money and ultimately benefit the ratepayers.

### GIS-Based Work Order Management

A critical component of successful Public Works GIS implementations is accurate and complete data. Maintenance crews and other field personnel will go out into the field and make changes or additions to the infrastructure and not report these changes back to GIS staff. Very quickly GIS layers are missing pertinent data or contain erroneous data. Users will not know what data is accurate and what is not. Therefore, data sets can become suspect and staff may begin to doubt its usefulness and reliability.

The solution to this problem is a GIS-based work order management system. A properly implemented work order management system would allow staff to quickly input specific information about a task and then print out a paper work order with an accompanying

map. This map would show the infrastructure for the area of concern. Field crews would then mark any changes or additions to the system on the work order. Once the job was complete field crew would return the work order with changes back to support staff for input into the work order management system and for update of appropriate data layers. An added benefit of such a system is continual fine-tuning and an improvement of mapped (GIS) data. If any errors exist on the GIS maps, then field crew will mark and correct the error. In turn, this information will be corrected in the GIS. Therefore, instead of GIS data degrading because of information not flowing back from the field, GIS data will continually improve because of corrections made in the field. Subsequently, GIS data will reflect a very accurate depiction of what is in the field. In addition, there are residual benefits of such a system. Implementing a work order system will insure that this data is accurate and will facilitate rapid determination of assets in the field.

There are several applications available to meet this need (see GIS Applications below). It is recommended that the Public Works Department implement an application that will easily integrate with existing information technology, including the City's various enterprise databases.

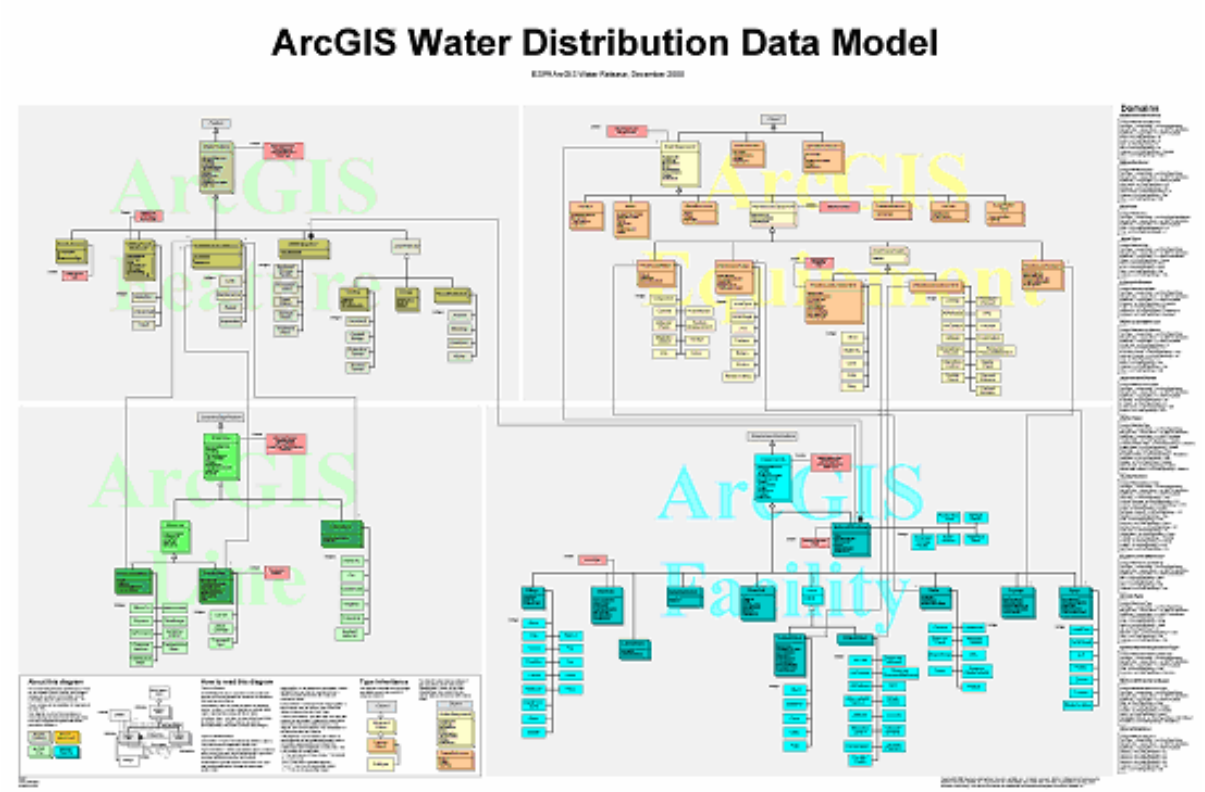
A Tier 3 GIS product that links to work order applications can meet a basic need for production of a blank work order form and a corresponding map. A GIS work order extension for work order software is practicable if the selected enterprise work order software stores data in an open database (ODBC compliant). This will allow use of a Tier 3 GIS application that can access data directly from the work order system. This application should allow users to quickly print out a map and a work order form for field crews to take into the field. It is critical that this application have the ability to track open work orders. Work orders that are not returned from the field will cause degradation in the GIS data. This must be avoided.

☑ Utility Geodatabase Geometric Networks for Water, Sanitary Sewer, and Storm Water Systems

ESRI, in conjunction with many public and private utility organizations, has developed data models for water and sanitary sewer distribution networks. These data models are designed to create a logical template for the creation of water, sanitary sewer and storm water ArcGIS geodatabases. The advantages of utilizing these data models include:

- Utility business logic: rules for how utilities can and do interact
- Standardized template of utility features, feature attributes, and relationships (fully customizable, however)
- Utility specific symbology
- Network tracing tools – ability to conduct tasks on each network, including: trace upstream, trace downstream, find connected features, and more

The following figure is a schematic of the full ArcGIS Water Distribution Data Model:




All of ESRI's ArcGIS data models, including Water Distribution and Sanitary Sewer/Storm Water can be downloaded for free from ESRI's website (www.esri.com). Data models can be downloaded in three different formats, including: GIF file, UML, or Repository. The GIF file is merely an image, to be used as an analysis diagram. The UML can be opened in MS Visio, to be modified using CASE tools. MS Visio Enterprise is required to be able to export the modified data model to an MS Repository database. The downloadable repository can be imported directly into ArcCatalog, to create a geodatabase. Data models can be modified in either MS Visio or ArcCatalog.

An enterprise geodatabase can be used to maintain water, sanitary and storm water networks. Separate feature datasets should be created for water, sanitary sewer and storm water networks. The next step is to populate each feature dataset with utility data. Once each feature dataset is conflated, sources and sinks must be added to the network. Sources designate the origin of flow, and sinks designate the end of flow. The following figure (Figure PW-1.3) represents a sanitary sewer network, created by Geographic Technologies Group for the City of Pearland, TX, displayed in ArcMap. Gravity mains are displayed in different shades according to pipe diameter. Force mains are displayed in red and blue. Lift stations and wastewater treatment plants are also displayed. Other features, such as manholes and cleanouts are available for display, but are not turned on in this example, because of the scale of the map.

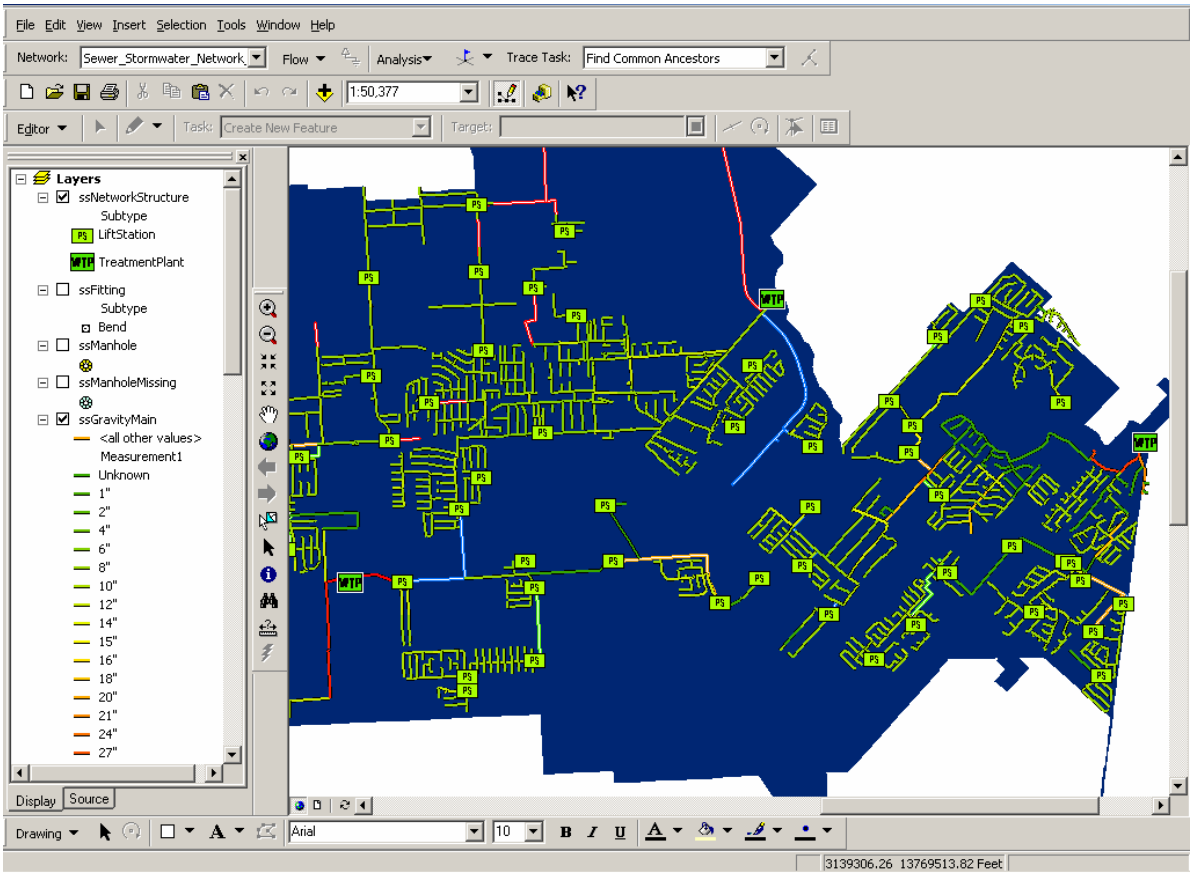
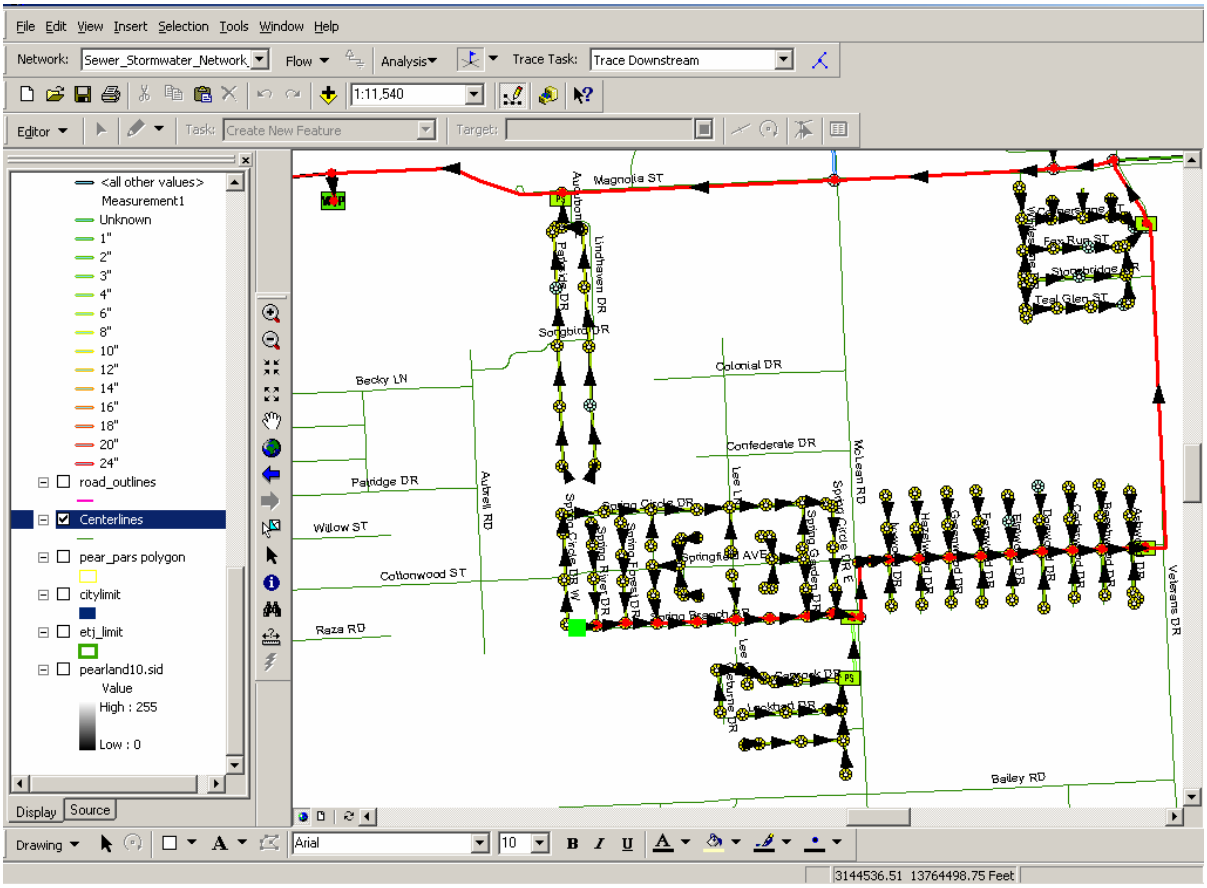



***Figure PW-1.3: Example of a Sanitary Sewer Geometric Network in ArcMap***

Properly configured utility networks will allow the Public Works Department to conduct network flow and tracing tasks. The figure below (Figure PW-1.4) shows the same sanitary sewer network, with gravity and force mains, manholes, lift stations, a wastewater treatment plant, and street centerlines. Arrows demonstrate the direction of flow throughout the network. Mains highlighted in red demonstrate the result of a downstream trace from a selected manhole to its wastewater treatment plant destination.




***Example of Network Flow and Tracing Functionality in a Sanitary Sewer Network***

It is recommended that the Public Works Department work to develop data models for the City's water, sanitary sewer, and storm water networks. By developing these models, and migrating existing and future data to the geodatabase format, departmental staff will be able to use powerful network design, analysis, and modeling features available with ArcGIS 9.

☑ <u>Water Distribution, Wastewater and Storm Water Modeling and Monitoring</u>

The Public Works Department can also use GIS to conduct water, wastewater, and storm water modeling. Accurate modeling requires accurate utility data. ArcGIS will let Public Works staff perform basic modeling tasks. For example, assuming the sanitary sewer network was setup correctly, users could select a lift station, choose to perform a "trace upstream" task, and all structures that flow to that specific lift station would be selected.

The Public Works Department should consider implementing Haestad Method's FlowMaster application for wastewater modeling and Haested Method's StormCAD, FlowMaster, CulvertMaster, and PondPack for storm Water modeling—these applications offer modeling that provides full, completely seamless integration with ArcGIS applications (see GIS Applications below).

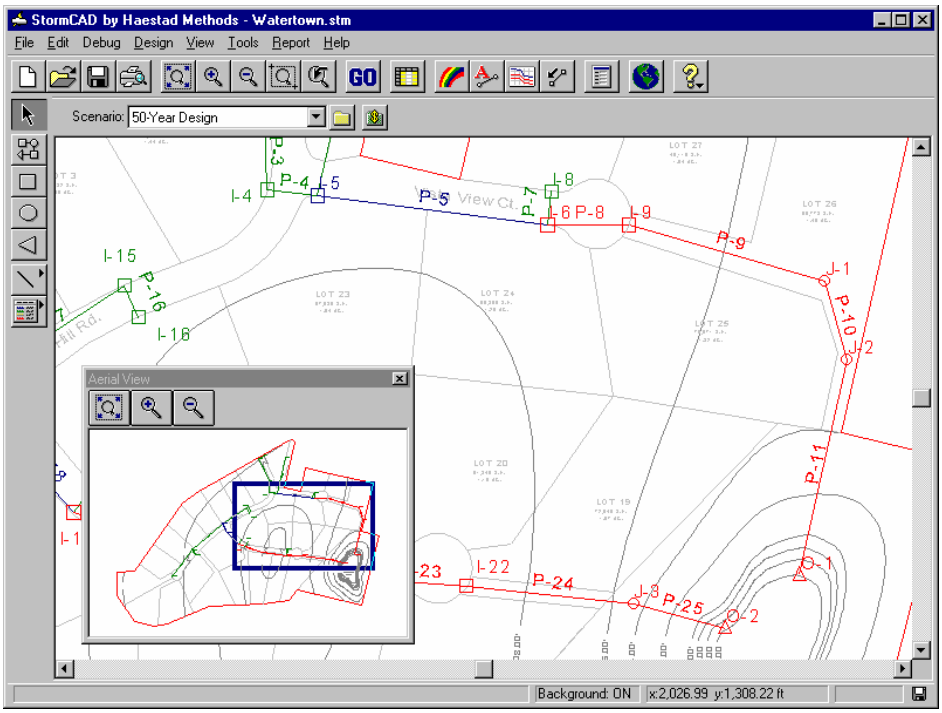



Figure PW-1.4: Example of Haested Method's StormCAD

## Public Access to Geo-Spatial Public Works Data

The Public Works Department expressed the need to disseminate spatial information to the public by providing a mapping application that will enable citizens to view infrastructure and utility information. The mapping application should incorporate the ability for the public to view ongoing maintenance and construction projects and associated areas, as well as water and sewer system features (see Figure PW-1.5).

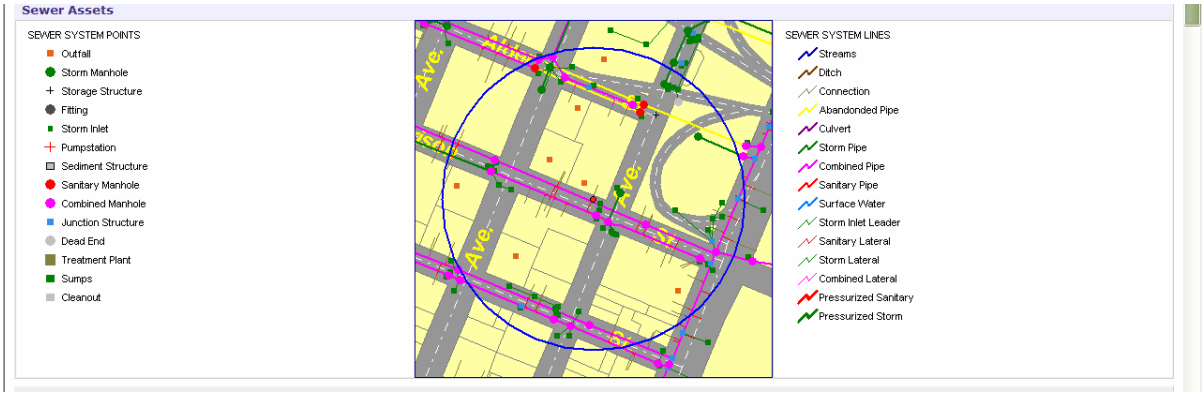



***Figure PW-1.5: Example of sewer system features available via an online GIS application***

As part of the City's objective to provide an Internet GIS data browser, the Department should coordinate with the GIS Specialist to integrate departmental GIS data into the Internet-based application. In addition the Department should identify additional functionality that may be required in addition to the City's base enterprise offering.

More information on Internet GIS data browsers can be found in the Enterprise-Wide Applications section of this chapter.

GIS-Based Public Notification for Emergencies and Maintenance

There is a need for a GIS-based public notification solution. It is recommended that the Department leverage the Reverse 911 system that the City plans to implement as a tool for notifying the public about maintenance, outages, and emergencies. See the GIS Applications section below for more information on Reverse 911 applications.

## GIS Data Layers

The Public Works Department will rely heavily on the Engineering Division (Community Development Department) for GIS data production and maintenance. It is recommended that Public Works personnel work in conjunction with the GIS Specialist and Drafting Services Section to determine an optimal strategy for data sharing, map production, and edits to infrastructure and utilities data. Use of an Intranet GIS application, as well as mobile computers, will provide Public Works personnel with dynamic mapping and analysis capabilities—it is expected that this will prove to be mutually beneficial, as it will allow the Public Works Department to produce many of its own maps, while reducing requests for maps from the Drafting Services Section.

In addition, to department-specific layers, the Public Works Department will benefit from access to several other departmental GIS data layers. It is expected that once all departmental data is integrated, consolidated, and centrally stored, that staff will have access to all non-classified GIS data layers from other City departments.

Department personnel expressed that access to the following GIS data layers would be beneficial:

| *Data Layer* | *Creation Methodology* | *Recommended Update Division or Individual* | *Existing or Recommended?* |
|---|---|---|---|
| **Address Points** | Extract, cleanse, geocode, and map from Springbrook; georeference based on aerial photography and GPS field work | Automated; GIS Specialist; Drafting Services Section | Recommended |
| **Aerial Photography** | Fly-over with control points | GIS Data Services Vendor | Recommended |
| **Backflow Devices** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Bad Bridges** | GPS data collection and integration with existing information | Fire Department; GIS Specialist | Recommended |
| **Bicycle/Pedestrian Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Buildings with Site Plans** | Manually digitize polygons from plans and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Census Data** | Download from Census Bureau →http://www.census.gov/geo/www/census2k.html | GIS Specialist | Recommended |
| **City-owned Property** | Extract, cleanse, geocode, and map from Yolo County tax roll; other map sources as required | Automated | Recommended |
| **Commercial Addresses** | Extract, cleanse, geocode, and map from Springbrook | Automated | Recommended |
| **Crime Data** | Extract, cleanse, and automatically map from Police VisionAIR database | Automated | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Critical Facilities** | Manually digitize points from aerial photography and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Drafting Water Sources** | GPS data collection; digitizing from existing maps | Fire Department; GIS Specialist | Recommended |
| **Easements** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Facilities** | Digitize on screen; aggregate layers as needed | Drafting Services Section | Existing |
| **Fire Hydrant Permits** | Extract, cleanse, geocode and map from Permits Plus database (TBD) | Automated | Recommended |
| **Fire Hydrants** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Flood Zones** | Acquire from FEMA (free to government entities) http://www.fema.gov/fhm/ | Drafting Services Section; GIS Specialist | Recommended |
| **General Plan** | Digitize features from aerial photographs and existing data layer | Drafting Services Section | Recommended |
| **Hazardous Materials** | GPS data collection for location; extract from FirePoint or other database once data is entered | GIS Specialist; YCCESA | Recommended |
| **Impervious Surfaces** | Digitize polygons from aerial photographs; derive polygons by raster analysis of remotely-sensed data | Drafting Services Section; GIS Specialist | Recommended |
| **Industrial Pretreatment** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Land Use** | Digitize polygons from aerial photographs and existing maps; existing CADD data | Drafting Services Section | Existing |
| **Levees** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Liens** | Extract, cleanse, geocode and map from Springbrook | Automated | Recommended |
| **Lighting and Landscape Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Oak Trees (Heritage)** | GPS field work; validation may be possible using aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Parcels** | Acquire from Yolo County | Yolo County ( and GIS Data Services Vendor) | Recommended |
| **Parks** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Port** | Digitize features from aerial photographs and other maps | Drafting Services Section; GIS Specialist | Recommended |
| **Reclamation District Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Rehabilitation Projects** | Extract, cleanse, geocode and map from Access database | Automated | Recommended |
| **Schools** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Sewer Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Sewer Fees Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Sidewalk Trip Hazards** | Based on citizen complaints; GPS field work | Drafting Services Section | Recommended |
| **Signs** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Site Location Base Map** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Existing |
| **Storm Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Storm Drain Fee Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Streets** | Derived from aerial photography; GIS Consortium | Drafting Services Section | Existing |
| **Street-Sweeping Routes** | Query route segments from existing street centerline layer | Drafting Services Section | Recommended |
| **Striping & Pavement Markings** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Recommended |
| **Telecommunication Facilities** | Aggregate from telecommunications | GIS Specialist; Automated | Recommended |
| **Traffic Accidents** | Extract, cleanse, geocode, and map from Crossroads database | GIS Specialist; Engineer; (Crime Analyst) | Recommended |
| **Traffic Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Traffic Calming Devices** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Traffic Counts** | Extract, cleanse, geocode and map from Access database | GIS Specialist | Recommended |
| **Traffic Signals** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Transit Routes** | Derive from street centerline layer; acquire from SACOG? | Drafting Services Section | Recommended |
| **Trees (Parks)** | Digitize from aerial photographs and existing maps | GIS Specialist | Recommended |
| **Truck Routes** | Derive from street centerline layer | Drafting Services Section | Recommended |
| **Vacant Properties** | Query from parcel layer; other sources as needed | GIS Specialist (eventually automated) | Recommended |
| **Water Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Water Meters** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Water Quality Complaints** | Extract, cleanse, geocode, and map from complaints database (TBD) | Automated | Recommended |
| **Waterways** | Digitize polygons from aerial photographs and existing maps | Drafting Services Section; GIS Specialist | Recommended |
| **Work Orders** | Extract, cleanse, geocode, and map from work order database (TBD) | Automated | Recommended |
| **Zoning** | Based on existing maps; General Plan | Drafting Services Section | Existing |

Additional layers may be required as the Department increases its GIS utilization and incorporates additional field data.

## GIS Applications

### Intranet GIS Data Browser

An Intranet GIS data browser has been recommended for use by Public Works Department personnel. A full description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### Internet GIS Data Browser

An Internet GIS data browser has been recommended to provide citizens with access to the City's geo-spatial data. Leveraging the existing ArcIMS platform, the City will need to develop an enterprise-wide Internet GIS data browser to provide the public with access to geo-spatial property data. A description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

**Water, Wastewater, and Storm Water Modeling**

The Public Works Department expressed interest in water, wastewater, and storm water modeling software. It is recommended that the Department work in conjunction with the Engineering Division to conduct this type of modeling. The Department should utilize Haested Method's WaterGEMS for ArcGIS for water modeling. In addition, the Department should utilize Haestad Method's SewerCAD and FlowMaster applications for wastewater modeling and Haested Method's StormCAD, FlowMaster, CulvertMaster, and PondPack for storm Water modeling. All of these applications work with the ArcGIS platform.

### WaterGEMS

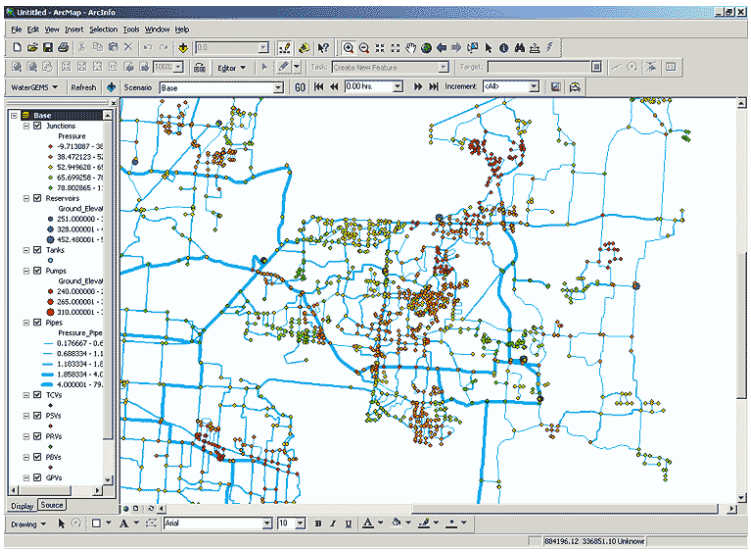
WaterGEMS allows users to display, edit, run, map, and design water models from within the GIS environment; users can view the results of the simulations as native GIS maps or with traditional Haestad Methods modeling tools. WaterGEMS also provides cross-product functionality provided by the core Unified Data and Object Model architecture.

With WaterGEMS, users can:

- View and edit multiple Scenarios in the same geodatabase.

Analysis functionality, including:

- Extended Period Simulations
- Fire Flow Analysis
- Unidirectional Flushing
- Valve Modeling
- Pump Simulation
- System Head Curves
- Leakage & Sprinkler Modeling



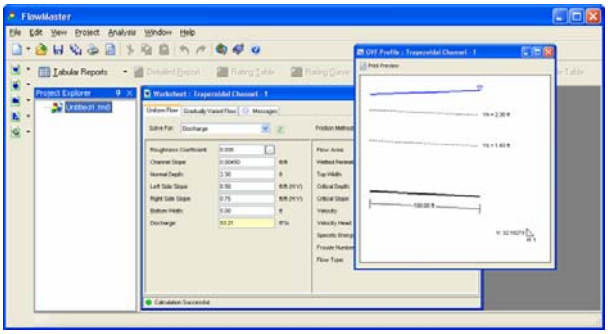
***Haested Methods WaterGEMS***

## FlowMaster

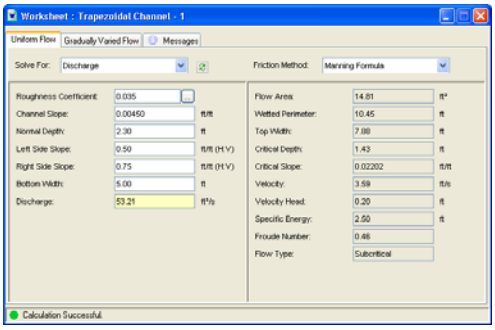
FlowMaster 2005 is an efficient and powerful program for the design and analysis of pipes, ditches, open channels, weirs, orifices, and inlets. FlowMaster's "Hydraulics Toolbox" can solve or rate any unknown variable using the Manning's, Hazen-Williams', Kutter's, Darcy-Weisbach, and Colebrook-White formulas. FlowMaster's new inlet computations strictly comply with the latest FHWA Hydraulic Circular Number 22 (replacing Circular 12).

FlowMaster will solve for any unknown variable in gutter cross sections, inlets, weirs, orifices, irregular channels, pressure pipes, standard open channels, parabolic channels, box pipes, and elliptical pipes. Create multiple design trials, calculate them all simultaneously, and compare the results in customizable tabular reports and graphs.

- FlowMaster can now perform gradually varied flow calculations for any free surface flow element
- Model curb, grate, slot, combination, and ditch inlets using calculations based on FHWA Hydraulic Engineering Circular No. 12 and Circular No. 22 methodologies
- Analyze any inlet in sag or on grade with a continuously or a locally depressed gutter
- Calculate water spread and gutter depth for a gutter or pavement section
- Size or evaluate flow for sharp-crested weirs, broad-crested weirs, and orifices
- FlowMaster can now calculate parabolic channels, box pipes, and elliptical pipes
- FlowMaster will solve for any variable, including discharge, headwater elevation, discharge coefficient and more. Even submergence (tailwater effect) in orifices and weirs is taken into account
- Enter the geometry and variable roughness for your irregular sections (open or closed) to model irregular open and closed cross sections effortlessly
- Compute composite roughness values for your irregular section using various methods including Lotter, Horton, Pavlovskii, or the Colebatch and Cox method, as well as the combination of Horton and Lotter that was available in the previous version
- Model ditches and swales regardless of size and shape. Geometric shapes include circular, rectangular, trapezoidal, triangular, gutter, and irregular
- Perform a quick check or a design on a pressure pipe by simply plugging in the known information and clicking to solve for the unknown
- Change friction methods from each individual worksheet on-the-fly, allowing you to compare the results using any method



***FlowMaster Interface***



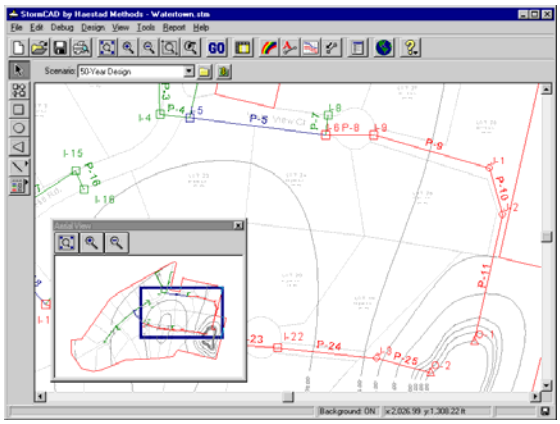
***FlowMaster Analysis and Design***

## StormCAD

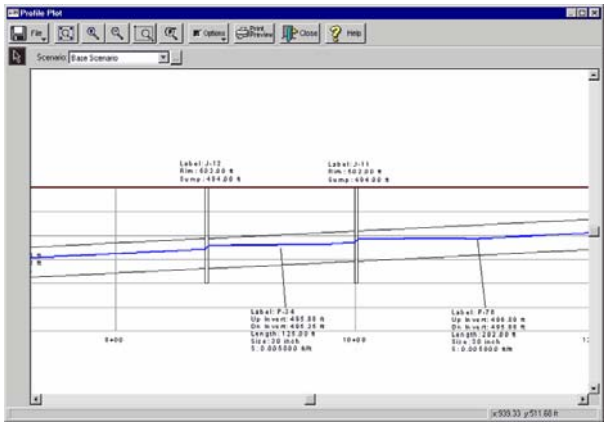
StormCAD offers a complete approach to storm sewer design and analysis, from rainfall to outlet.

- StormCAD makes it easy to model stormwater systems with:

- Gradually varied flow computations
- IMPROVED! HEC-22 inlet and gutter flow computations
- NEW! Profile manager
- NEW! Curved pipe alignments
- NEW! HEC-22 and AASHTO headloss detailed reports
- Scenario management
- Construction drawing preparation
- Capacity analysis
- Automated constraint-based design
- Integration with AutoCAD Land Development Desktop
- Polyline-to-pipe conversion tools



***StormCAD Mapping***



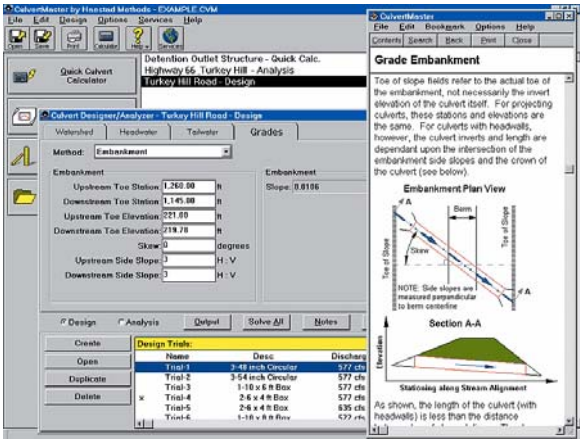
***StormCAD Pipe Hydraulics Analysis***

## CulvertMaster

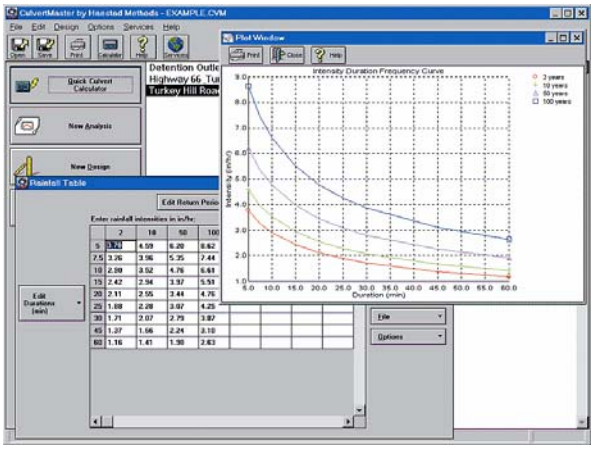
CulvertMaster is a tool available for solving culvert hydraulics problems. For simple culverts with known characteristics, the Quick Culvert Calculator can be used to plug in the data you know and solve for what you need. For more complex systems with multiple barrels, different shapes and sizes, special tailwater considerations, and roadway overtopping, make use of the Analyzer. Incorporate whatever data you have, including watershed data, tailwater conditions, culvert characteristics, and even weir geometry. Use the Designer to compare several proposed options. Incorporate these design trials into complex hydraulic analyses and evaluate the results. With all three options, just click a button to create a new "worksheet," enter your data in the clearly labeled fields, and click to solve. The data entry and manipulation are flexible and straightforward. On top of it all, you'll never have to look at another blurry nomograph or HY-8 blue screen again

CulvertMaster can be used for:

- Hydraulic Analysis
- Rainfall & Watershed Analysis
- Rational Hydrology
- SCS Hydrology



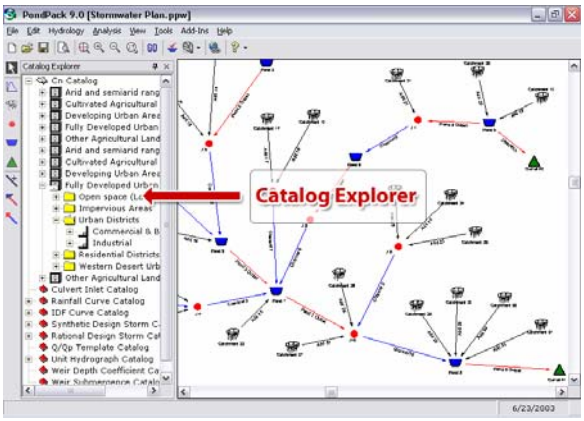
***Hydraulic Analysis with CulvertMaster***



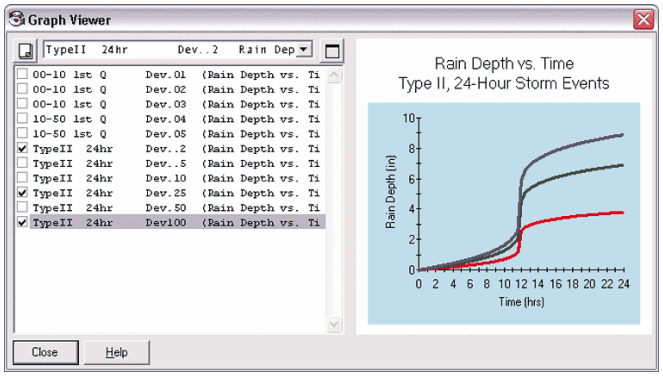
***Rainfall and Watershed Analysis with CulvertMaster***

PondPack

PondPack analyzes pre- and post- development hydrology, sizes ponds, develops outlet rating curves with tailwater effects, accounts for pond infiltration, calculates pond detention times, and analyzes channels. PondPack even performs interconnected pond routing computations and handles divergent (multiple) outfalls.




***PondPack Interface***




***Rain Fall Data in PondPack***

Additional details can be found at: http://www.haestad.com

ArcPad 6.0

ArcPad software is an easy-to-use, lightweight, low-cost solution for mobile mapping and geographic information systems. ArcPad enhances portable touch screen computers with intuitive mapping, GIS, and GPS functionality. ArcPad makes field data collection fast and easy, improves data accuracy, and provides immediate data availability and validation. It is recommended that ArcPad technology be utilized in the Public Works Department. ArcPad will enhance and streamline infrastructure maintenance and repair as well as field surveys.

With ArcPad 6.0, Public Works personnel can:

- Use existing data - ArcPad supports industry-standard vector and raster image display.
- Add data from the Internet - Data can be provided from the Internet via wireless technology.
- Move around the map - ArcPad includes a number of map navigation tools including zoom and pan, spatial bookmarks, and center on the current GPS position.
- Query data - Identify features, display hyperlinks, and locate features.
- Measure distance, area, and bearings on the map.
- Navigate with GPS - Connect a GPS and with ArcPad.
- Edit data - Create and edit spatial data using input from the mouse pointer, pen, or GPS.
- Extract, convert, and project existing data using ArcGIS Desktop

Reverse 911

GIS has proven to be a valuable technology for community alerting and public outreach, such as Reverse 911. Reverse 911 is inherently a GIS application as spatial selection and analysis are fundamental for the effective utilization of Reverse 911. Reverse 911 is a requirement of the City's technology strategy plan; it is recommended that the Public Works Department leverage the GIS-based Reverse 911 solution that the City decides to implement.

The uses of GIS-based Reverse 911 applications include:

- Emergency Evacuations
- Missing Person Alerts
- **HAZMAT Emergency**
- Crime Prevention Safety Tips
- Public Service Announcements
- **Maintenance Notification & Alerts**
- **Utilities Service Alerts**
- **Water Contamination Alerts**
- Investigation Assistance
- Prison Escape Alerts
- Sexual Offender and Predator Notices
- Parolee and Juvenile Check-ups
- Search and Rescue Operations
- Neighborhood Watch Meeting Notices

Several effective GIS-based Reverse 911 applications are currently available on the market. It is recommended that the City procure and implement a solution that integrates GIS technology with the telecommunications capability of the Internet. Listed below are several Reverse 911 applications that include mapping and spatial analysis functionality.

***CodeRED™ Emergency Telephone Calling System***

The CodeRED™ Emergency Telephone Calling System is a high-speed telephone communication service available for emergency notifications. CodeRED™ utilizes Internet mapping capability for geographic targeting of calls, coupled with a high speed telephone calling system capable of delivering customized, pre-recorded emergency messages at the rate of up to 60,000 calls per hour. CodeRED™ subscribers control their emergency broadcasts from anywhere in the world via a secure Internet Portal.

More information can be found at http://www.coderedweb.com

***Message911™***

Message911™ is a voice notification system designed to meet critical emergency alert situations. Message911™ is controlled from a phone or a web browser. It can deliver messages to land lines, cell phones, pagers, mobile radios and PDAs. With over 3,000 phone lines, it can deliver more than 3,000 calls per minute. Message911™ can activate other devices such as sirens, public address systems and EAS as a "single point of control". Message911™ is GIS ready. Mapping tools seamlessly integrate map selections directly with the notification system.

More information can be found at http://www.msg911.com

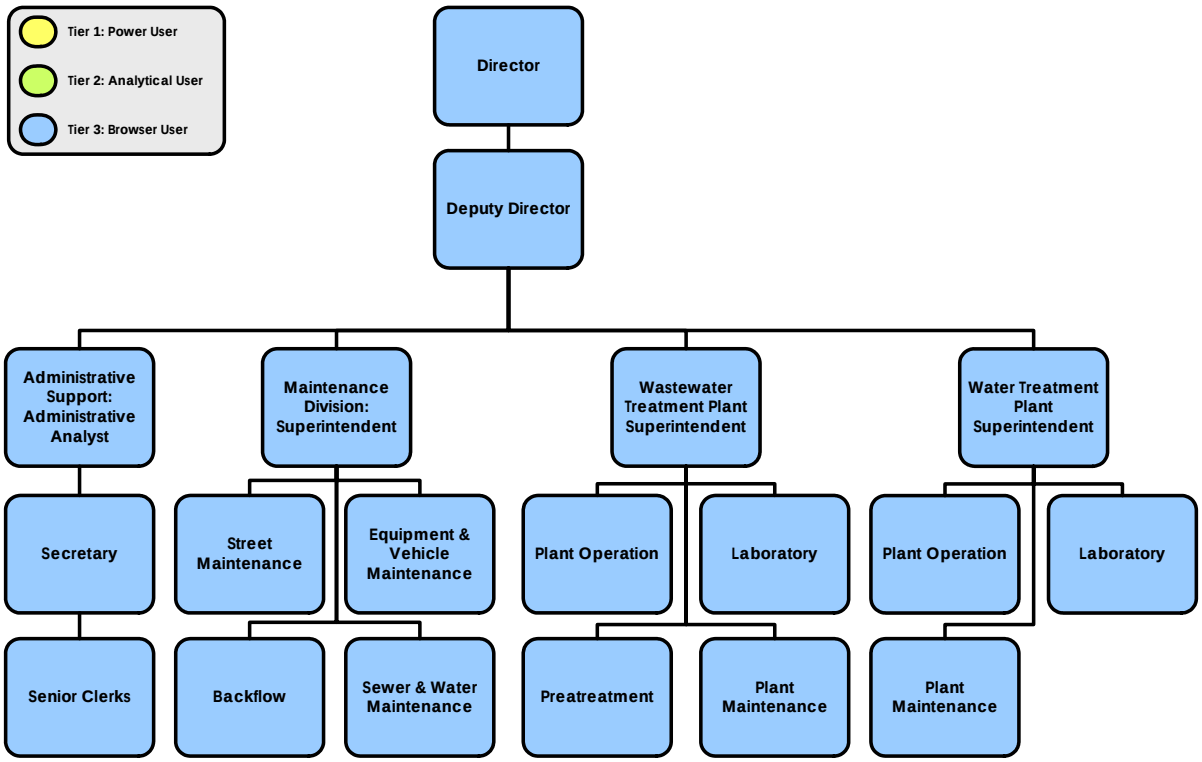
***REVERSE 911®***

REVERSE 911® is a windows-based application that integrates ESRI's mapping capability with powerful database functionality. Application functionality includes Geo-Zone calling, list calling, call confirmation, two way calling, survey capabilities, remote access, and more. Optional modules provide other features such as bulletin board service, faxing, voice mail, and more.

More information can be found at http://www.reverse-911.com

Multi-Tier GIS Application Use within the Public Works Department

The following chart describes the recommended GIS application use by the Public Works Department. A Tier 1 user is a power GIS user who should have access to a fully functioning GIS toolset. A Tier 2 users focus is data analysis in addition to general browsing capabilities. A Tier 3 user requires only general browsing GIS data functions. The Public Works Department will consist of Tier 3 users.




***Public Works Department Multi-Tier GIS Application Use***

# Redevelopment Agency

## History of the Redevelopment Agency

The West Sacramento Redevelopment Project Area was originally adopted in 1986 by the Yolo County Board of Supervisors. Following the City's incorporation in 1987, the project area was transferred to the West Sacramento Redevelopment Agency.

In West Sacramento, as in most cities, the City Council is also the governing board for the Redevelopment Agency. The City and the Agency, however, are two separate, distinct legal entities. As with other City departments, Agency staff is hired by the City to carry out the day-to-day operations of the Agency and implement its redevelopment plans.

The Redevelopment Agency is responsible for carrying out a redevelopment plan. This plan represents a process and basic framework within which specific projects will be undertaken. The plan provides the Agency with powers to take certain actions such as to buy and sell land within the area covered by the plan (the project area); and to improve dilapidated facilities and to use tax increment financing.

The project area is the area within which actual redevelopment will take place. The West Sacramento Redevelopment Project Area contains 5,416 acres and comprises much of the nonresidential portion of the northern part of the city. The area contains a mix of developed and vacant land, and some limited residential areas.

When originally adopted, the Project Area suffered from a number of significant blighting influences, including:

- Obsolete, aged and deteriorated buildings
- Incompatible uses, including a mix of residential and industrial uses
- Inadequate and/or deteriorated public improvements
- Deteriorated housing conditions
- The need for additional land use planning, and
- A lack of neighborhood serving retail uses.

Since 1987 the Redevelopment Agency has made significant strides to address these issues. The staff of the West Sacramento Redevelopment Agency remains committed to achieving further improvements in the quality of life for West Sacramento residents.

## Personnel and Duties

The Redevelopment Agency employs ten staff members, including:

- Director (1)
- Redevelopment Manager (1)
- Program Managers (3)
- Economic Development Coordinator (1)
- Administrative Analysts (2)
- Secretary (1)
- Senior Clerk (1)

The Agency also has two part-time temporary employees (interns). One intern is working on a GIS-based vacant land survey among other projects and tasks for both the Redevelopment Agency and the GCI Department.

The Redevelopment Agency is responsible for redevelopment activity throughout the 5,416-acre Redevelopment Project Area. The Economic Development Division manages the city's Business Recruitment and Business Retention Programs.

The Redevelopment Agency has two divisions:

- **Redevelopment**
  Provides critical information to real estate developers interested in the construction of new residential, office, retail and mixed use facilities in the Project Area.
- **Economic Development**
  Manages the City's Business Recruitment and Business Retention Programs that provides time sensitive information to new businesses that either want to locate in West Sacramento or existing businesses that desire to expand and remain in the community.

The Agency's mission is to stimulate positive change, build a vibrant retail sector, a prestigious office address, diverse, high-quality residential neighborhoods, and to provide quality employment opportunities for all residents.

The Redevelopment Agency facilitates redevelopment within the project area by encouraging investment by private developers and property owners, aggregating development sites and planning and entitling properties for development. Other activities include assisting in the financing and installation of public facilities and attracting and retaining businesses and targeted industry facilities.

Some of the projects the Agency is responsible for include:

- Waterfront Redevelopment (Private and Public)
- Port of Sacramento Master Plan
- Pacific Materials Spur Relocation
- Mixed Use Development-Washington & Triangle Areas
- Triangle Infrastructure Financing Study
- Agency Owned Property Disposition
- West Capitol Avenue/Central Business District Revitalization Projects
- Private Child Care Facility Development
- Retail Attraction - Riverpoint Retail Site
- Economic Development Division:
  - Business Recruitment – Target Industry
  - Yolo County BioZone
  - Business Retention and Expansion
  - Business Loan Fund
  - Economic Development Strategy
  - Retail Attraction – Riverpoint Retail Site

Given existing GIS knowledge within the Agency, some personnel will be Level 2 GIS Users; however, some GIS use within the Agency will incorporate less complex analyses and basic mapping, such as that of Level 3 GIS Users (see Chapter 2: GIS Organizational Structure and Staffing for more information on Level 2 and Level 3 GIS Users). In general, the Redevelopment Agency has significant potential for continued utilization of GIS, as the Agency has been utilizing GIS for over a year). GIS users within the Agency have a higher level of technical and theoretical GIS knowledge than that of most other departmental GIS users at the City. With the exception of ArcGIS, Agency personnel, including Administrative Analysts and at least one Program Manager, will utilize a Tier 2 GIS data browser (see GIS Applications below as well as the Enterprise-Wide Applications section of this chapter).

Agency personnel indicated that the current GIS support provided by one of the interns is beneficial for the Agency's GIS efforts; however, given the temporal limitations of internships, the Agency identified a potential need for a full-time GIS Technician to work on GIS efforts (see Chapter 2: Organizational Structure and Staffing for more information on GIS technicians). Based on the Agency's anticipated increased utilization of GIS for project and program support, it is recommended that the Agency work in conjunction with the GIS Specialist, and the Information Technology Division as a whole, to determine the feasibility of hiring a GIS Intern or GIS Technician that would serve as a primary GIS resource for the Agency. It is recommended that the Agency work with relevant City departments, such as the Human Resources Department, to determine the viability for acquisition of a full time staff member within the general context of the City's programs. This recommendation is given in light of the financial and administrative implications of hiring additional staff. A long-term option may be the hiring of an additional GIS staff member that is a shared resource between all departments, but who is primarily dedicated to the Redevelopment Agency.

The main role for such a resource would be based on the production of high-end cartographic products and implementation of spatial analyses; additional GIS tasks, such as data production, may also be required. However, it should be noted that all GIS activity within the Agency should be coordinated and communicated with the GIS Specialist. This coordination/facilitation is expected to occur by both technical and non-technical staff within the Agency—all GIS-based data and products will need to conform to the standards, protocols, and business logic established by the GIS Specialist.

## Hardware and Software

The Redevelopment Agency currently has 11 PCs, including one shared "research" workstation with several applications including ArcView.

All Redevelopment Agency PCs have the Windows 2000 or Windows XP operating system.

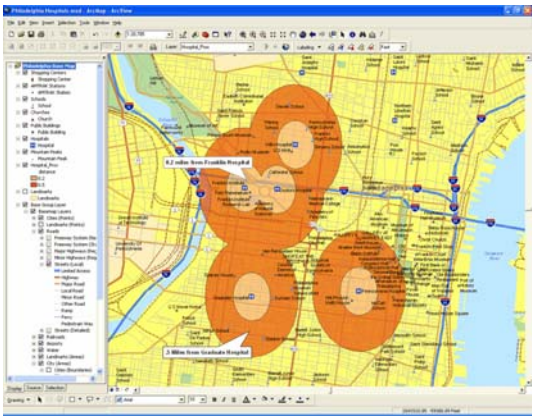
The Redevelopment Agency uses the following software applications:

1. Microsoft Office
2. Microsoft Project
3. Microsoft Visio
4. ArcView 8.3
5. ArcExplorer Java edition 4.0
6. PCensus
7. Abode Acrobat Professional 6.0
8. Adobe Pagemaker 7.0
9. Adobe Illustrator 10
10. Adobe Image ready 7.0
11. Adobe Photoshop 7.0
12. D & B Ratings Plus Home
13. RealQuest (MetroScan) (shared with GCI Department)

The Agency utilizes two core GIS applications. Two staff members in the Agency utilize ArcView as the primary GIS application; ArcExplorer is a free desktop GIS data browser that can be used for data viewing and basic mapping.

ArcView

ArcView is used extensively to view and map various GIS data layers; ArcView is also used to perform spatial analyses. The Agency also uses ArcView to generate cartographic products for use by administrative and management staff.



***ESRI's ArcView***

## GIS Needs and Duties

The Redevelopment Agency has great potential for comprehensive implementation of GIS, given that the Agency already has implemented some GIS-based mapping and analysis. At present, the Agency has several staff members who possess some knowledge of GIS: one part time staff member has advanced knowledge of GIS, one staff member has intermediate level of GIS expertise and two staff members have a beginner's level of GIS knowledge. Working in conjunction with the City's GIS Specialist, the Agency will be able to leverage existing knowledge and skills in GIS to increase the scope and extent of GIS utilization throughout the Agency.

The Agency's primary mapping activities include economic development, business recruitment, business data, demographic data, property ownership, property transfer, site plan exhibits, and annotated aerial photography. GIS-based spatial analyses have been limited, although the Agency currently has an intern working on a Vacant Land Survey of the City. The Agency has identified a potential project for producing a three-dimensional economic "landscape" of the City. One of the key needs of the Agency is the production of high-end cartographic products for grant proposals, council meetings, meetings with potential investors, and marketing materials, such as brochures and flyers. Agency staff indicated that the expectation for these high-end cartographic products is increasing.

Some of the Agency projects for which GIS has been utilized include:

- Vacant Land Survey
- Brownfields Mapping Project
- Census Mapping-Business Attraction Program
- Washington Area/Metro Place Catalyst Mapping Project
- West Capitol Avenue Survey of Vacancy/Underutilization

The Agency will also be producing an Internet-based GIS application to serve as a Community Asset Tracking System (CATS), based on a CDBG grant secured by the Agency and the GCI Department; this system will need to display real time information for real estate professionals to promote economic development, redevelopment, housing and municipal projects in West Sacramento. The system will be maintained by staff in the Information Technology Division (including the GIS Specialist and potentially a GIS Intern or Technician); additional support may be needed from an outside consultant.

➔ Redevelopment Agency personnel identified the top five benefits of GIS for the Agency as follows:

1. GIS technology will allow all levels of Agency staff the ability to map and analyze economic opportunities and constraints, individual businesses, business clusters, emerging industries, business issues, business trends, business districts, specific plan areas and potential redevelopment projects.
2. Thorough analysis of the economic assets and needs of the community using GIS technology will assist the Agency in determining the best locations for investment of tax increment, grants and other funding sources in public infrastructure and private development projects throughout the city.
3. GIS technology will improve departmental efficiency and the quality of project management by encouraging interdepartmental, intra-city and intra-agency sharing and tracking of GIS information and maps on specific programs and projects.
4. GIS technology will allow all levels of agency staff to create template-driven customizable maps for presentations to the City Council, business community, citizen's advisory committees, state agencies and other interest groups. GIS technology will allow all levels of agency staff to automate (to a certain extent) site planning and locational analysis by not having to create customized maps for every project.
5. The development of online GIS applications by the Agency will permit 24-hour access to site specific real estate, property, financial, demographic, infrastructure, and other City information creating increased awareness of the benefits of business investment in West Sacramento.

Based on this needs assessment, the Redevelopment Agency has the following GIS needs:

- Mapping and spatial analysis for support of economic development and Redevelopment projects
- Geo-spatial data layer creation
- Public access to geo-spatial housing and land data

It is recommended that Agency staff use software such as ArcView to conduct basic and detailed spatial analysis and produce maps. For advanced analysis and other tasks such as data creation, the Agency should work with the City's GIS Specialist, who can use software such as ArcEditor, ArcInfo, and AutoCAD to perform sophisticated analyses and create/convert data.

It is also recommended that the Agency utilize an Intranet GIS data browser as a basic application to view the City's GIS data. Many users in the City will be relying on the Intranet GIS data browser as a primary GIS application--it is recommended that all personnel in the Agency familiarize themselves with this application.

☑ <u>Mapping and Spatial Analysis for Support of Economic Development and Redevelopment Projects</u>

The Redevelopment Agency has existing resources that will allow it to continue to undertake numerous mapping and spatial analysis tasks. Some of the Agency's mapping needs are similar to those of the GCI Department. Based on existing collaboration with that

department, it is recommended that the two continue to collaborate on GIS efforts as use of the technology expands across the enterprise.

Agency staff identified that the following mapping and analysis would be of greatest value:

- Ability to quickly locate suitable sites for development inquiries. Necessary layers include parcel size, zoning broker information (price, listing agent, etc.). This will assist in the Agency's business retention and recruitment efforts.
- Ability to conduct analytical and spatial property and business analysis (e.g., locate all properties zoned waterfront, larger than five acres and within 1,000 feet of the Sacramento River or analyze of the types of businesses in the community by SIC/NAICS Codes).
- Ability to conduct demographic analysis (e.g., determine number of households with $50,000 plus household income within two mile radius of potential coffee shop location).
- Access to utility information (e.g., size and location of sewer, water, and storm drain lines adjacent to 1110 West Capitol Avenue).
- Easy and quick preparation of maps and graphics for presentation of GIS data.

In addition, the Redevelopment Agency will use GIS to perform other mapping and analysis tasks, including:

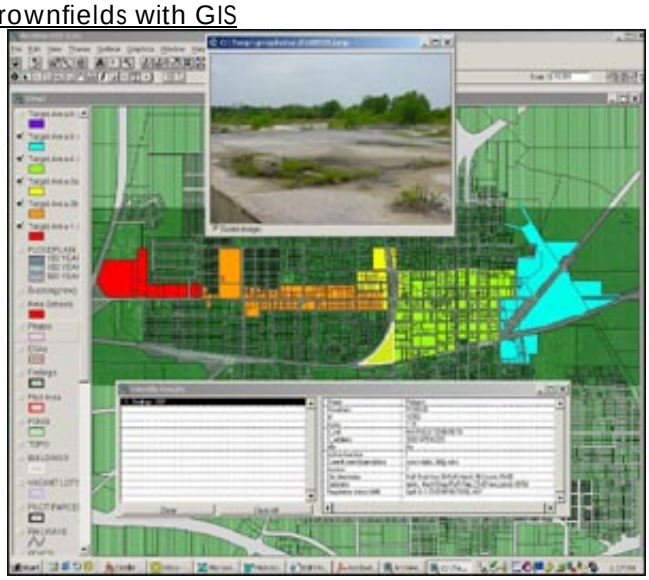
- Proposed project location analysis
- Identifying vacant and underutilized land
- Community Development Block Grant (CDBG) administration and analysis
- Environmental Assessment for CDBGs
- Focus area identification and evaluation
- Citizen education and advocacy
- Statistical analysis for budgetary preparations
- Using maps to train personnel

Working in conjunction with the GIS Specialist, the Redevelopment Agency will be able to derive valuable, spatially-driven information on key issues for each of the Agency's divisions. It is recommended that the Agency work with the GIS Specialist to identify and prioritize GIS-based analyses that can be performed independently by Agency staff or in collaboration with (or with support from) the GIS Specialist.

## Case Studies

### The City of Greenville, Texas, Approaches Brownfields with GIS

The city of Greenville, Texas, located 45 miles northeast of Dallas, Texas, was incorporated in 1850. With the arrival of railroads in 1880, access to agricultural markets opened up much of the area to farming. Greenville grew quickly from a town of a few hundred to several thousand. Cotton was the primary catalyst for this rapid expansion. Greenville's cotton compress became the largest inland press in the world and was so highly regarded by the spinners of Manchester, England, that growers soon shipped cotton from many miles away to the Greenville press to get the Greenville marking. For the past 50 years, however, much of the commercial, retail, and industrial development has shifted away from the central downtown areas toward Interstate 30. This shift has resulted in a steady abandonment of the downtown area, leaving many buildings vacant and in a state of disrepair.



***This image shows output from ArcView of five of the six target areas within the city of Greenville Brownfields Pilot Area. The green areas are outside the target area. The lower parcel from the yellow zone has been selected with a site picture and associated findings illustrated in the lower information box.***

Philip Sanders, director of community development for Greenville, assembled an application for the city to the United States Environmental Protection Agency (EPA) Brownfields Program (see sidebar) in 2000 in the hopes of getting a brownfields grant to address some of the problems faced by the downtown area. On September 20, 2001, the city was awarded an EPA Brownfields Assessment Demonstration Pilot Grant.

Because of the volume of environmental information to be collected and assembled, the first task was to create a system that could be simultaneously utilized for public outreach, redevelopment prioritization, and tracking the city's progress. In addition, it would not only need to catalog potential brownfields within the Brownfields Pilot Area but also be capable of Web-based interactive use by all interested parties and provide a smart growth tool for city planners.

Terracon (Dallas, Texas) was awarded the contract to help in managing selected parts of the Brownfields Program in January 2002. According to Sanders, "The city chose Terracon based on its extensive experience with brownfields projects, environmental assessments, and remediation projects."

In keeping with current city development tools, it should also be developed using GIS. ESRI's ArcView and ArcGIS were the clear choices for the task.

*Compiling Existing Information*

As part of the pilot, the city is required to inventory the brownfields within target areas. Since the target areas were well defined (approximately 600 parcels), the effort was set up to obtain available information for the parcels that could potentially affect redevelopment efforts. Information was readily available from the Hunt County tax appraisal office, city of Greenville's GIS Department, and the North Central Texas Council of Governments (NCTCOG) that provided the general layers needed to represent the target areas. The information not available, however, included many of the things routinely collected during an environmental assessment of specific properties. This information was also the piece of the puzzle of most interest to potential lenders and redevelopers (i.e., site history). Unfortunately, the costs to conduct a full Phase I Environmental Site Assessment (ESA) for every parcel would be prohibitively expensive compared to the $200,000 from the initial Brownfields Pilot Grant. Therefore, the goal was to identify a plan to collect as much of the required data as possible without the extensive cost and to present it in a system that allowed the user to perform a query either for individual or collective needs.

*Building New Information*

The GIS Department proceeded to create new layers to specifically address the issues of current and historic use as it pertained to potential sources of contamination. ArcView was chosen because of the program's flexibility for merging data sources, creating new shapefiles, and interfacing with existing systems used by the city. Principal shapefiles were created and augmented with their associated databases in ArcView. The new databases were then populated with selected information reflecting each parcel's history and other related concerns.

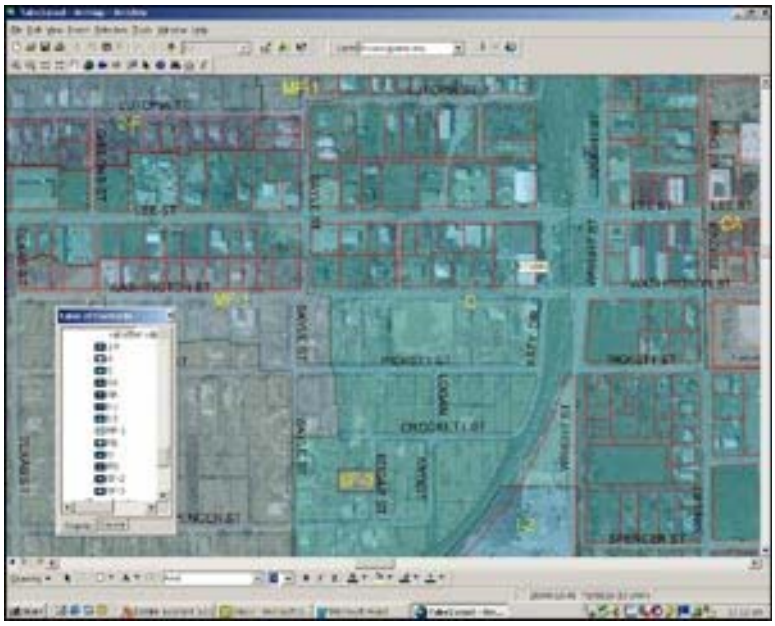
**Brownfields Background**

Across much of the United States, cities are finding areas that were once used for industrial and/or commercial purposes have slowly been abandoned and passed over time and again for redevelopment. The perception is that these properties have been contaminated by past site activities and that the cost from both a liability and redevelopment perspective is just too high. While it is true that some of these properties are likely contaminated, it is often the case that many of the properties are simply perceived to be contaminated or have only a small problem that can easily be addressed. Whether real or perceived, the obstacles associated with this environmental stigma are often enough to deter lending institutions, real estate developers, or other investors from taking part in the property's redevelopment. In the end, this process hurts local communities the most, as they see new development occurring farther and farther from where they live. These "abandoned" urban areas often become a community eyesore and feed into the overall sense of hopelessness commonly associated with "Brownfield" areas. In many communities, new development is planned at the expanding edges of town on historically undeveloped property or "greenfields." Some of the many secondary effects of this greenfield development are the extension of urban sprawl, the loss of historical heritage within a community, higher rates of unemployment, and the lengthening of commuter traffic, all of which carry additional costs to the environment and the community.

The Environmental Protection Agency (EPA) defines a brownfield site as "real property--the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant."

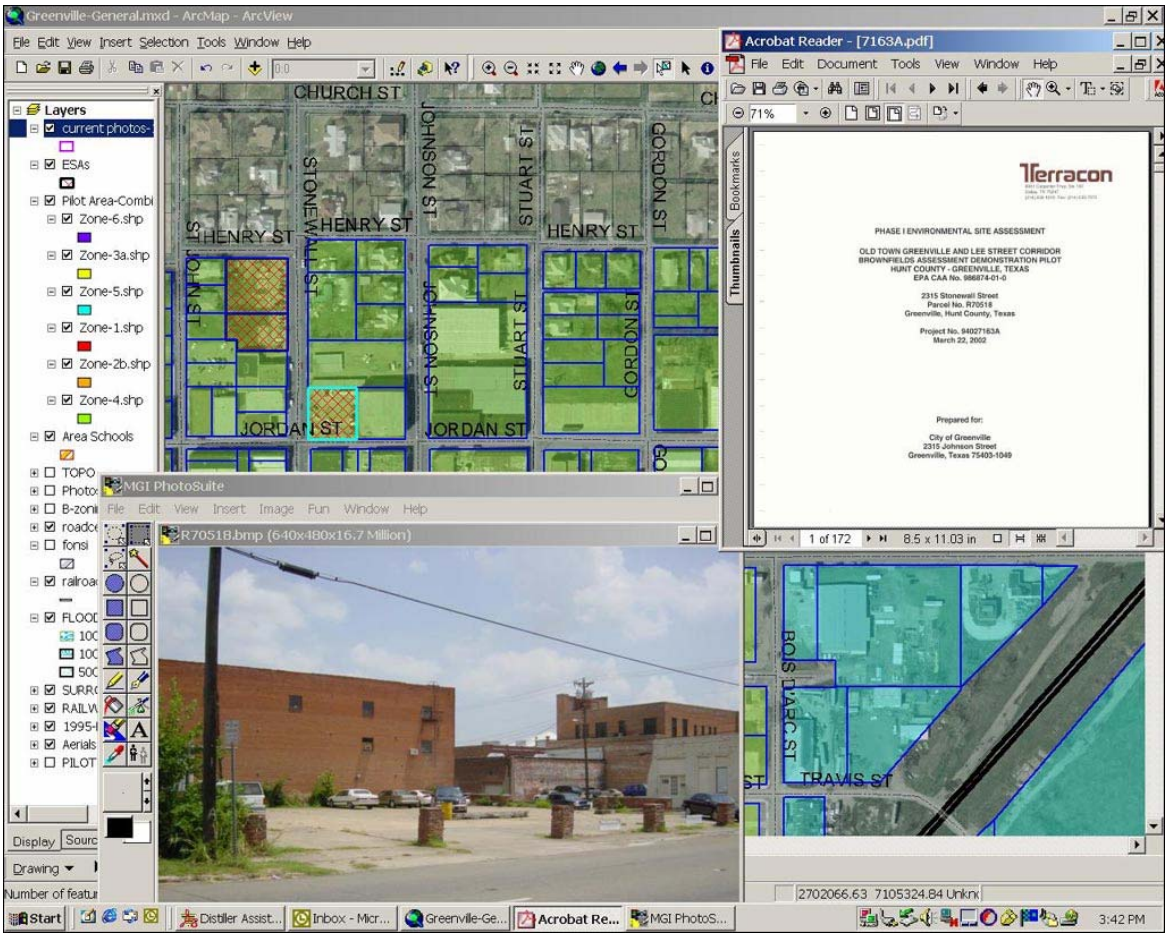
To address the problems associated with brownfields, the EPA began pilot programs to provide states, tribes, municipalities, and communities with useful information and strategies to promote a unified approach to site assessment, environmental cleanup, and redevelopment of contaminated properties. In January 2002, President George W. Bush signed legislation (Small Business Liability Relief and Brownfields Revitalization Act) to further encourage the cleanup and redevelopment of commercial and industrial properties. In addition, President Bush has requested an increase of EPA funding for brownfields from $98 million to $200 million for fiscal year 2003.

Use of ArcView allowed for additional database editing in Microsoft Access. While the information collected for the new databases excluded a few portions of the standard ESA format, such as historical interviews, it did focus on available records concerning each of the individual parcels. The layers included selected environmental concerns as far back as 1885. Focusing on these areas maximized the useful information placed into the database and reduced the project costs significantly.



***A zoning map created with ArcGIS for potential redevelopment interest.***

By bringing together a team with more than 50 years of combined experience assessing environmental concerns, the data could now be evaluated efficiently as to its inclusion within the various databases. A follow-up review of selected records provided quality assurance/quality control for the process. Additional layers included current digital site photographs for each parcel and the ability to link the parcels to electronically stored documents for each site as the inventory system matures. The new information allows the user to identify environmental obstacles early on in the process of redevelopment.




***This image shows output from ArcView of parcel no. R71122 with a detailed listing of information in the box above it. Additionally, a picture of the facility and attached historical grain elevators serve as a reminder of site history. The green areas are outside the Brownfields Target Area.***

The city formed a Brownfields Advisory Committee (BAC) in September 2002 consisting of community representatives, including members of the National Association for the Advancement of Colored People (NAACP), Clean Greenville, the Main Street Advisory Board, and other public associations, to provide input into the redevelopment effort utilizing the new inventory system. By harnessing the power of new and existing GIS data and community efforts for the revitalization of the pilot area, a new focused approach allows for redevelopment activities to proceed with more informed decisions. Kenneth Tramm, a senior project manager with Terracon, notes, "The hope of this system's approach is that it will reduce investigation expenditures and provide developers with relevant information that affects not only the cost of development, but more critically, the schedule of development. Only the interrelated ESRI systems, such as ArcView, ArcIMS, and the newer ArcGIS software, would allow for the numerous objectives of this project to be effectively met."

Dwayne Ford, EPA Brownfields project manager for the city, says, "The inventory system allows for real-time discussions of the potential environmental concerns facing redevelopment of a given site." Some of the benefits of the system include the following:

- Powerful decision making tool
- Area view versus property view (macro versus micro)

- Accelerates redevelopment by identifying environmental obstacles early on
- Able to query for important information (e.g., dry cleaners, city property, gas stations)
- Interactive (individual/group settings)
- Easy to update
- Customized to meet community needs
- Easy to integrate with existing databases and systems
- Real-time/current information for analysis and decisions
- Easy to adapt for Web site use

Work on the basic inventory system was completed within four months. In addition, four ESAs on 33 parcels have been completed. As redevelopment occurs within the target areas, the new information is tracked and updated for the city and EPA's databases accordingly. The next step is to begin wide-scale use of the Brownfields Target Area Inventory System with ArcView and ArcIMS via the Web for public outreach, future city planning, tracking proposed investigations and remediation, and attracting redevelopment partners.

**Case Study Courtesy of ESRI ArcNews Magazine*

FEC Corridor Redevelopment in Miami, Florida

The FEC Corridor is an economically distressed inner-city redevelopment area consisting of nearly 1400 acres. The corridor is comprised of a mix of industrial, warehouse, commercial and residential uses with a disproportionate share of vacant parcels and underutilized buildings. Most of the neighborhoods within the corridor have double-digit unemployment rates due to the loss of 19,150 jobs in the area between 1980 and 1995; as a result, there has been a major exodus leading to a decline in population (Figure RA-1.1). The corridor contains 70% of the city's remaining land zoned for industrial and warehouse uses.

The FEC Corridor is the subject of an on-going redevelopment study initiated by the City of Miami through a Task Force comprised of government officials, business leaders, non-profit community organizations and the real estate development community. The mission of the Task Force is "to identify and facilitate redevelopment opportunities within the corridor by facilitating private sector investment in underutilized areas; stimulating and safeguarding industrial and commercial uses; ensuring compatible land use buffers; improving transportation accessibility; and, enhancing employment opportunities for city residents as well as the overall economic impact on the city, all within the context of creating and preserving a livable community."

More information can be found at the following URLs:
http://gislab.fiu.edu/gisrsal/frames/fec/home.html
http://webgis.fiu.edu/website/fec/frame.htm

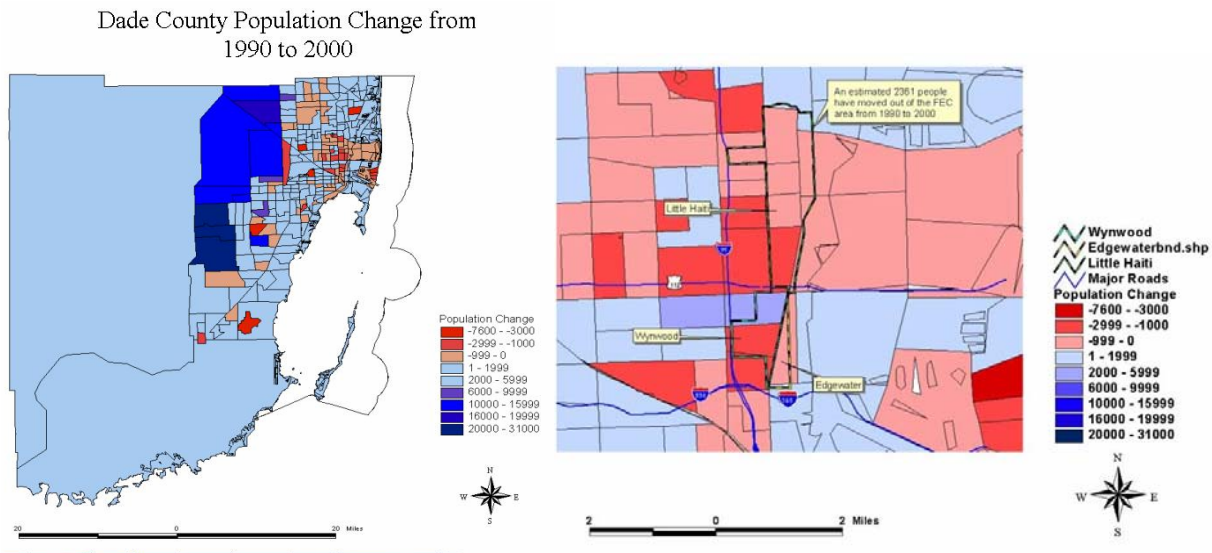



***Figure RA-1.1: FEC Corridor Population Change in Miami, Florida***

Public Access to Geo-Spatial Housing and Land Data

As aforementioned the Agency, in conjunction with the GCI Department, has secured a CDBG grant for the development of CATS. The CATS application will be a web-based application that leverages the power of GIS to serve as a gateway for promoting investment in redevelopment in the City—the application is expected to generate interest for economic and redevelopment for potential investors.

The Agency should coordinate the development and implementation of CATS with the GIS Specialist; CATS should be developed in conjunction with the recommended City Internet GIS data browser (this application will serve as the foundation for CATS). The mapping application should incorporate the ability for the public to view housing, neighborhood, and demographic data integrated with address locations and parcels. The Agency should also identify additional functionality that may be required in addition to the City's base enterprise offering. The development effort for CATS should be based on existing City software standards to ensure compatibility and ease of use.

It is recommended that the Agency work with other departments/divisions to identify which data can be made available to the public as part of the CATS application. As part of the City's objective to provide an Internet GIS data browser, the Agency should coordinate with the GIS Specialist to integrate Agency-specific GIS data into both the CATS and City Internet GIS data browser.

A formal review and assessment process should be established prior to making any information available, as some data may be sensitive or confidential. Reviews should be coordinated with the GIS Specialist and approved by the Redevelopment Director and City Attorney to ensure that no sensitive or confidential data is distributed publicly.

As a general recommendation, the CATS application should leverage the City's existing ArcIMS platform, which will serve as a public facing map server. Additional technology infrastructure for the CATS system will require a dedicated server, fiber network connectivity, and a customized graphical user interface (GUI) that utilizes the ArcIMS application programming interface (API) in conjunction with other web services (such as ESRI's ArcWeb Services). The development of the GUI should be performed using a standard programming

language/environment such as Cold Fusion, Visual Basic, and/or Java. The customized GUI will need to be developed in-house by the City's Information Technology personnel or by an external consultant. Subsequent maintenance and upgrades to the CATS application will need to be performed in close cooperation with the Information Technology Division; some or all of this maintenance and upgrades may need to be performed by an external consultant.

Listed below are the basic requirements for the CATS application:

| Software | Hardware | Network |
|---|---|---|
| ArcIMS 9 (1 License) | Dedicated Web/Map Server<br>• Dual Processor (2.8 GHz or higher)<br>• Minimum 1 GB Ram<br>• 40 GB Hard Drive | High-speed Broadband Connection (Can use existing fiber network) |
| Customized GUI<br>• Active X Control or Java Applet | N/A | N/A |
| ESRI Shapefiles or ArcSDE 9 equivalent library; ArcSDE requires SQL Server | GIS Data Server (utilize existing server maintained by IT Division) | Internal 1GB Connectivity |
| Web Server (utilize existing web server setup by IT Division) | See web/map server above | N/A |

Some of the typical pitfalls and problems of implementing an ArcIMS solution include:

- Providing too much functionality—this can confuse users, especially the public at large
- Providing too little functionality—the application will not meet the public's needs
- Slow performance due to any of the following factors:
    - Inadequate network connectivity/bandwidth
    - Feature-rich data that may slow server performance
    - Inadequate server memory (either web/map server or data server)
    - Inadequate server processing capacity
    - Improper or non-existent data indexing
- Lack of security/authentication methods
- Lack of data/system backup—redundancy is required to maintain an ArcIMS setup during scheduled and non-scheduled system maintenance and outages
- Inadequate application configuration and administration knowledge
- Lack of scalability due to improper system architecture

More information on ArcIMS system design strategies can be found on the ESRI web site: http://www.esri.com/library/whitepapers/pdfs/sysdesig.pdf

In order to implement the CATS application, the Agency will need to procure the services of a qualified ArcIMS application developer that specializes in providing local government ArcIMS solutions.

The application developer should have a history of proven success in the following:

- Understanding customer needs
- Familiarity with ESRI products and data models
- Designing and developing a sound system architecture
- Designing and developing an intuitive GUI(s)

- ArcIMS installation, configuration, and support
- Design and development of data standards and specifications, including data dictionaries, metadata, and data models (including tables, fields, GIS data layers, etc.)
- Integration of enterprise and database systems for use in online mapping applications
- Providing consistent support and maintenance

The primary elements that the Agency should include in an RFP for this system include:

- Needs assessment/requirements gathering phase
- System architecture design and review phase
- GUI design and prototyping phase
- System integration phase
- Database development phase (if needed)
- System development phase
- GUI development phase
- QA phase, including unit testing, system testing, and load testing
- Beta release phase
- Additional system/GUI maintenance
- Final release phase
- Support and maintenance schedule

Addition information on Internet GIS data browsers, in general, can be found in the Enterprise-Wide Applications section of this chapter.

Examples of Public Internet Mapping Applications (Economic Development)

*OKCEDIS*

The Oklahoma City Economic Development Information System (OKCEDIS) is an Internet GIS application that offers businesses immediate access to information that will assist with expansion and relocation decisions (see Figure RA-1.2). With OKCEDIS, businesses can generate economic, business, planning, geographic, and demographic information in real time via the web. The website application allows users to view, create, and print maps; perform site selection searches; and customize and analyze demographic and business data. More information is available at http://www.okcedis.com

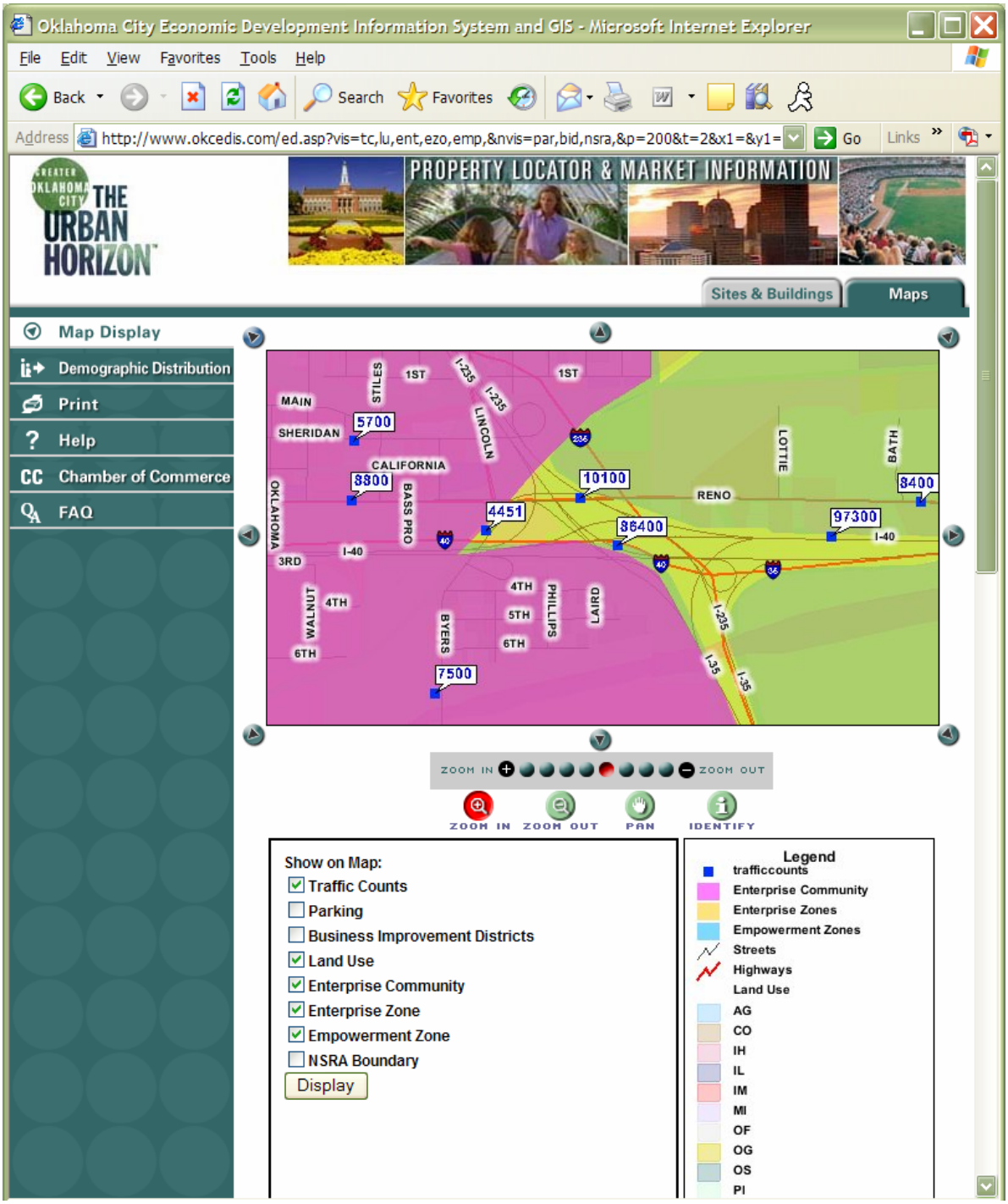



***Figure RA-1.2: OKCEDIS Interface***

City and County of Honolulu, Hawaii Economic Development Property Locator

The City and County of Honolulu have an online GIS application that geographically locates available commercial real estate property and displays different types of demographic reports and business reports based upon a selected calculated distance from the property. More information is available at: http://gis.hicentral.com/website/ecodev/ed.asp

***Figure RA-1.3 City and County of Honolulu Offer an Economic Development Property Locator Interface***

## GIS Data Layers

The Redevelopment Agency will benefit from access to several other departmental GIS data layers. It is expected that once all departmental data is integrated, consolidated, and centrally stored, that staff will have access to **all** non-classified GIS data layers from other City departments.

Agency personnel expressed that access to the following GIS data layers would be beneficial:

| *Data Layer* | *Creation Methodology* | *Recommended Update Division or Individual* | *Existing or Recommended?* |
|---|---|---|---|
| **Address Points** | Extract, cleanse, geocode, and map from Springbrook; georeference based on aerial photography and GPS field work | Automated; GIS Specialist; Drafting Services Section | Recommended |
| **Aerial Photography** | Fly-over with control points | GIS Data Services Vendor | Recommended |
| **Bicycle/Pedestrian Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Building Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Buildings with Site Plans** | Manually digitize polygons from plans and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Business Data** | Purchase commercially available business data from Claritas, Info USA, and other business data providers. Arranged by NAICS/SIC Code | Data Vendor | Recommended |
| **Business Loans** | Acquire data from lending institutions (if available); other financial data sources. Geocode and map. | Lending Institutions; Financial Data Vendors | Recommended |
| **Census Data** | Download from Census Bureau →http://www.census.gov/geo/www/census2k.html | GIS Specialist | Recommended |
| **City-owned Property** | Extract, cleanse, geocode, and map from Yolo County tax roll; other map sources as required | Automated | Recommended |
| **Commercial Addresses** | Extract, cleanse, geocode, and map from Springbrook | Automated | Recommended |
| **Community Facilities District** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Crime Data** | Extract, cleanse, and automatically map from Police VisionAIR database | Automated | Recommended |
| **Day Care Facilities** | GPS field work. | GIS Specialist; Redevelopment Agency | Recommended |
| **Enterprise Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Facilities** | Digitize on screen; aggregate layers as needed | Drafting Services Section | Existing |
| **Flood Zones** | Acquire from FEMA (free to government entities) http://www.fema.gov/fhm/ | Drafting Services Section; GIS Specialist | Recommended |
| **GCI Special Plan and Special Study Areas** | Digitize from base map data; aggregate layers as needed | GIS Specialist | Recommended |
| **General Plan** | Digitize features from aerial photographs and existing data layer | Drafting Services Section; GIS Specialist | Recommended |
| **Hazardous Materials** | GPS data collection for location; extract from FirePoint or other database once data is entered | GIS Specialist; Fire HAZMAT Manager | Recommended |
| **Housing Condition Data** | Extract, geocode, and map from database | Automated | Recommended |
| **HUB Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Labor Force** | TBD | GIS Specialist | Recommended |
| **Land Use** | Digitize polygons from aerial photographs and existing maps; existing CADD data | Drafting Services Section | Existing |
| **Levees** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Licensed and Unlicensed Businesses** | Extract, cleanse, geocode, and map from in-house database | Automated | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Liens** | Extract, cleanse, geocode and map from Springbrook | Automated | Recommended |
| **Lighting and Landscape Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Liquor Licenses** | Acquire from state ABC database; geocode and georeference using base layers | GIS Specialist; Drafting Services Section | Recommended |
| **Major Intersections** | Use street centerline layer as source | Drafting Services Section | Recommended |
| **Mello-Roos Districts** | Digitize from base map data; aggregate layers as needed | GIS Specialist; Redevelopment Agency | Recommended |
| **Neighborhood Watch Areas** | Digitize from base map data; GPS field work (if needed) | GIS Specialist; Drafting Services Section | Recommended |
| **Oak Trees (Heritage)** | GPS field work; validation may be possible using aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Parcels** | Acquire from Yolo County | Yolo County ( and GIS Data Services Vendor) | Recommended |
| **Parks** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Police Station Location** | Manually digitize points from aerial photography and address sources | GIS Specialist; Drafting Services Section | Recommended |
| **Port** | Digitize features from aerial photographs and other maps | Drafting Services Section; GIS Specialist | Recommended |
| **Real Estate Sales** | Geocode and map from MLS database and utilize automated entry system created for Community Asset Tracking System (CATS) allowing brokers to enter their own listings | Automated; Administrative Analyst | Recommended |
| **Redevelopment Project Areas** | Digitize from base map data; aggregate layers as needed | GIS Specialist | Recommended |
| **Redevelopment Projects** | Extract, cleanse, geocode and map from Access database | Redevelopment Agency | Recommended |
| **Riverfront Infrastructure** | Digitize existing Riverwalk from base map data; GPS field work; require new design firm to submit digital data | Drafting Services Section | Recommended |
| **Schools** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Sewer Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Storm Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Streets** | Derived from aerial photography; GIS Consortium | Drafting Services Section | Existing |
| **Tax Assessment Districts** | Aggregate parcels and assessor data; other sources, such aerial photography, as needed | GIS Specialist | Recommended |
| **Telecommunication Facilities** | Obtain data from telecommunications companies and/or purchase data from commercial sources | GIS Specialist; Automated | Recommended |
| **Transit Routes** | Derive from street centerline layer; acquire from SACOG? | Drafting Services Section | Recommended |
| **Trees (Parks)** | Digitize from aerial photographs and existing maps | GIS Specialist | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Truck Routes** | Derive from street centerline layer | Drafting Services Section | Recommended |
| **Under-utilized Buildings** | Query from parcel layer; other sources as needed | GIS Specialist; Redevelopment Agency | Recommended |
| **Vacant Properties** | Query from parcel layer; other sources as needed | GIS Specialist; Redevelopment Agency | Recommended |
| **Water Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Water Meters** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Waterways** | Digitize polygons from aerial photographs and existing maps | Drafting Services Section; GIS Specialist | Recommended |
| **Work Orders** | Extract, cleanse, geocode, and map from work order database (TBD) | Automated | Recommended |
| **Zoning** | Based on existing maps; General Plan | Drafting Services Section | Existing |

Additional layers may be required as the Agency increases its GIS utilization and incorporates additional field data.

## GIS Applications

### ArcGIS 9

ArcView is recommended for use by Agency personnel. A description of this application is provided in the Enterprise-Wide Applications section of this chapter. Use of ArcView will be dictated by the Agency's need to edit GIS layers and perform advanced spatial analysis. Five (5) licenses of ArcView are recommended for the Redevelopment Agency.

### Intranet GIS Data Browser

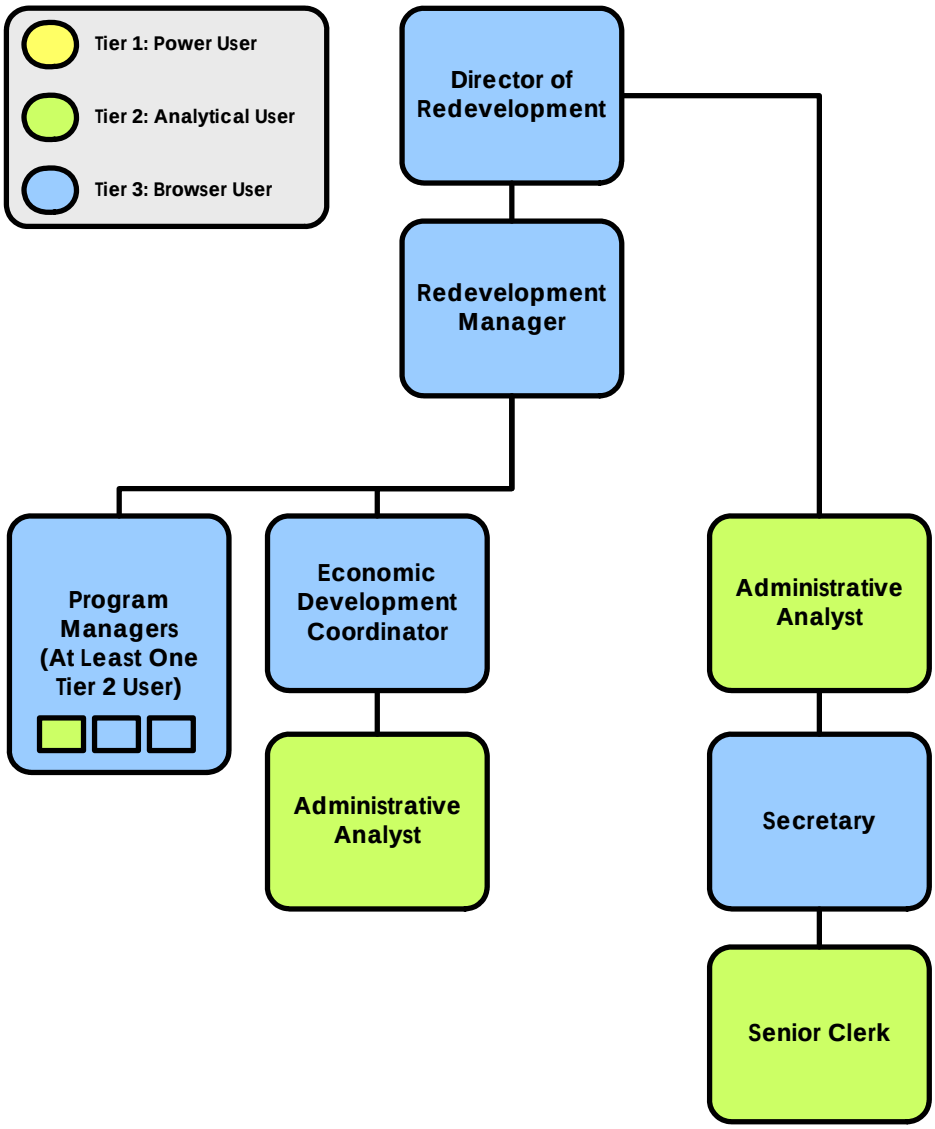
An Intranet GIS data browser has been recommended for use by Redevelopment Agency personnel. A full description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

### Internet GIS Data Browser

In addition to the CATS application referenced above, the Redevelopment Agency should also participate in the implementation of a more general City Internet GIS data browser. An Internet GIS data browser has been recommended to provide citizens with access to the City's geo-spatial data. Leveraging the City's existing ArcIMS platform, the City will need to develop an enterprise-wide Internet GIS data browser to provide the public with access to geo-spatial economic and property data. A description of recommended GIS data browser solutions is provided in the Enterprise-wide Applications section of this chapter.

## Multi-Tier GIS Application Use within the Redevelopment Agency

The following chart describes the recommended GIS application use by the Redevelopment Agency. A Tier 1 user is a power GIS user who should have access to a fully functioning GIS toolset. A Tier 2 users focus is data analysis in addition to general browsing capabilities. A Tier 3 user requires only general browsing GIS data functions. The Redevelopment Agency will consist of Tier 2 and Tier 3 users.




***Redevelopment Agency Multi-Tier GIS Application Use***

# Enterprise-Wide Applications

This section provides details about GIS applications that will be used Citywide by personnel in various departments, by the public, or by both City personnel and the public. GIS applications are on of the key building blocks for the City's enterprise-wide GIS implementation. GIS application use is based on a multi-tiered model based on three types of users: power users, analytical users, and browser users. Please refer to specific department/division sections to determine the types of users within each department/division.

## Desktop GIS Applications

### ArcGIS 9

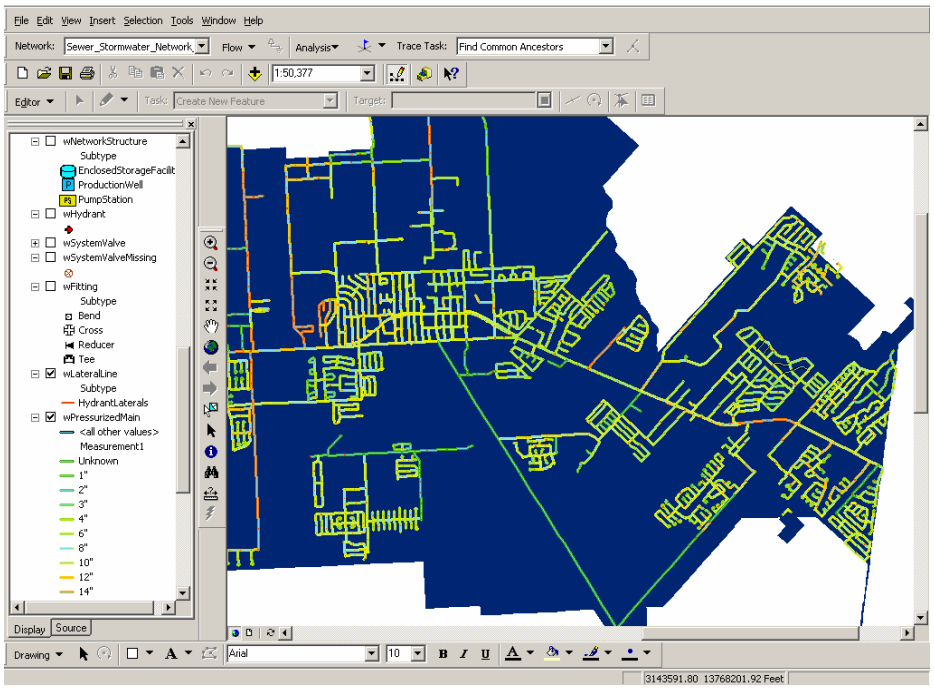
ArcGIS is a scalable system of software designed to meet all Tier 1 and Tier 2 needs. Three different levels of ArcGIS are available: 1) ArcInfo, 2) ArcEditor, and 3) ArcView. Although licensed separately, ArcGIS is a scalable set of software with the same underlying executables and user interface. ArcInfo, ArcEditor, and ArcView can all be customized using VB, C, and many other popular programming languages within the ArcObjects object model.

Individual recommendations for utilization of ArcGIS are included in each department/division section in this chapter.

Tier 1—Flagship GIS

ArcEditor 9 for ArcGIS is the recommended Tier 1 application for the City of West Sacramento. ArcEditor 9 (Figure ii.2) includes all the functionality of ArcView 9 and allows users to access the power of ESRI's Spatial Data Engine (ArcSDE). As described in Appendix I and Chapter 5: Database Design and Setup, the geodatabase is the primary data format used in ArcGIS. Two types of geodatabases are offered: 1) personal geodatabases, which store data within MS Access MDB files (regardless of whether the user has MS Access on their computer), and 2) enterprise geodatabases, which store data in a wide variety of commercial relational database management systems (RDBMS), including Oracle, SQL Server, Informix, and DB2. ArcSDE is required as a gateway between ArcGIS and the enterprise geodatabase stored in an RDBMS. ArcEditor can store and edit data in enterprise-wide geodatabases and personal geodatabases. ArcView can only store data in personal geodatabases. The primary advantage of using ArcSDE and enterprise-wide geodatabases is simultaneous, multi-user editing of geodatabases.

ArcEditor 9 costs approximately $4,000 per license. Most users will not need access to the full functionality of ArcEditor 9.




***Tier 1 - ArcEditor***

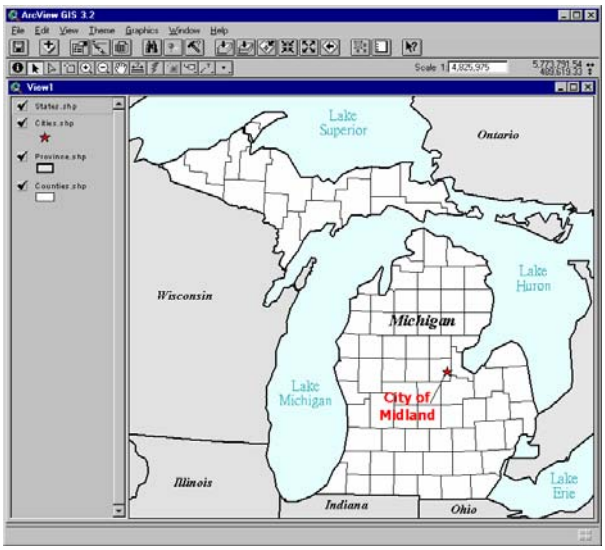
## Tier 2—Desktop GIS

Over the past few years the use of desktop GIS has increased dramatically, facilitated by advancements in computing power and improvements in operating systems. Desktop GIS includes many of the more popular functions of the flagship GIS products but omits some of the lesser-used functions. Desktop GIS is much less expensive than the flagship product. Desktop GIS can be purchased for an average price of $1,000 per license. Products such as ArcView have proliferated throughout local government and have allowed a new, larger group of employees to use the GIS. If 5 people are using the flagship package, perhaps 30 will be using the desktop version.

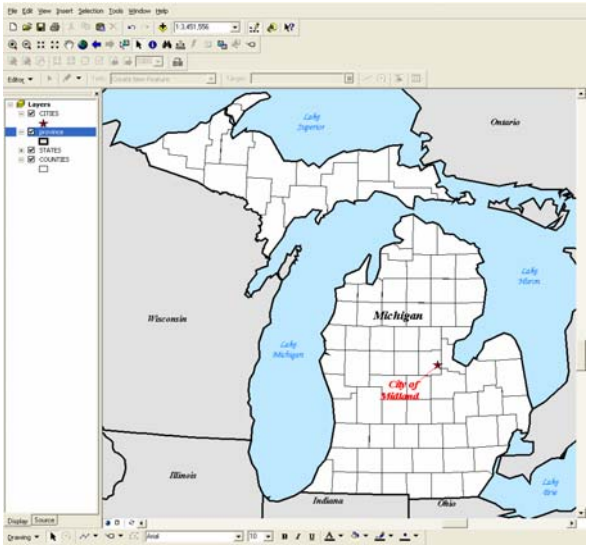
ESRI's Tier 2 software application has recently migrated from ArcView 3 (Figure ii.3) to ArcView 9 (Figure ii.4), although ArcView 3 is still supported. ArcView 3 was much more user-friendly than ArcInfo Workstation, as it was all menu-driven, as opposed to ArcInfo Workstation's command line interface. ArcView 9 is the least robust and least expensive of the ArcGIS suite. As an ArcGIS product, it uses the same interface as the Tier 1 one products, ArcInfo and ArcEditor. The primary differences (beside cost) between ArcView 9 and the Tier 1 products is that ArcView: 1) cannot edit coverages, 2) can only use personal geodatabases, 3) has less geoprocessing tools, 4) and lacks many database schema customization tools.

Tier 2 desktop applications still offer more functionality than many users need, and their robust functionality often cause them to run slowly on machines not intended to operate memory intensive applications.

***Tier 2 – ArcView 3x***



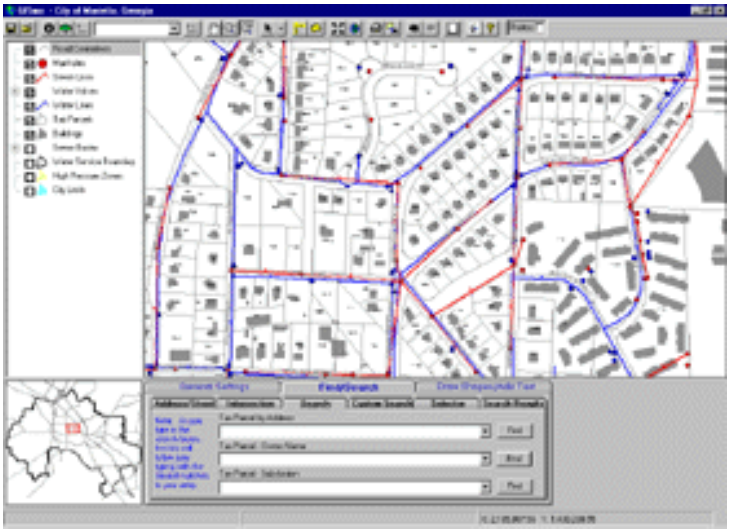

***Tier 2 – ArcView 8x***




## Tier 3—Customized/Open GIS

The majority of potential GIS users need easy-to-use, intuitive interfaces that perform well-defined tasks. Thus, the third tier of GIS software was born: customizable/open GIS. GIS software companies have moved GIS functionality to common, widely used programming languages such as C++ and Microsoft Visual Basic. The result is that application developers can create very user-friendly interfaces that have the look and feel of other personal computer applications. Only the GIS functionality needed for a specific program is used. Thus the overhead of non-used functionality is not slowing down the applications. Custom applications can be created and distributed throughout the organization. The Tier 3 product has a price tag of $3,000 to $4,000, which includes all the necessary programming software and 10 deployment licenses. For each additional deployment, a $100 fee is paid to the software company.

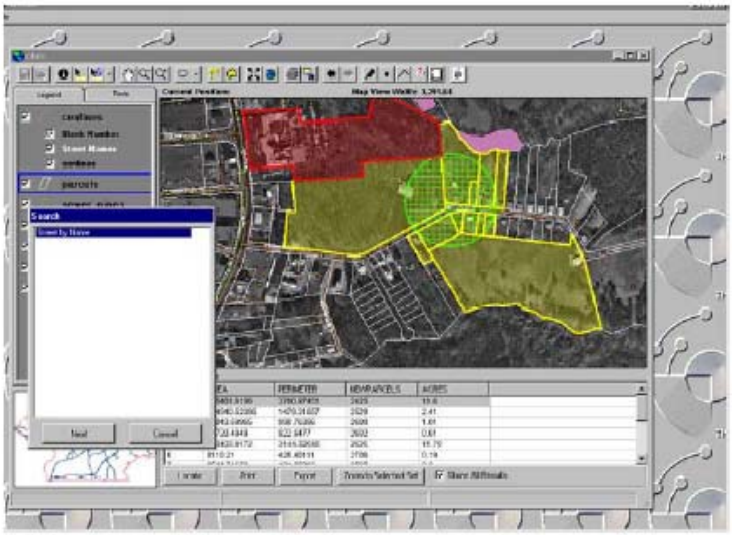
***A generic data browser.***



Counties like Columbia County, Georgia, are deploying a GIS using all three tiers and concentrating on custom applications. Columbia County will be deploying a "generic data browser" that will allow citizens, elected officials, and anyone with a personal computer to access a wealth of information.

The open programming interface opens the GIS door for any application developer in any industry. No longer is GIS development the domain of an elite few GIS gurus. Now any programmer adept at a standard programming language can embed GIS functionality in applications to be used by anyone throughout the organization.

More information can be found at: http://www.esri.com



***Example of a GIS Data Browser***

## Internet/Intranet Departmental GIS Data Browsers

The ability to view data in a quick and easy format is important for local governments and is needed throughout an enterprise. Web-based data browsers allow quick viewing and printing of map data. Web-based data browsers can be configured either for use solely within City of West Sacramento departments or as a web site available to the public. A potential application for a GIS browser would be for the visualization and query of property information, voter address and precincts, zoning, and other pertinent layers; additionally, this application could serve as a tool for creating mailing labels for targeted areas.

**Intranet**

Departmental Intranet GIS Data Browser Solutions are ArcIMS-based applications for data dissemination by departmental function across an Intranet. Intranet browser's represent a step forward in enterprise-wide GIS technology as it offers just enough spatial analysis, geographical viewing and map production, as well as external database links. The browser should include: 1) Advance Search Criteria, 2) Automated Mailing Labels, 3) Customized Departmental Query Control, 3) On-Line Help and Tutorial, 4) Advanced Graphic Design, 5) Enhanced Text Placement, 6) Link to external web Databases, 7) Easy-to-Use interface

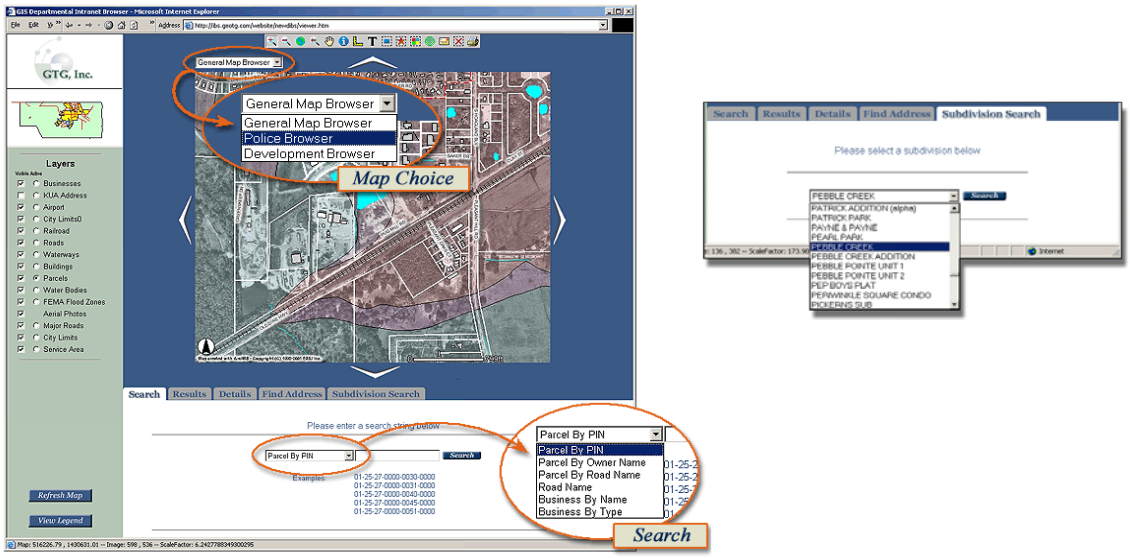
Each department is presented with pertinent GIS data and custom defined queries for easy end-user interaction and module development allows for the configuration or addition of module departments or functions to the browser based interface.

### Intranet GIS Data Browser

The City currently has an existing platform that can serve as the backbone for Internet and Intranet GIS Data Browsers: ArcIMS. The City recently upgraded to the latest release of ArcIMS (version 9). Subsequent to initial needs assessment information gathering it was identified that the GIS Specialist, with support from the Information Technology Division, already has begun work on installation and configuration of ArcIMS—this effort should continue to be supported by the Information Technology Division. The current ArcIMS implementation (ArcIMS version 9) is in a beta-testing stage; ongoing enhancement and configuration by the GIS Specialist and the Information Technology should yield a good foundation for future efforts.

Upon consolidation, centralization and standardization of GIS data, the Intranet GIS data browser should be modified to provide department-specific data and functionality. Additional functionality should include the ability to view all base map data, department-specific queries, and standardized mapping templates. Additional departmental/divisional requirements are provided in specific department/division sections in this chapter.

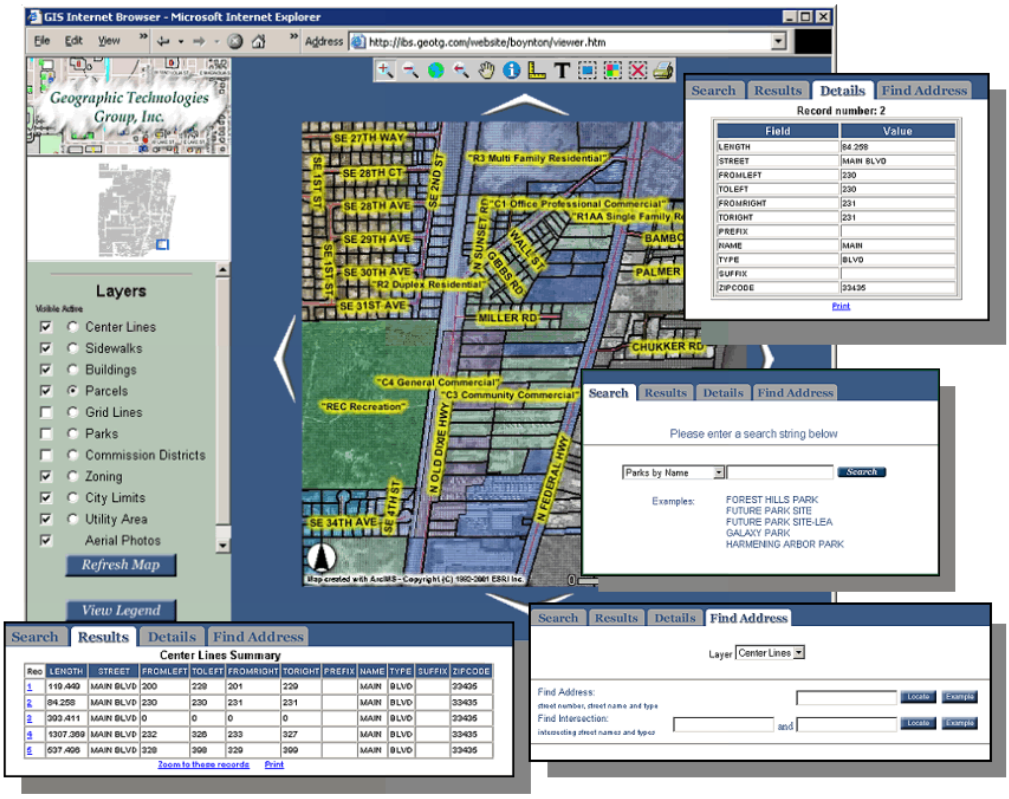
The ArcIMS platform utilized for the Intranet GIS data browser can also be leveraged to implement other Intranet GIS applications in the future as well as an Internet GIS data browser.




***Example 1. Departmental Intranet Browser***

## Internet GIS Data Browser

The City of West Sacramento expressed an interest in providing its citizens with access to online maps and geo-spatial information via a web-based solution. An enterprise Internet GIS Browser application, based on ArcIMS, will need to be implemented to provide such a solution. The Internet browser application should include an intuitive interface, and should incorporate the use of a graphic outline. The interface should be developed to match the current City of West Sacramento Web Site in color scheme, layout, logo etc.




***Example 2. Departmental Internet Browser***

### *Map Navigation Query Tools via Intranet Data Browser*

The Intranet and Internet browsers should have a variety of navigation and query tools.

***Sample Navigation and Query Toolbar***

### *Navigation tools should include*

- Pan
- Zoom in
- Zoom out
- Zoom to active layer
- Zoom previous
- Zoom to full extent

- Zoom to address
- Zoom to neighborhood

<u>The simple query tools should include the following functions:</u>

- Identify
- Ad-hoc query builder
- Find Address
- Spatial selection by box or polygon
- Buffer selection by layer

*<u>Multiple Interfaces or Services by Department or Function</u>*

The browsers should have a selection box for every major department or function in the organization. Once the department is selected then the interface, layers available, search mechanisms, and available reporting change to focus on the needs of that department. These associated layers and stored queries should be definable by staff and not require the use of outside consultants to edit or update.

*<u>Data Search Methods and Stored Queries</u>*

Various methods of finding information should be available. Each departmental interface will have a definable list of data search methods. These methods will be editable and storable by an administrative user and the shared out to the end user community. The following graphic depicts some more popular ways of searching for data in local government.

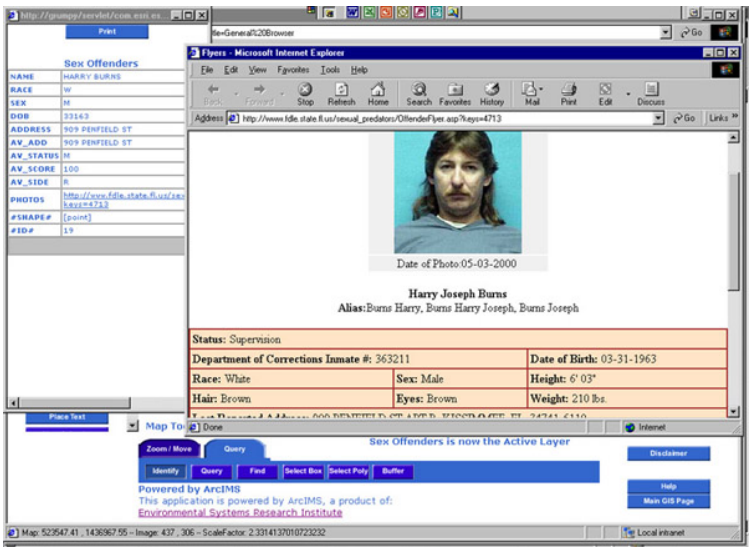
***Departmental or Function List of map Interface***

***Standard Neighborhood Search or Stored Configurable Search list***

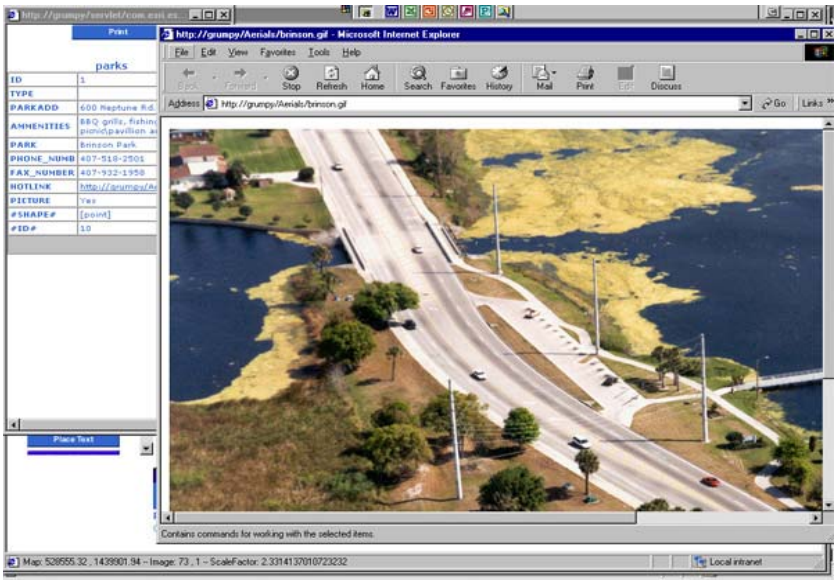
*Data Display and Hyper-linking*

The browser solutions should support hyper linking to web supportable file formats. Following are excellent examples of hyper-linking opportunities from the application datasets:

- Parcel deeds and plats
- Sexual Offenders link to the State
- Imagery of Community Facilities
- Pictures of individual structures
- Maps to community facilities



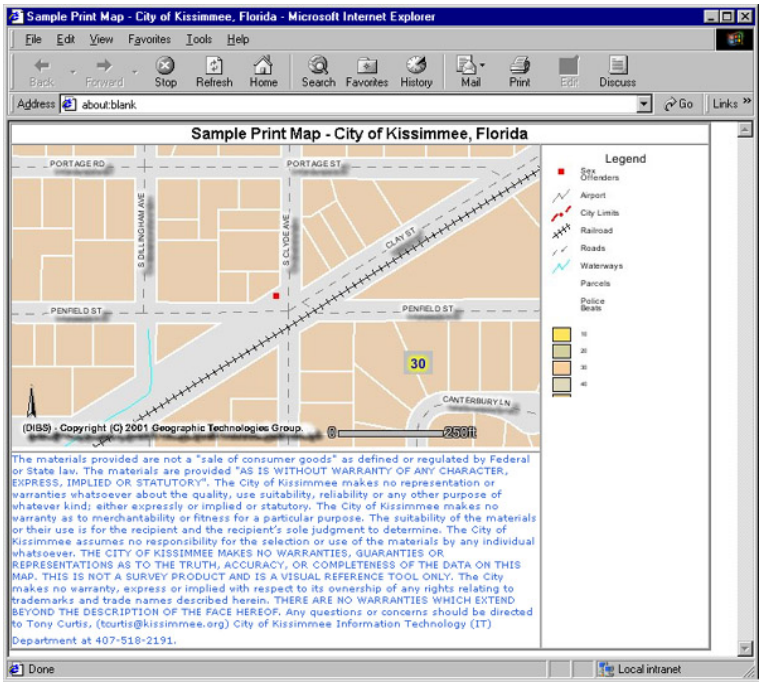

***Sample of Sexual Offender link***




***Sample of Park Aerial Photo***

*Printing and Reporting*

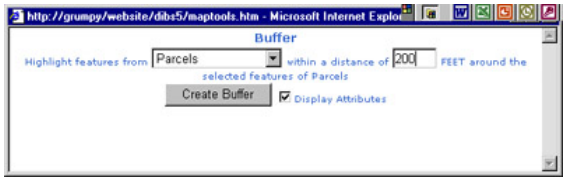
The browser solutions should provide the ability to generate quality prints to a local printer. The print should include the map, legend, title and scale bar for quick reference.



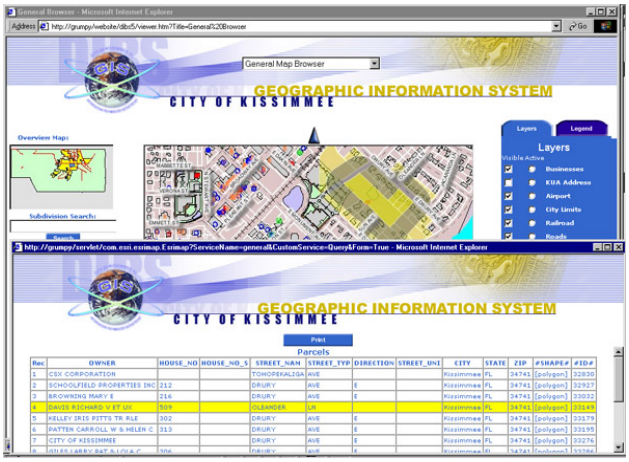

***Sample of Print Page***

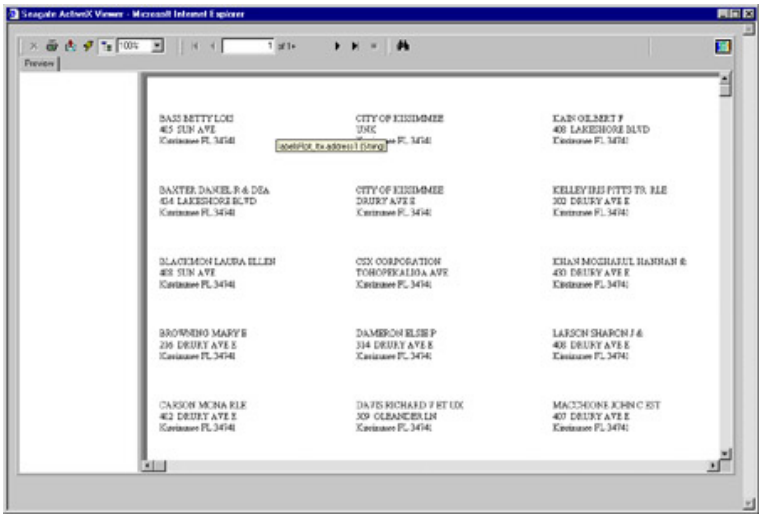
*Buffering for Notification or Mailing Label Generation*

The browser solutions should provide a method for staff to generate mailing labels for notification purposes. This should be accomplished by the server automatically producing a standard list using Crystal Reports or a similar reporting application.




A buffer interface (above) should provide the user with a simple method to produce buffers and select features based on that buffer. The resulting buffer and selected set should be displayed for the user (right). Generation of mailing labels should be supported by the application (below).





***Sample Buffering and Mailing Label Generation***

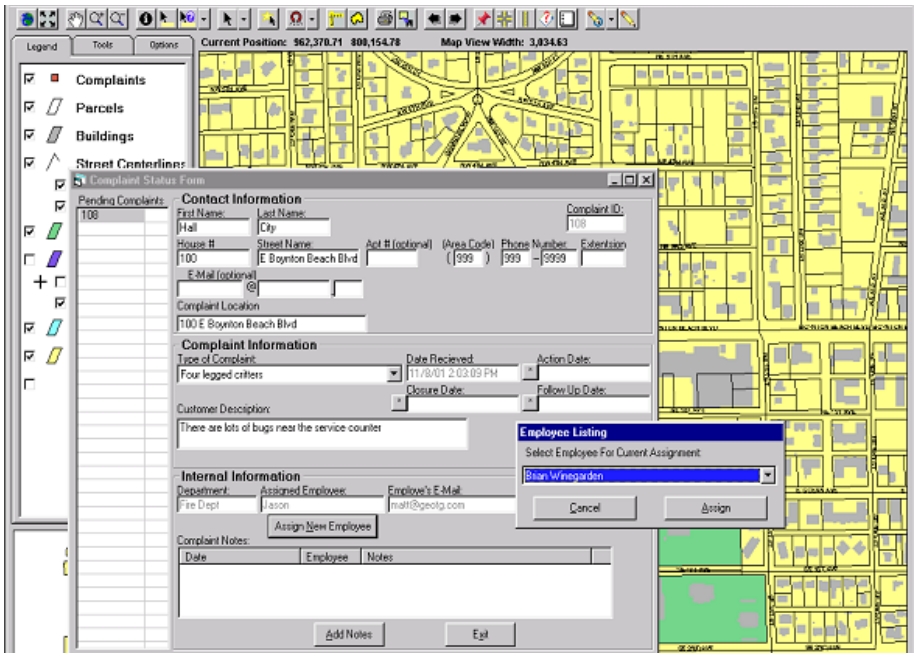
## Complaint Tracking Application

Many City of West Sacramento departments would benefit from a web-based GIS application designed for tracking citizen inquiries, complaints, concerns, and other general feedback. Such an application would enhance communication with the public, and allow the City of West Sacramento to quickly and effectively respond to requests. From the citizen's perspective, one call to any City staff member should result in an inquiry or complaint being logged into the system, routed to the correct department or point of contact, action taken by City employees, and follow up to the initial inquiry in an effective and timely manner. Inquiries or complaints should also be logged and tracked via the Internet or in person.

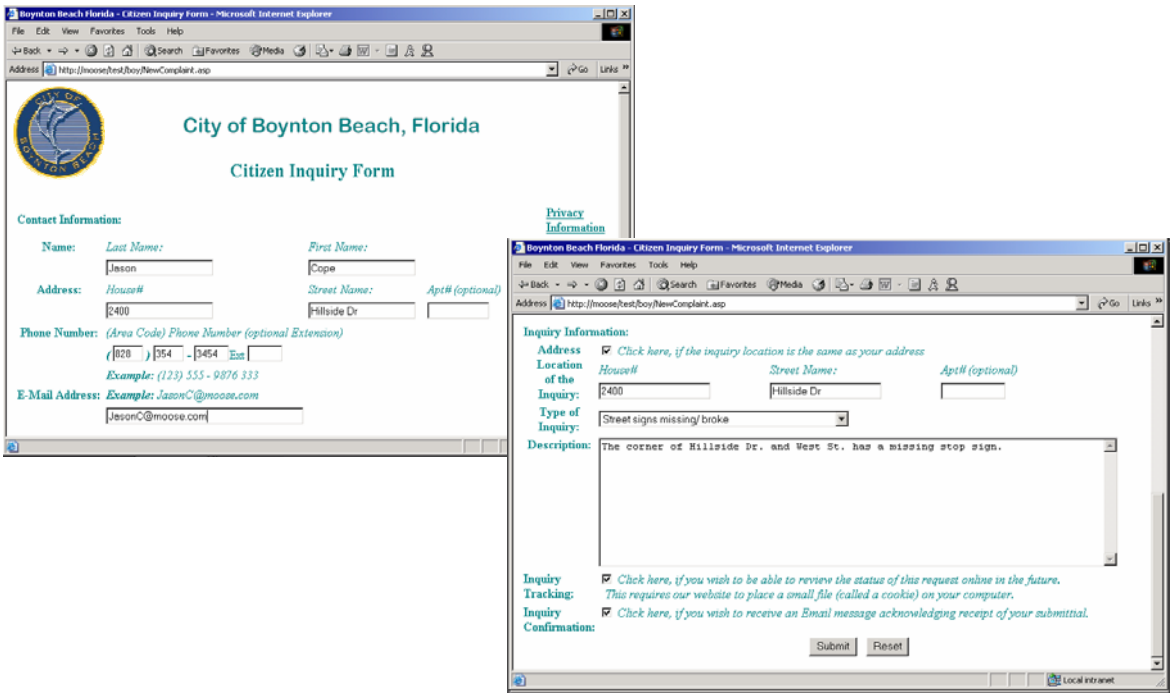
By implementing such an application, the public no longer has to be transferred from one department to another on the phone or in person. Routing of inquiries and complaints would be done internally through email notification, and is therefore transparent to the citizen. City staff can then proactively track, manage, analyze, map and report inquiries and complaints, actions taken, final results, and citizen satisfaction.

A complaint tracking system should include:

- Web/Phone-in/Walk-In Submittal of Inquiries
- Multiple Search (Query) Capabilities
- Internal Email Server
- Levels of End-User Security
- Assignment of Employees/Departments to Specific Inquiry Types
- Ability to Sub-classify Inquiry Types for Internal Department Use/Reporting
- Automated Email Notification of New Inquiry to Designated Employee and Response to Person Submitting
- Logging of Actions Taken Toward a Solution
- Map and Summary Report Generation




***Complaint Tracking Application – Sample User Interface***




***General Web Input Form (Citizen or City Employee)***

# Chapter 2 – GIS Organizational Structure and Staffing

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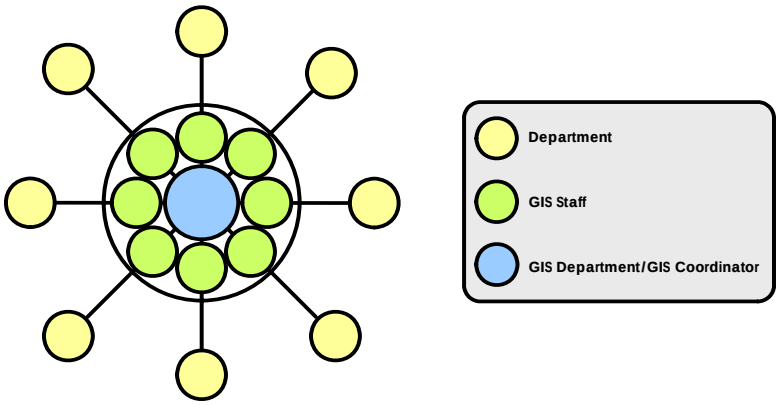
## Enterprise-wide Organizational Models

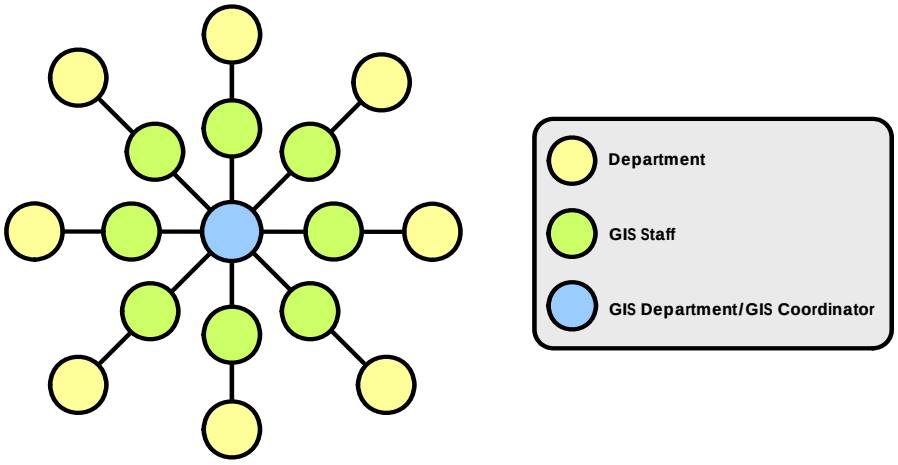
Essential to the success of the City of West Sacramento's enterprise-wide GIS effort will be how GIS fits best within the organization. There are two primary organizational structures used to implement enterprise-wide GIS within organizations throughout the United States.

The first type is a **centralized** structure. A centralized organizational structure maintains a central department or division that is responsible for all GIS services. In this type of structure GIS often has its own dedicated department or it is a division of an Information Technology or Technology Services department. The GIS department/division will employ a cadre of management, analysts, technicians, and programmers tasked with hardware, software, application development, planning, and training. Data are created and maintained by this group, or outsourced to contractors. All other participants are characterized as end-users, with only the capability to view, query, and analyze spatial data.



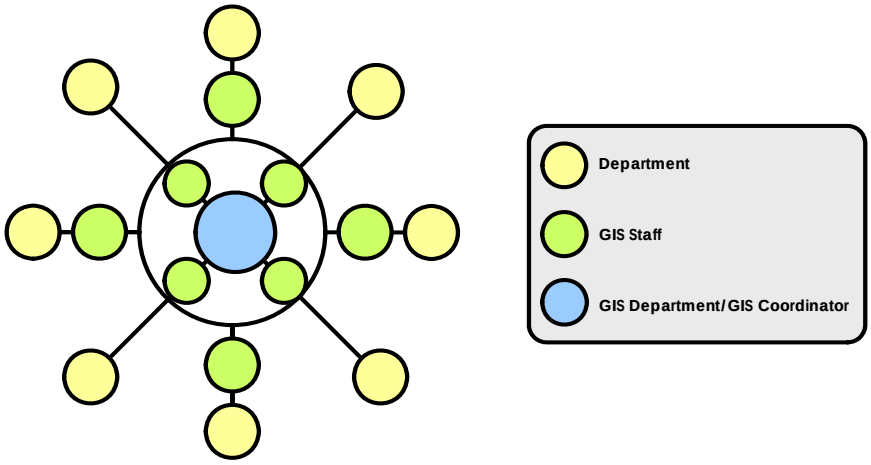

***Centralized GIS Organizational Structure***

The second type is a **decentralized** structure. A decentralized organizational structure divides GIS responsibilities throughout various departments. Decentralized organizational structures may still have a GIS Section, operating independently or under the jurisdiction of another department. This approach divides system and data maintenance between the GIS Section and departmental end-users. During their course of daily business, users update an enterprise database (e.g., using ArcEditor to edit data). All users share responsibility for maintaining the GIS, and users within each department maintain specific data according to their thematic disciplines and specialties. This type of organizational structure enables the GIS Section to focus on hardware and software maintenance, data exchange and distribution, application/data design and development, user training and support, community extension, and technology innovation, instead of devoting time to the creation and maintenance of data.




***Decentralized GIS Organizational Structure***

Many local governments utilize a **hybrid** GIS organizational structure, based on centralized and decentralized organizational structures. This type of structure provides the benefits of both organizational structures in scenarios where full implementation of either organizational structure cannot be readily attained.




***Hybrid GIS Organizational Structure***

**Definitions Summary of Organizational Structures**

Centralized Organizational Structure:
All GIS tasks except data viewing and analysis are handled by a central GIS department or division. All GIS staff are located within the central GIS department or division.

Decentralized Organizational Structure:
GIS data updating and maintenance responsibilities are assigned to individual GIS-participating departments. Departments have their own GIS staff members.

Hybrid Organizational Structure:
GIS tasks may be handled centrally or at department level, depending on needs and available GIS staff at individual departments.

## City of West Sacramento GIS Organizational Structure

The following City of West Sacramento departments/divisions/offices will utilize GIS in various capacities:

- City Manager's Office
  - Information Technology Division
- Community Development Department
  - Building Division
  - Engineering Division
  - Facilities Development & Maintenance
  - Planning Division
- Finance Department
- Fire Department
- Grants & Community Investment (GCI) Department
- Parks & Recreation Department
- Police Department
- Public Works Department
- Redevelopment Agency

The utilization of GIS in the aforementioned departments/divisions/offices will vary from consistent daily use to sporadic use every few weeks or months. In addition, the knowledge and understanding of GIS technology is also variable within and among these entities, such that there are GIS users from each functionality tier (i.e., power user, analytical user, browser user).

The knowledge and understanding of GIS technology varies within and among these entities, such that there are GIS users from each functionality tier (i.e., power user, analytical user, browser user). The City recently hired a GIS Specialist in the Information Technology Division. The GIS Specialist is poised to lead and coordinate the City's GIS implementation. The GIS Specialist is responsible for providing enterprise-wide support to all City departments/divisions. The GIS Specialist's organizational position within the Information Technology is optimal, as GIS and Information Technology are inherently interconnected. The GIS Specialist will work closely with other Division personnel to ensure that all GIS infrastructure, including data, software, hardware, network, and customer support issues are addressed. In addition, a Drafting Services Section (CADD) exists within the Engineering Division; this Section primarily conducts CADD-based mapping and drafting work for the Community Development as well as cross-functional work for other City departments. The

GIS Specialist and the Drafting Services Section are a crucial component of the City's enterprise-wide GIS implementation.

The basic context for GIS use within the City, as a whole, has incorporated mapping and some spatial analysis. Each department/division has identified the need for a holistic coordination effort aimed at managing an integrated enterprise-wide GIS. Assessment and evaluation of the existing GIS organizational structure and staffing is critical for establishing a viable and successful GIS coordination effort.

Based on departmental interviews and information gathering, GTG has determined that the City of West Sacramento currently has a hybrid GIS organizational structure. This hybrid structure is based on the GIS Specialist, Information Technology Division, and the Drafting Services Section, which together are the City's core GIS staff; some GIS functions are distributed within each department/division, yet the GIS Specialist, Information Technology Division, and Drafting Services Section are a focal point for GIS. GIS users within departments/divisions are responsible for some utilization and minimal maintenance of the GIS, yet each GIS-participant department has access to and support from qualified staff.

## GIS Organizational Structure Recommendations

GTG recommends that the City of West Sacramento continue to utilize a **hybrid organizational structure** for its GIS effort.

Data content and metadata standards should be created and enforced by the GIS Specialist. A central data repository (centralized GIS server or servers) should be created for all GIS data (including the Drafting Services Section's CADD data). This is especially effective with ESRI's ArcGIS 8.x and 9.x software, which is designed to operate from a single GIS server, utilizing the geodatabase model.

The GIS Specialist, in conjunction with other personnel from the Information Technology Division and Drafting Services Section, will be responsible for data creation, conversion, and maintenance for all non-departmental specific data layers, and establishing data integrity checks for critical enterprise layers such as planimetrics. GIS-participating departments should be responsible for updating and maintaining all other GIS data layers, utilizing standards developed and issued by the GIS Specialist.

GIS-participating departments should still have the primary authority to recommend new GIS applications for their own use, but the GIS Specialist should review all requests for compatibility and applicability.

The GIS Specialist should implement three levels of departmental support, depending upon the current level of GIS use and internal capabilities per department. This support will be coordinated with the Information Technology Division and the Drafting Services Section, as there may be some overlap. Levels of support include:

> **Level 1** – GIS Specialist provides minimal support for department/division/office GIS activities, system and application support. The GIS Specialist is used primarily for strategic and procedural support. The Drafting Services Section is essentially at Level 1. Other departments/division, including the Engineering and Planning Divisions should aspire to be at Level 1 in the near future.
>
> **Level 2** – GIS Specialist provides partial support for department/division/office GIS activities. A Level 2 department/division/office will do most of its own data

maintenance, but the GIS Specialist will provide advanced support; the GIS Specialist will also be responsible for advanced spatial analysis as well as application development.

**Level 3** – GIS Specialist provides all support for department/division/office GIS activities. The GIS Specialist is responsible for data maintenance, complex data analysis, and cartographic products.

Each department/division should strive to achieve Level 1 support status as GIS develops and is incorporated into its respective business processes.

The GIS Specialist, in conjunction with the Information Technology Division, should provide training and technical support for all enterprise-wide GIS applications. All GIS software training should be coordinated through the GIS Specialist to ensure maximum efficiency and effectiveness at a minimum cost.

Not every department/division/office at the City of West Sacramento that wants to utilize GIS is able to hire or convert staff to effectively handle the tasks of data analysis and data maintenance. The GIS Specialist will assist these departments/divisions/offices with their GIS needs. However, as usage of GIS in the aforementioned entities grows, the GIS Specialist must encourage and facilitate the acquisition of appropriate resources to handle data maintenance responsibilities for these departments/divisions/offices.

To reiterate, how GIS fits within the organization is essential to the success of this enterprise-wide effort. The City of West Sacramento should continue to utilize a hybrid organizational structure. Having a GIS Specialist is an important factor with regard to GIS success. The GIS Specialist should continue to be utilized to direct the overall GIS efforts of the organization. He or she should not be seen as the person who will conduct all daily GIS tasks for various departments. The GIS Specialist should provide technical expertise, training, and direction for all City of West Sacramento staff. Working in tandem with the GIS Specialist, the Information Technology Division and Drafting Services personnel can provide sound and sophisticated technical GIS services for the City of West Sacramento. However, each department/division/office should eventually develop its own expertise and begin to utilize GIS in its daily routine as the city's GIS implementation progresses.

## GIS Enterprise Staffing

Staffing issues will be critical to the success of the City of West Sacramento's enterprise-wide GIS effort. Unfortunately, staffing can also be a complex and frustrating issue. Budgetary and political realities within local governments place restraints on what can be accomplished. Ideal staffing structures are sometimes difficult to attain. Nonetheless, there are fundamental steps that the City of West Sacramento can take to ensure a proper staffing foundation, which can be improved upon as time and necessity dictate.

The organizational structure of the GIS effort will have an impact on staffing issues. Organization structure and staffing are inherently interrelated. GIS staff allocations must be determined before specific job requirements and responsibilities can be agreed upon. Please refer to the previous section for organizational structure recommendations for GIS within the City of West Sacramento.

The size of a local government organization plays a significant role in staffing issues. The needs of a large city are different from those of a small rural town. Based on this variability in

needs, this document focuses on staffing issues related to medium-sized cities, such as West Sacramento, whenever possible.

## Functional Areas

There are six functional areas in which most GIS positions can be classified: coordination, system support, application design, database support, user support, and production/data collection. Not all organizations will have staff members in every functional area, and often individual staff members will have responsibilities in two or more functional areas. Individual job descriptions are provided later in this document. The City of West Sacramento already has its own job classification structure in place, so careful consideration will be needed when assigning employees of particular functional area to the proper job classification.

Coordination: It is vital to the success of the City of West Sacramento's GIS effort to have a GIS Specialist. The GIS Specialist is responsible for all resource and project coordination as well as the effective day-to-day operation of all GIS aspects. This includes hardware and software issues, database design and maintenance, technical support, and management of the GIS Specialist. A GIS Specialist must have the technical savvy to run diverse operating systems, networks, and GIS software and the people skills to coordinate, sell, champion, teach, and referee the implementation of GIS.

System Support: System Support staff provides the necessary support to ensure that all GIS software, hardware, networks, and databases are properly implemented and working. Technical support for all GIS end-users is the responsibility of System Support staff. Systems Support within the City of West Sacramento will be provided primarily by the Information Technology Division; additional support should be provided by the GIS Specialist.

Application Development: Many larger organizations have their own GIS application development staff. Packages such as ESRI's MapObjects and ArcObjects allow for custom application development to suit individual department and enterprise-wide needs. Flagship and desktop GIS packages such as ESRI's ArcGIS allow customization of design and functionality. Recently, the development of a GIS-enabled web site has become an important goal for many cities. Primarily developed with ESRI's ArcIMS, these GIS-based web applications require staff for its creation and maintenance. It is recommended that the City of West Sacramento work with the GIS Specialist to determine which application development efforts can be implemented in-house. Given the application development resources available within the City's Information Technology Division, it is expected that many application development efforts can be led, coordinated, and/or implemented by staff within the Division, including the GIS Specialist, IT Specialists, and Application Support Specialists. In the context of this model, the Information Technology Division will be instrumental in providing ad hoc and project-driven application development support. Efforts that cannot be implemented in-house should be outsourced to a qualified GIS services vendor.

Database Support: Most GIS packages are designed to operate from commercial relational database management systems (RDBMS), such as Oracle, MS SQL Server, or MS Access. ESRI's ArcGIS uses a geodatabase model for data storage, retrieval, and editing from an RDBMS. This allows for the preferred creation of a central GIS data repository. Therefore, it is imperative that knowledgeable staff is employed to implement and maintain the effective operation of the central GIS repository. If a city is already using a specific RDBMS citywide, it makes sense to use that same RDBMS for its GIS, as it ensures compatibility and easier. Additional responsibilities of database support are the enforcement of GIS data structure and metadata standards for GIS- participating departments. No specific database support staff is recommended at this time for the City of West Sacramento. Database support tasks

can be conducted by the GIS Specialist and other personnel in the Information Technology Division.

User Support: This is a very broad category, and encompasses both GIS-core staff and GIS-departmental staff, depending on organizational structure. Generally, GIS Analysts and Specialists fall under the User Support category. This staff provides enterprise-wide GIS activity support as well as support to departments beyond what existing staff requires. A successful GIS effort must be results-oriented. Therefore, the expertise and quality of analysis conducted by User Support staff are vital. It is recommended that the GIS specialist provide User Support for those departments that he/she deems appropriate. As GIS usage grows throughout the City, the Information Technology Division may wish to hire additional GIS resources, such as GIS Technicians, to meet future GIS user support demand.

Data Collection/Production: A great deal of time and effort is spent by most organizations to develop accurate and effective GIS datasets. This data must be maintained properly for it to retain its usefulness. This is primarily the role of GIS Technicians and GIS Specialists. As GIS develops within an organization, new data will be collected and will need to be converted to adhere to data standards. Specific tasks such as digitizing, scanning, and metadata creation are also the responsibility of GIS Technicians and/or GIS Specialists. It is recommended that the GIS Specialist serve to collect, produce, and maintain GIS datasets for those departments that do not have the necessary staff to perform this task.

## Hiring vs. Retraining

A fundamental question encountered by organizations during implementation of an enterprise-wide GIS is: "When should we hire additional GIS staff, and when should we retrain existing staff to handle GIS responsibilities?" The answer to this, in large part, depends on the existing status of GIS within each organization. Larger cities will require GIS staff in several functional areas (outlined in the previous section).

There are two general categories for the hiring or retraining of staff. The first is core GIS staff. As outlined previously in this chapter, even decentralized GIS organizational structures require core GIS staff to handle non-department specific GIS issues. Many of the responsibilities of core GIS staff require specific knowledge of GIS and Information Technology issues. As a general rule, a large organization without existing staff to handle all of these responsibilities will need to hire additional staff.

Staffing issues in GIS-participating departments are more complex when compared to core GIS staff. A primary reason for implementing an enterprise-wide GIS is to facilitate and improve existing business processes. A large organization utilizing enterprise-wide GIS will have more end-users of GIS than specific GIS staff. The majority of staff within GIS-participating departments will primarily utilize GIS data browsers. Although basic GIS data browsing and querying require limited training, the functionality required for advanced spatial analysis, using robust applications such as ArcEditor or ArcView, is much more complex. Individual departments will need to have staff with appropriate knowledge to effectively operate these applications. In general, it is easier to hire a professional for the required business function (such as engineer or planner), and train them in GIS, than it is to hire a GIS-trained staff member and train them for the required business function. In addition, professionals will have more intimate knowledge of the specific objectives and goals that they wish to accomplish.

As GIS within individual departments grows, it may be found that existing staff cannot handle all of the desired GIS analyses; under these circumstances, the hiring of additional staff should be assessed.

## Position Classes

Within each functional area there can be several specific position titles. One effective method is to differentiate position classes within position titles. For example, the general position "GIS Specialist" can be differentiated into "Senior GIS Specialist" and "GIS Specialist."

The reason for creating position classes is two-fold. First, it allows for greater flexibility. As GIS technology grows, and use within the City expands, job responsibilities may change. Position classes will accommodate any changes needed to adapt to changing responsibilities. Second, position classes allow for mobility and career potential. As specific staff members demonstrate initiative and capability, it is advantageous for an organization to offer upward mobility as an incentive to existing staff members to perform well and learn as much as possible.

## Salary Structures

Equitable and consistent salaries for GIS staff and professional staff with GIS skills are important for the success of the City of West Sacramento's GIS endeavor. Enterprise-wide GIS implementation can only be as successful as the people that supervise and operate it. Attracting and retaining qualified staff are inherently tied to the compensation that the City of West Sacramento is willing to provide. It should be noted that public sector GIS salaries traditionally have been less than those obtainable in the private sector; accordingly, every effort must be made to make the City of West Sacramento an attractive place to work.

Salaries primarily depend on two factors: market conditions and skill sets. Although every organization is unique, the City of West Sacramento must ensure that salaries for GIS staff are in line with other organizations of equal size and structure. As aforementioned, it is expected that public sector jobs will offer less compensation than the private sector; however, the difference in compensation cannot be too great if the City of West Sacramento expects to hire and retain qualified GIS staff.

Different functional areas require positions with varying skill sets. The GIS Specialist is the most important position to the success of the City of West Sacramento's GIS effort. It requires a broad knowledge of both GIS technical expertise and management skills. Proper compensation for this position should be of the highest priority. Frequent turnover in this position can have disastrous consequences to the overall success of the GIS effort.

System Support, Application Development, and Database Support positions require personnel with advanced technical capabilities. These positions require knowledge of hardware specifications, networks, programming, and database administration. These same skills are also easily transferable to the Information Technology sector, where salaries are consistently higher, both in the public and private sector. Salaries for these positions must be reasonably competitive with public sector IT positions.

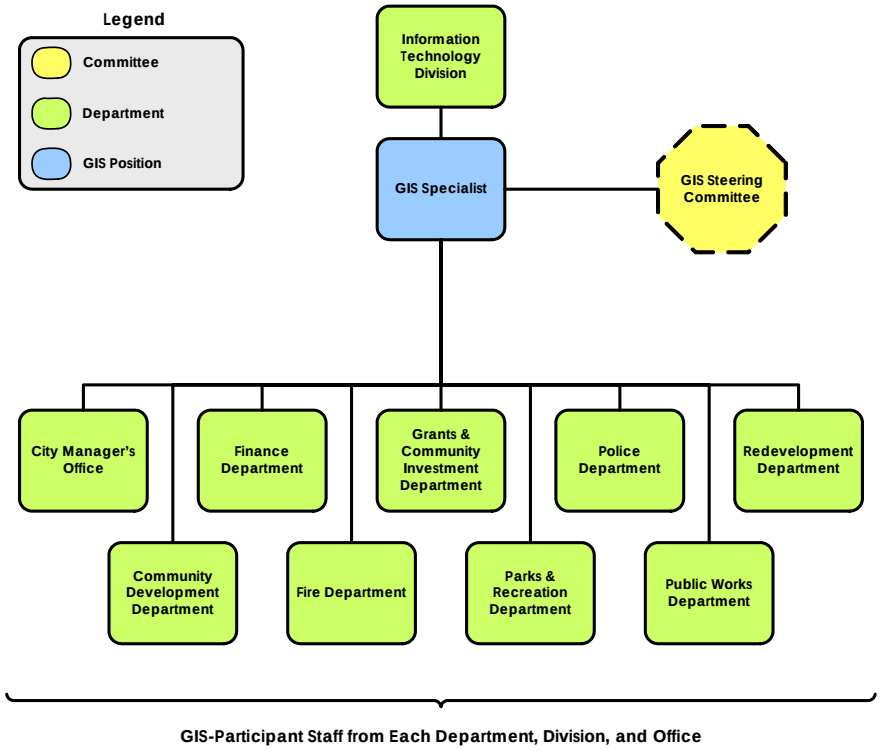
User Support positions are occupied by full-time GIS Analysts and GIS Specialists, as well as professionals with GIS skills. Full-time GIS Analysts and GIS Specialists typically have bachelor's degrees at a minimum, and often they have graduate degrees. In many cases, GIS is not their only skill set – they learned it in addition to another field of study. Salaries must

be in line with professional jobs in their area of focus. For example, a GIS Analyst in Public Works should receive a similar salary to an engineer in Public Works with similar education and work experience.

Department-specific professional staff positions that require GIS usage need to be addressed separately. Once GIS has been effectively integrated into the business processes of individual departments, employees with GIS skills become more valuable. Applicants with GIS skills should receive higher compensation than comparable candidates without GIS skills. Additional compensation should be dependent on the time and finances required to train an employee without previous GIS skills. It should be noted that time spent training is time that employees are not spending on their required job responsibilities. Current professional staff members that learn required GIS skills should also be appropriately compensated. Existing employees may be hesitant to take the time to learn these skills, as it will detract from their job responsibilities in the short-term. However, if GIS is effectively integrated into business processes, the amount of time spent training will be recouped by more efficient work facilitated by GIS. Additionally, employees become more marketable when they acquire new skill sets. In order to retain qualified staff that attains new marketable skills, it is prudent to appropriately compensate them.

Production/Data Collection positions can be difficult to properly staff. These positions (primarily filled by GIS Technicians) are primarily at the lower end of the GIS hierarchy. Nonetheless, qualified GIS Technicians are essential to GIS efforts. The work of a GIS Technician can be repetitive and uninteresting at times. The key to ensuring job satisfaction is to assign a variety of responsibilities, so that less satisfying tasks are interspersed with more challenging tasks. Effective production and data collection work requires knowledgeable employees. Although the manual tasks of digitizing, scanning, or GPS data collection are not terribly difficult during the actual performance of the task, prerequisite knowledge for proper setup, techniques, and post-processing is important. The City of West Sacramento should continue to utilize university students as interns or in co-op positions (cooperative partnership positions) to supplement the work performed by the GIS Specialist. This is mutually beneficial, as university students with GIS education have the background knowledge to successfully complete tasks, yet they are willing to accept lower salaries in return for gaining experience.

# City of West Sacramento
# Recommended GIS Organizational Structure



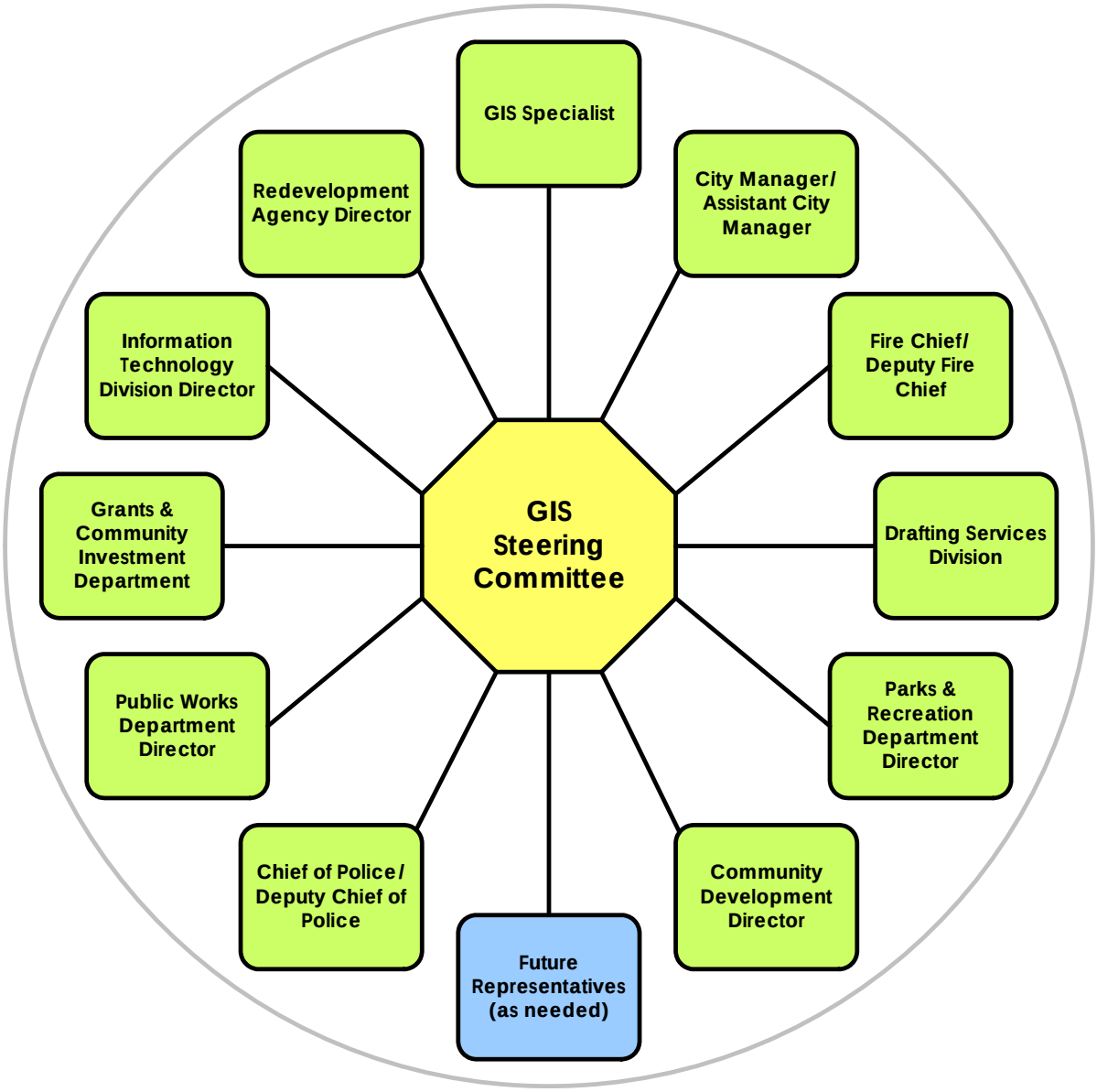

## GIS Steering Committee and Users Group

### Creation of a GIS Steering Committee for the City of West Sacramento

The City of West Sacramento should create a GIS Steering Committee. The GIS Steering Committee should be relied upon to guide GIS implementation development for the City. The GIS Steering Committee should meet on a monthly basis; however, as critical strategic issues are resolved, it may need to meet less often. The City of West Sacramento should ensure that its GIS Steering Committee consists of upper management and high-level GIS staff. A management-level employee from each major City of West Sacramento department should be on the committee. This committee ensures that GIS is implemented effectively throughout the organization and that enterprise-wide goals and objectives are being met.

The GIS Steering Committee provides critical, high-level commitment to investment in GIS. Each member of the committee will gain an understanding of the technology and feel some ownership for the City's GIS Implementation. These high-level participants will be indispensable during budgeting, and each will serve as a champion for GIS within his or her own department. Committee members will see the benefits of GIS, subsequently lobbying for greater utilization of the technology.

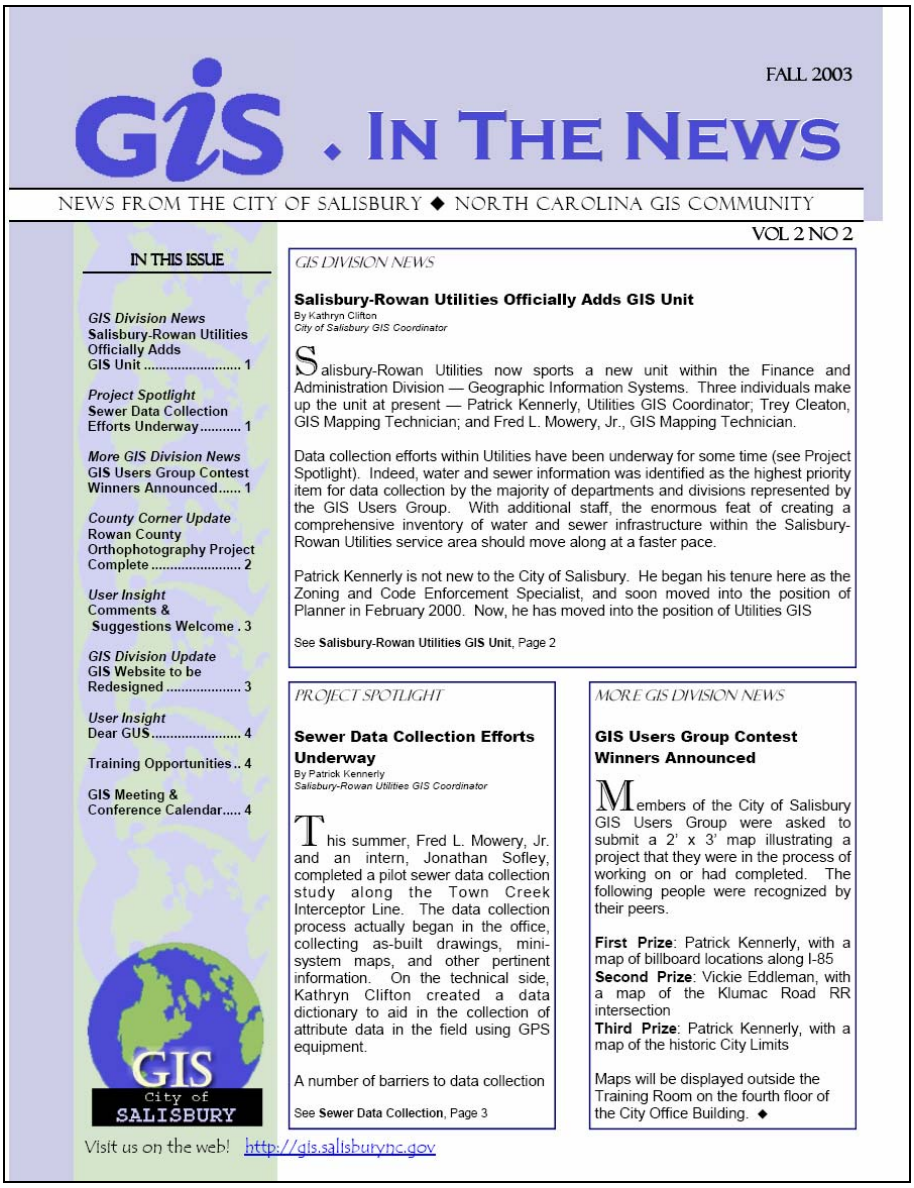
## City of West Sacramento
## Recommended GIS Steering Committee Representation




**Creation of a GIS Users Group**

The City of West Sacramento should create a GIS Users Group. The GIS Users Group should include GIS-utilizing staff from all departments with identified GIS needs. The GIS Specialist should lead this group. A GIS Users Group meeting provides an excellent opportunity for communication between all GIS users. It is a good venue for users to share their successes and failures. Duplication of efforts will be minimized and sharing of ideas and data will be optimized. A GIS Users Group is also a great platform for internal training initiatives.

In addition to GIS Steering Committee and GIS Users Groups, it will be beneficial for the City of West Sacramento to create a GIS Newsletter. Development of a GIS Newsletter should be supervised by the GIS Specialist, but there also must be contributions from each department that utilizes GIS on a regular basis. A GIS Newsletter will help foster communication between departments and help build support for increased GIS use.



FALL 2003

GIS . IN THE NEWS

NEWS FROM THE CITY OF SALISBURY ◆ NORTH CAROLINA GIS COMMUNITY

VOL 2 NO 2

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*GIS DIVISION NEWS*

**Salisbury-Rowan Utilities Officially Adds GIS Unit**

By Kathryn Clifton
*City of Salisbury GIS Coordinator*

Salisbury-Rowan Utilities now sports a new unit within the Finance and Administration Division — Geographic Information Systems. Three individuals make up the unit at present — Patrick Kennerly, Utilities GIS Coordinator; Trey Cleaton, GIS Mapping Technician; and Fred L. Mowery, Jr., GIS Mapping Technician.

Data collection efforts within Utilities have been underway for some time (see Project Spotlight). Indeed, water and sewer information was identified as the highest priority item for data collection by the majority of departments and divisions represented by the GIS Users Group. With additional staff, the enormous feat of creating a comprehensive inventory of water and sewer infrastructure within the Salisbury-Rowan Utilities service area should move along at a faster pace.

Patrick Kennerly is not new to the City of Salisbury. He began his tenure here as the Zoning and Code Enforcement Specialist, and soon moved into the position of Planner in February 2000. Now, he has moved into the position of Utilities GIS

See **Salisbury-Rowan Utilities GIS Unit**, Page 2

*PROJECT SPOTLIGHT*

**Sewer Data Collection Efforts Underway**

By Patrick Kennerly
*Salisbury-Rowan Utilities GIS Coordinator*

This summer, Fred L. Mowery, Jr. and an intern, Jonathan Sofley, completed a pilot sewer data collection study along the Town Creek Interceptor Line. The data collection process actually began in the office, collecting as-built drawings, mini-system maps, and other pertinent information. On the technical side, Kathryn Clifton created a data dictionary to aid in the collection of attribute data in the field using GPS equipment.

A number of barriers to data collection

See **Sewer Data Collection**, Page 3

*MORE GIS DIVISION NEWS*

**GIS Users Group Contest Winners Announced**

Members of the City of Salisbury GIS Users Group were asked to submit a 2' x 3' map illustrating a project that they were in the process of working on or had completed. The following people were recognized by their peers.

**First Prize**: Patrick Kennerly, with a map of billboard locations along I-85
**Second Prize**: Vickie Eddleman, with a map of the Klumac Road RR intersection
**Third Prize**: Patrick Kennerly, with a map of the historic City Limits

Maps will be displayed outside the Training Room on the fourth floor of the City Office Building. ◆

GIS City of SALISBURY

Visit us on the web! http://gis.salisburync.gov

**Sample GIS Newsletter (Courtesy of City of Salisbury, NC)**
(complete newsletter available at
http://gis.salisburync.gov/newsletter/october2003.PDF)

# Chapter 3 – Short–Term and Long–Term Strategies: Hardware, Networks, and Software

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## Hardware

### Desktop Computers

Like many organizations, the City of West Sacramento is continually upgrading personal computers. New software packages often require new computer hardware. Individual departments are budgeting replacements for their older PCs. Therefore, recommendations are given in this report that specify minimum and desired configuration of personal computers to run GIS applications. The City of West Sacramento needs to refer to these specifications to see if it will need to upgrade PCs to run specific GIS applications. Specifications will be looked at in two tiers.

- **Level One**: PCs to run robust GIS software such as ArcGIS (ArcEditor or ArcView)
- **Level Two**: PCs to run ArcIMS or MapObjects-based applications, such as an Intranet Data Browser and Desktop Data Browser

There is a difference between a typical personal computer and a GIS workstation. A typical personal computer for word processing is not likely appropriately configured for GIS use. A GIS workstation demands, at a minimum, a high-end processor, large amounts of RAM (memory), and large disk space.

In the short-term, it is important that all City of West Sacramento personnel that will utilize Level One computers are capable of effectively supporting recommended GIS applications. In the long-term, as more City of West Sacramento personnel begin to use Level 1 and Level 2 GIS applications, they should have access to computers that can effectively support these applications.

**Level 1 PC to Run ArcEditor and ArcView**

***Minimum Configuration***

***Approximate cost = $1,500 each***

- Windows 2000 Professional, Windows XP Professional Edition
- 1.2 GHz Pentium PC or Greater
- 512 MB of RAM or Greater
- 17” or Greater High Resolution Monitor
- 24x CD-ROM drive or greater

- 30 Gigabyte hard drive or greater
- 10/100 MBPS Ethernet Card
- 16 MB Video RAM or greater

***Recommended Configuration***
***Approximate cost = $2,250 each***

- Windows XP Professional Edition
- 2.8 GHz Pentium Processor or Greater
- 1 GB of RAM or Greater
- 19" or Greater High Resolution Monitor
- 48x CD-ROM Drive or Greater
- 80 Gigabyte Hard Drive or Greater
- 10/100 MBPS Ethernet Card
- 64 MB Video RAM or Greater

**Level 2 PC to Run ArcIMS or MapObjects-based Custom Applications**
***Minimum Configuration***
***Approximate cost = $1,000 each***

- Windows 98/NT/2000/XP
- 256MB of Ram or Greater
- 17" Monitor
- 700 MHz Processor or Greater
- 100 MB of Unused Disk Space or Greater
- CD-ROM Drive
- 10/100 MBPS Ethernet Card
- 8 MB Video Ram or Greater

***Recommended Configuration***
***Approximate cost = $1,500***

- Windows 98/NT/2000/XP
- 512 MB of Ram or Greater
- 19" Monitor or Greater
- 2.0 GHz Processor or Greater
- 100 MB of Unused Disk Space or Greater
- CD-ROM Drive
- 10/100 MBPS Ethernet Card
- 64 MB Video RAM or Greater

## Servers

The City of West Sacramento should continue to utilize its existing GIS server to host the City's GIS data and server-based GIS applications (ArcIMS). This server currently stores GIS data as flat files. As more GIS data are migrated to this environment, the server will need to be upgraded to have increased disk storage and faster processor capability. Should the City decide to migrate to a geodatabase-based GIS data maintenance model, it will be necessary to either migrate data to the City's SQL Server hardware or to convert the GIS Server to a standalone SQL Server/ArcSDE server.

In the short term, the GIS Server may be used to host ArcIMS for use in the City's Intranet GIS data browser. However, as utilization of this Intranet application increases across the enterprise, it will be necessary to migrate ArcIMS to a standalone server; in addition, the server may be used in the future to host the City's Internet GIS data browser application as well as other server-based applications. It is recommended that the GIS server store the

license system for concurrent licenses of ArcGIS utilized by the City of West Sacramento.* The existing GIS server has the following configuration:

| Component | Specification |
|---|---|
| **Processor** | Pentium III 997 MHz |
| **Memory** | 1 GB RAM |
| **Disk Storage** | 100 GB local |
| **Operating System** | Windows 2003 Server |
| **1st Network Adapter** | Onboard NIC |

***Figure 3-1: City of West Sacramento GIS Server Configuration***

**Subject to the Redevelopment Agency's procurement and development of the CATS application, it may be feasible to leverage the information technology infrastructure utilized for CATS to serve a dual role and provide a platform for the City's Intranet and Internet GIS data browsers.*

In addition to the GIS server, the City maintains an Intranet server. This server is currently used to host the City's Intranet and associated server-based applications such as Cold Fusion. The Intranet server has the following configuration:

| Component | Specification |
|---|---|
| **Processor** | Xeon 3.06 GHz |
| **Memory** | 2 GB RAM |
| **Disk Storage** | 136 GB local |
| **Operating System** | Windows 2003 Server |
| **1st Network Adapter** | Onboard NIC |

***Figure 3-2: City of West Sacramento Intranet Server Configuration***

As aforementioned, the existing GIS server configuration is adequate to meet the City's current and near-future data storage needs. However, as additional data are created/acquired and integrated into the City's GIS, additional disk storage may be required. It is recommended that the GIS server disk storage be increased, as needed, utilizing local disk storage. In addition, the server's processor may need to be upgraded in the future as well.

In the long term, the City of West Sacramento should procure another server to host the Intranet Data Browser application, Call/Complaint Tracking Application, and eventually the Internet GIS Data Browser. The recommended server is a Dell PowerEdge with the following minimum and recommended requirements:

| Component | Minimum Requirements | Recommended Requirements |
|---|---|---|
| **1st Processor** | 1.8 GHz/512K cache | 3.6 GHz/512 Cache |
| **2nd Processor** | None | 3.6 GHz/512 Cache |
| **Memory** | 1 GB RAM | 4 GB RAM |
| **1st Hard Drive** | 60 GB | 100 GB |
| **2nd Hard Drive** | None | 40 GB |
| **Operating System** | Windows 2003 Server | Windows 2003 Server |
| **1st Network Adapter** | Onboard NIC | Onboard NIC |

***Figure 3-3: Minimum and Recommended Server Requirements – Intranet/Internet GIS Data Browser***

The addition of this server will enable the City of West Sacramento to meet its GIS data and application serving needs. Once use of the Internet GIS Data Browser within the public reaches high levels, the City of West Sacramento should consider purchasing a third server to exclusively host the Internet GIS Data Browser.

## Notebook Computers

The recommended solution for field access to spatial data for the Fire and Police departments is the use of notebook computers. There are two hardware options for accessing GIS data in the field: hand-held computers and notebook computers. The primary advantage of hand-held computers is their small size, which allows for greater portability. The primary disadvantages of hand-held computers are their small-screen size, and limited memory capacity. Notebook computers have much more memory capacity and processing speed than hand-held computers, and also have much larger screens.

Ruggedized notebook computers are recommended for field personnel for access to GIS data in the field. Mounts for notebook computers should be installed in any vehicle that will contain a notebook computer. Mounting computers in vehicles makes them much easier to access and reduces wear on the machine. The mount should not be permanent, however, as notebook computers will need to be taken out of the field periodically to update data. Ruggedized notebook computers are more expensive than regular notebook computers, but the cost of ruggedized notebook computers is offset by their longevity.

The following is the recommended configuration for notebook computers:

***Notebook Computer – Approximate Cost = $2,500***

- Ruggedized
- Weigh Less than 5 Pounds
- 1.6 GHz Processor or Greater
- 12 Inch or Greater Anti-glare Display
- CD-ROM Drive
- 512 MB RAM or Greater

- 80 GB Hard Drive Space or Greater
- 10/100 MBPS Ethernet Card
- Wireless Network Adapter

The Police Department currently uses notebook computers for key field personnel. It is recommended that the Police Department retain existing notebook computers and purchase additional notebook computers as required; in addition, existing notebook computers should be upgraded to the aforementioned recommended configuration. A general recommendation is provided for the acquisition of a notebook computer by the Information Technology Division for use in the development and testing of applications and configurations that will be used by Fire and Police personnel in field notebook computers.

| Department/Division | Number of Units |
|---|---|
| Fire Department | 15 |
| Information Technology Division | 1 |
| Police Department | 15 |

***Figure 3-4: Notebook Computer Recommendations***

## Hand-held Computers

In the long term, it will prove beneficial to provide field staff with additional GIS capabilities via the use of hand-held computers. The hand-held computers should be able to support various relevant applications such as ESRI's ArcPad. The following is the recommended configuration for hand-held computers:

***Hand-Held Computers – Approximate cost = $500***

- RAM: 128 MB
- Operating System:
- Pocket PC, Pocket PC 2002, and Pocket PC 2003 (also known as Windows Mobile 2003 for Pocket PC)
- CPU Chips for Windows Pocket PC
  - Hitachi SH3 and SH4
  - XScale
  - StrongARM
  - MIPS
  - X86
- GPS Support
  - National Maritime Electronics Association
  - Trimble
  - Delorme Earthmate
  - Rockwell

The aforementioned configuration for hand-held computers should be adequate in the short-term. However, hand-held computers are becoming increasingly faster and capable of supporting larger memory. All relevant departments should invest in new, faster hand-held computers as needs and demand dictate. A general recommendation is provided for the acquisition of hand-held computers by the Information Technology Division for use in the development and testing of applications and configurations that will be used by personnel that utilize GIS in hand-held computers.

| Department/Division | Number of Units |
|---|---|
| Engineering Division | 4 |
| Facilities Development and Maintenance Division | 3 |
| Information Technology Division | 2 |
| Parks & Recreation Department | 3 |
| Police Department | 3 |
| Public Works Department | 12 |

***Figure 3-5: Hand-held Computer Recommendations***

A general recommendation is provided for the provision of hand-held computers at the discretion of each department/division, based on guidance and support from the GIS Specialist and Information Technology Division. It is recommended that the City invest in acquiring notebook computers with GIS data browsers prior to investing in hand-held computers; by doing so, departments/divisions will have access to systems with memory and processing speed adequate for field-based GIS applications.

## Data Capture Devices

### GPS Receivers

The City's Drafting Services Section utilizes a Leica GS50+ GPS receiver with Leica's GIS DataPro software. The potential utilization of GPS for data capture covers a wide range, from mapping grade GPS receivers, such as those used by the Drafting Services Section, to less accurate, lower-grade GPS receivers. It is recommended that one additional mapping-grade GPS receiver be procured as a shared resource for the GIS Specialist and departments that require field collection of high-accuracy data. In addition, it is recommended that a basic hand-held GPS received be procured for use by the GIS Specialist (and GIS Intern). The GIS Specialist will regulate the use of GPS resources and provide ad hoc assistance as needed by each department.

In addition, the City of West Sacramento will eventually need to acquire GPS receivers for use in vehicles and field equipment. The utilization of these units will vary according to department. It is recommended that departments utilize these GPS receivers to their full capability by implementing several tracking applications, such as Automatic Vehicle Location (AVL) tracking. Use of AVL is especially valuable for the facilitation of emergency response management typically addressed by Fire and Police departments.

Field-mounted GPS receivers will need to be configured and linked, as needed, to City of West Sacramento computing resources, including computer systems (hand-held computers, notebook/tablet computers, workstations, and servers), networks, and enterprise-wide databases.

## Output Devices

### Printers

It is important that the City's GIS users have the means to print maps and documentation generated from these applications. Every GIS user should have access to a high-resolution color printer, to print 8"x11" or 8"x14" maps. In the short-term, each GIS user should have access to at least one networked color printer, even if it is not in their immediate work space. Initially, one 11"x17" color printer is recommended for use by the GIS Specialist and the

Information Technology Division. As output demand increases, additional color printers should be purchased for appropriate departments and users.

## Plotters

It is important that Level One GIS Application users (ArcEditor and ArcView) have access to wide-format plotters. Many maps must be output onto large sheets to be properly visualized. The following are recommend specifications for wide format plotters:

HP 1055

***Plotters – Approximate Cost = $7,000***

- 36" or Greater Paper Sheet Size
- 64 MB of Built-in RAM
- 7.5 GB Hard-drive
- 1200 dpi Addressable Resolution
- Adobe PostScript 3 Capability

The City currently maintains three plotters and one large format printer: three HP DesignJet 1055 CM plotters and one Xerox Phaser 790 color printer located in the Engineering Division. The Information Technology Division, Engineering Division, and Police Department each have one of the HP plotters. These three plotters are adequate to address most, if not all, of the City's wide-format GIS printing needs. Two additional plotters may also be required in the future as Level One GIS utilization in the City expands and departmental needs for wide-format printing increase.

## Networks

The City of West Sacramento must maintain and manage optimal networking of computers. A major challenge for many enterprise-wide GIS efforts is inadequate network speed (capacity). GIS data are usually quite large, and often such large data sets can slow a network considerably, thereby rendering GIS applications non-functional.

The City is connected to an SBC Central Office (CO) via multiple PRI T1 lines. Currently there are T1 connections between all City buildings, with the exception of the Police Department, which has a dedicated fiber connection. Existing 1 GBPS fiber connections between some buildings will prove beneficial to the implementation effort, and it is recommended that in the future all network connections between buildings be upgraded to this standard. The existing network infrastructure is adequate for current GIS needs, but more network bandwidth will be required as data access and distribution needs increase in the near future. The City's LAN should be increased in the future to 1 GB Ethernet connectivity for those users that transfer large amounts of data.

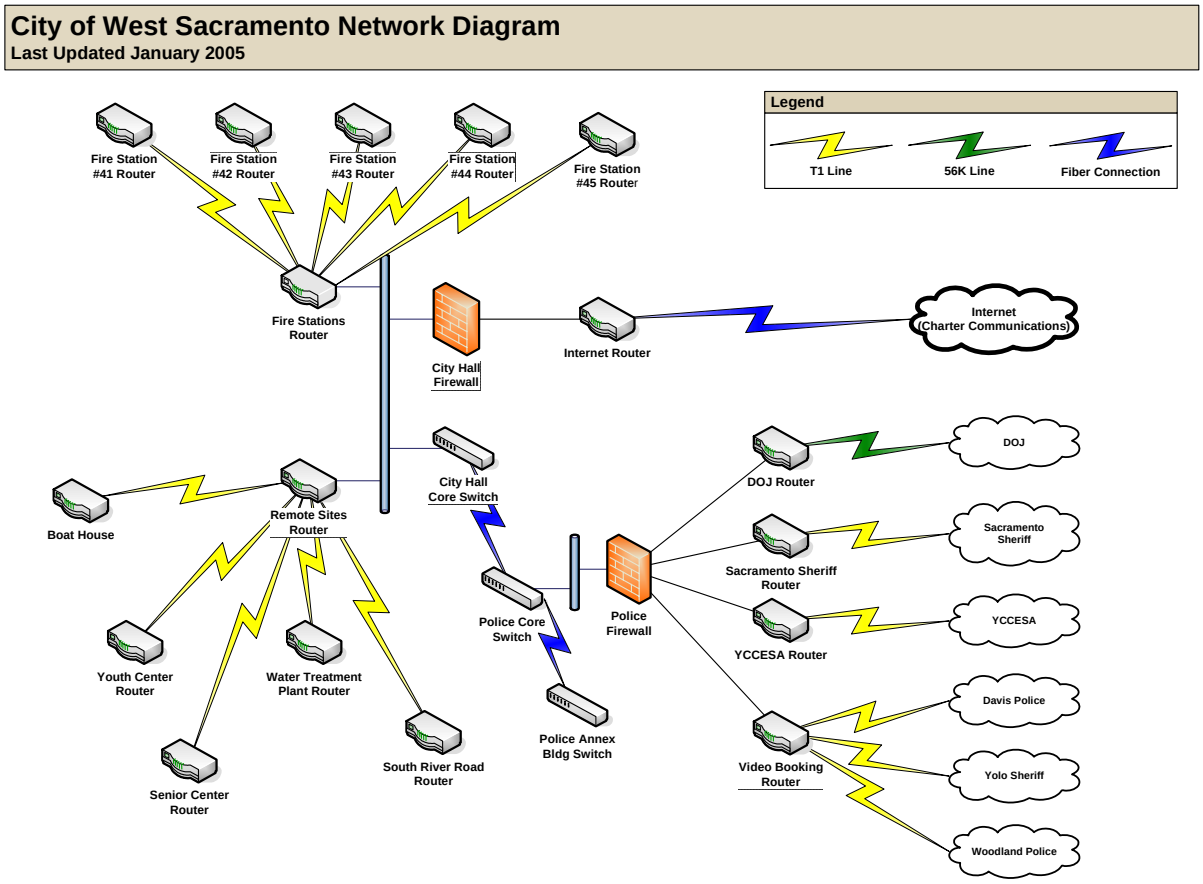



***Figure 3-1: City of West Sacramento High Speed Network Infrastructure***

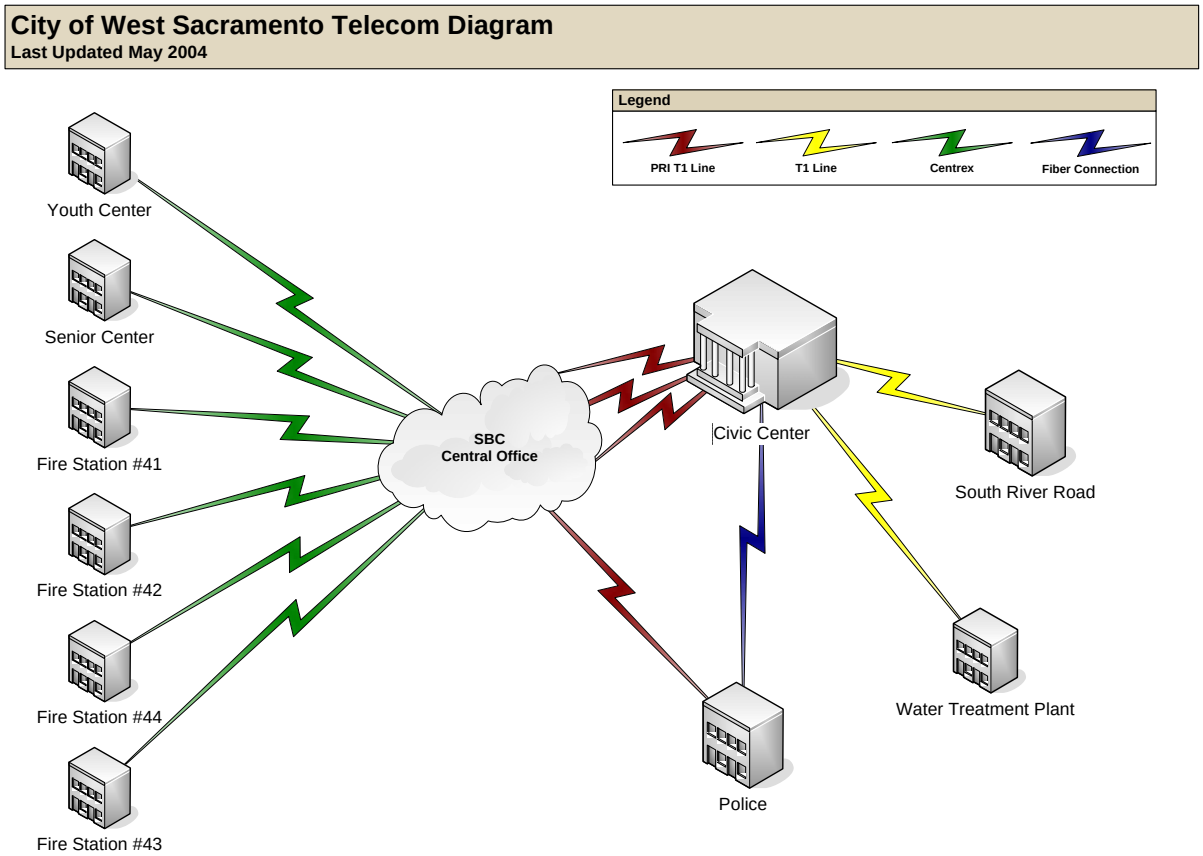



***Figure 3-2: City of West Sacramento Telecommunications Infrastructure***

## Software

The City of West Sacramento currently maintains the following software that can be used as part of the City's GIS:

| Software | Version | Number of Licenses | Department(s) |
|---|---|---|---|
| **ArcIMS** | 9 | 1 | Information Technology |
| **ArcView** | 9 | 11 | Drafting Services (2)<br>Information Technology (1)<br>Planning (1)<br>Police (1)<br>Redevelopment (2)<br>*Extra License (1) |
| **ArcView** | 3.x | 3 | Information Technology (3) |
| **AutoCAD LT** | 2005 | 2 | Drafting Services (2) |
| **AutoCAD Map 3D** | 2005 | 1 | Drafting Services (1) |
| **AutoDesk Land Desktop** | 2005 | 6 | Engineering Division/Drafting Services (6) |

The City recently upgraded ESRI GIS software to the latest version available (ArcIMS 9; ArcView 9). It is recommended that a standard be established for the maintenance and

management of software licenses; this standard will ensure that all GIS users have the same version of a specific type of software.

In addition to the aforementioned ESRI software products, each department maintains various GIS-capable applications that incorporate a spatial component or integrate with ESRI software. These applications are department-specific and provide users with the ability to import, integrate, and extract GIS data. These applications should be upgraded and configured, as necessary, to ensure that they are compatible with the new versions of ESRI software that have been recommended.

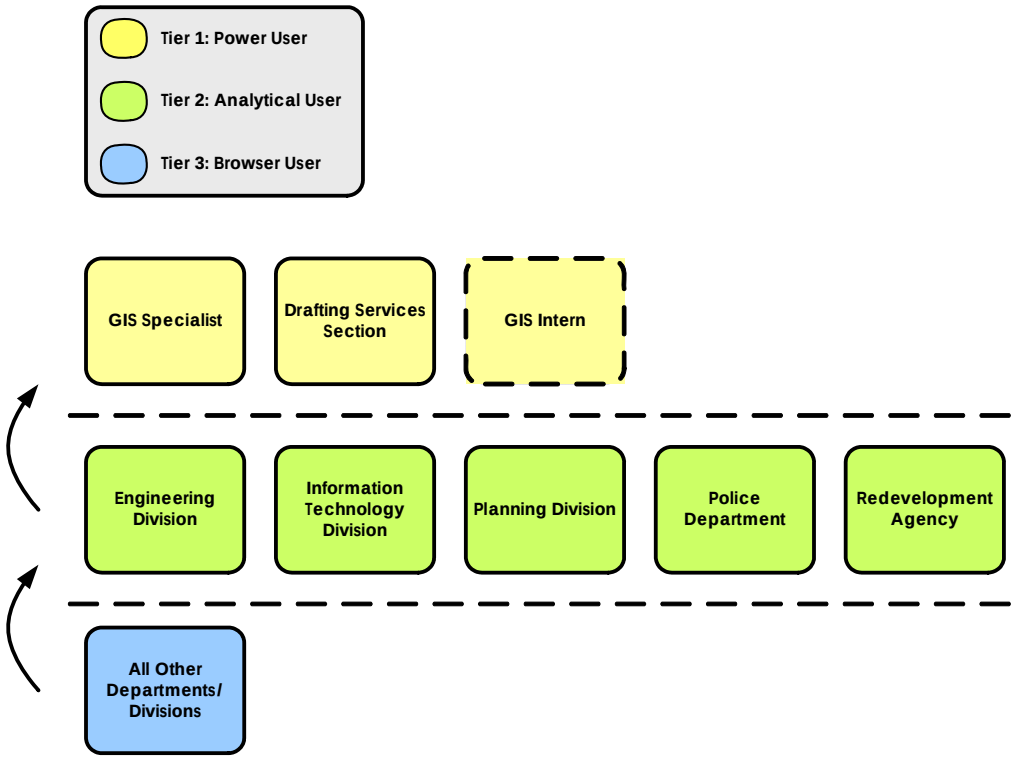
Additional GIS software recommended for the City of West Sacramento (applications are described in Chapter 1 – Departmental GIS Needs Assessment: Enterprise-Wide Applications or in specific needs assessments) includes:

| Department/Division | Software | Recommended Number of Licenses | Recommended Year of Purchase | Long-Term Opportunity for More Users? |
|---|---|---|---|---|
| Building Division | Intranet GIS Data Browser | 3 | 1 | Yes |
| City Manager's Office | Intranet GIS Data Browser | 3 | 1 | Yes |
| Drafting Services Section | Intranet GIS Data Browser | 3 | 1 | Yes |
| Drafting Services Section | GISConnect | 2 | 1 (or 2) | Yes |
| Engineering Division | Intranet GIS Data Browser | 26 | 1 | Yes |
| Engineering Division | ArcView 9 | 1 | 2 | Yes |
| Engineering Division | Cartegraph Suite | 1 | 1 | Yes |
| Engineering Division | ArcPad 6 | 5 | 1 | Yes |
| Facilities Development and Maintenance Division | Intranet GIS Data Browser | 8 | 1 | Yes |
| Facilities Development and Maintenance Division | ArcPad 6 | 2 | 1 (or 2) | Yes |
| Finance Department | Intranet GIS Data Browser | 10 | 1 | Yes |
| Fire Department | Intranet GIS Data Browser | 35 | 1 & 2 | Yes |
| Fire Department | Reverse 911 (Code Red) | 1 | 2 | Yes |
| GCI Department | Intranet GIS Data Browser | 2 | 1 | Yes |
| Information Technology Division | Intranet GIS Data Browser | 6 | 1 | Yes |
| Information Technology Division | Safe FME | 1 | 1 | Yes |
| Information Technology Division | ArcPad | 2 | 1 | Yes |

| Department/Division | Software | Recommended Number of Licenses | Recommended Year of Purchase | Long-Term Opportunity for More Users? |
|---|---|---|---|---|
| Information Technology Division | ArcSDE 9 | 1 | 1 (or 2) | Yes |
| Information Technology Division | ArcGIS Extensions | 1 | 2 | Yes |
| Parks & Recreation Department | Intranet GIS Data Browser | 10 | 1 | Yes |
| Parks & Recreation Department | ArcPad 6 | 7 | 2 & 3 | Yes |
| Planning Division | Intranet GIS Data Browser | 6 | 1 | Yes |
| Planning Division | Planning Support System | 1 | 2 | No |
| Planning Division | Public Access Kiosk | 1 | 1 (or 2) | Yes |
| Police Department | Intranet GIS Data Browser | 25 | 1 | Yes |
| Police Department | GIS Data Browser (including PIN mapping) | 5 | 1&2 | Yes |
| Police Department | Mobile GIS Data Browser | 15 | 2 (or 3) | Yes |
| Police Department | ArcPad 6 | 3 | 2 | Yes |
| Police Department | Reverse 911 (Code Red) – see Fire Department | 1 | 2 | Yes |
| Police Department | Public Access Kiosk | 1 | 2 (or 3) | Yes |
| Public Works | Intranet GIS Data Browser | 12 | 1 | Yes |
| Public Works | Haested Methods Modeling Suite | 2 | 2 & 3 | No |
| Public Works | ArcPad 6 | 12 | 1 & 2 | Yes |
| Public Works | Reverse 911 (Code Red) – see Fire Department | 1 | 2 | Yes |
| Redevelopment Agency | ArcView 9 | 4 | 1 & 2 | Yes |

The following diagram provides a general overview of the expected types of GIS use within each department/division. It should be noted that the classification is based on the current utilization of GIS within each department/division. Departments/divisions are expected to move into different tiers as GIS utilization within the City increases.

**City of West Sacramento**
**Multi-tier GIS Software Users by Department**



# Chapter 4 – Base Map Creation and Consideration

In This Chapter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## Base Map Benefits

For local governments, the acquisition and integration of an accurate and up-to-date parcel base map is arguably the critical centerpiece of a City's GIS effort. The successful deployment of a comprehensive parcel/ownership ("cadastral") base map requires careful planning and consideration of its proposed and anticipated uses. Technological developments and advanced applications that can affect these considerations include: controlled digital image and planimetric feature overlays (hydrology, water utility features, pavement outlines, building footprints, etc.), and emergency vehicle location and routing through real-time GPS tracking (AVL/AVI). Subsequent attempts to accommodate unanticipated data and/or application needs, which are dependent upon or associated with the quality and accuracy of the original base map, can be extraordinarily time-consuming and cost-prohibitive.

Several immediate and long-lasting benefits normally derived from parcel base map integration include:

- A comprehensive inventory and accounting of all taxable land
- Comparisons of deeded and calculated (actual) acreage
- Inventory and determination of City-owned lands and conveyances
- Verification of tax rolls & incorporation of City annexations, providing checks-and-balances of appraisal entity records
- Provides a strong foundation for control of future growth, land development, and population forecasting
- Fosters closer cooperation with other local governmental entities

Among the more tangible and practical benefits emerging from the parcel base map:

- City mailing lists & affected property owner notifications (i.e., zoning changes, floodway notification)
- Improved Police/Fire response and emergency evacuation

- Readily available property ownership information
- Property valuations and City service expansion/prioritization
- Floodway management & building code enforcement
- Creation of City Map Books and Atlases

# Tax Parcels

## History & Current Status

The City of West Sacramento maintains its own parcel map. A legacy base map solely comprised of lines is currently maintained, but it is expected that this map will no longer be maintained in the near future. A new base map that includes parcels is regularly updated by the Drafting Services Section—this base map is accurate within ±5 Feet within city limits. One of the priorities for the City's GIS implementation effort will be migration away from maintenance of the legacy base map. A general recommendation is provided for the migration to occur within the first six months of the first year in the current GIS implementation; the Drafting Services Section and GIS Specialist will need to coordinate the prioritization of data development efforts with this objective in mind.

The City submits its parcel files to a vendor that serves as a central repository for parcel maps for members of the Yolo GIS Cooperative; this vendor processes and integrates the parcel geometries to create a cohesive county-wide parcel map. This county-wide parcel map is then redistributed back to the cooperative member organizations, including the City of West Sacramento. A "Yolo GIS Cooperative Basemap Management Plan" was released by the Cooperative in December 2002. This plan, prepared by an outside consultant, provides the basis of the management plan and includes specifics about program strategy, development, maintenance, and associated costs. An RFP for the compilation, adjustment, and maintenance of the Cooperative's parcel files was released in March 2003. The consultant initially selected to perform this work is continuing to provide support for this effort at present.

Tax assessment data is acquired from the County Assessor twice a year, once in March and once in July. County tax information is linked to the City parcels by the APN (Assessor's Parcel Number).

The Drafting Services Section maintains all base map layers, including the parcel layer, in the AutoCAD environment; utilizing CADD object data, the parcel layer has attributes associated with it. Attributes maintained for this parcel layer include APN, Situs, City, and ZIP Code (see Figure 4-1)

At present, several departments, including the Community Development Department and Redevelopment Agency, utilize the parcel map data. This data is made available by the Drafting Services Section; the data is also maintained in a derivative version as a Shapefile. The City expects to continue to maintain its parcel layer in the AutoCAD and ArcView environments, utilizing CADD object data to reference attribute information, and AutoCAD Map and ArcView to create parcel-based maps.

OD:YOLO_parcels

| | |
|---|---|
| APN | 046 351 01 |
| AREA | 4616.6554 |
| BOOKPAGES | 046 351 |
| BOUNDARY | LL |
| CENTROID_X | 0.0000 |
| CENTROID_Y | 0.0000 |
| CITY | WEST SACRAMENTO |
| CITY1 | WEST SACRAMENTO |
| HYPERLINK | |
| LOTNUM | |
| MODDATE | 2003 926 |
| OBJECTID | 6043 |
| OVERLAY | |
| PERIMETER | 291.8385 |
| REVDATE | 200012 7 |
| SITUS | 1650 RANDOLPH RD |
| SITUSGEO | |
| SITUSNAM_1 | RANDOLPH RD |
| SITUSNUM_1 | 1650 |
| SITUSSUFFI | |
| SUBNAME | |
| YEAR_ | 01/02 |
| ZIP | 95691 |
| ZONE_ | |

***Figure 4-1: Parcel Layer Attributes***

## Recommendations

There are five primary recommendations for the management and maintenance of City of West Sacramento tax parcels:

1. Continued Data Sharing between the City of West Sacramento and Yolo County
2. Integration of Geo-Spatial Data to a Centralized Data Store
3. Consolidation of Tax Assessment Data with the City's Parcel Layer
4. Implementation of Standards for All Geo-Spatial Data
5. Implementation of an Alternate Key for the Parcel Layer

☑ Continued Data Sharing between the City of West Sacramento and Yolo County

Based on the City's existing relationship with Yolo County and the GIS Cooperative, it is recommended that the City continue to work closely with the County on the sharing and maintenance of the City's parcel layer. The City's membership in the Cooperative is a great asset that should yield continuing benefits during the City's GIS implementation.

The Yolo GIS Cooperative Basemap Management Plan outlines several alternatives for managing a county-wide base map:

*Alternative 1: Centralized Management*

This alternative represents the centralization of base map updating with a lead agency, and other Cooperative members receiving updates from the central point of updates. In this alternative, the County is the lead agency responsible for base map maintenance and distribution. The cities will collect and forward to the County standardized digital base map data that they originate through their administrative processes. Updates will be made to a master database by the County and accessed by the Cooperative members for use as needed.

*Alternative 2: Distributed Management*

This alternative distributes the base map management responsibility among each Cooperative member agencies. Each member agency will perform the base map maintenance functions and submit the updated base maps to the County. The member agencies are responsible for the compliance with the standardized base map specifications. The County will aggregate the individual base maps into a composite parcel base map and distribute to all the member agencies.

*Alternative 3: Outsourced Maintenance Services*

This alternative represents the centralization of base map updating with the outsourced maintenance services, and other Cooperative members receiving updates from the central point of updates. A contractor under the direction of the Cooperative performs the base map maintenance and distribution. The cities will collect and forward to the contractor standardized digital base map data or hardcopy information that they originate through their administrative processes. Updates will be made to a master database by the contractor and accessed by the Cooperative members for use as needed.

Based on the City's current maintenance of the parcel layer, which is efficient and effective, it is recommended that the City continue to utilize the existing parcel maintenance model (a hybrid of the three alternatives listed above). As part of the City's ongoing effort to produce and maintain a comprehensive and up-to-date parcel layer, it is recommended that the City implement a quarterly (or semi-annual) parcel audit schedule. This schedule will establish a timeline for quality assurance (QA) of the parcel layer. During each quarterly (or semi-annual) audit, the City should conduct detailed geo-spatial data audits and inventories in cooperation with Yolo County. The primary goal of these audits is to verify that all parcel

boundaries are up-to-date and that the corresponding assessment data is properly referenced.

The City's GIS Steering Committee will need to meet periodically to determine if any additional audit or verification criteria are needed. Each department should participate in ongoing evaluation of the parcel layer and its corresponding attributes to determine if any additional modifications or additions to the dataset are needed.

☑ Integration of Geo-Spatial Data to a Centralized Data Store

All City of West Sacramento departments will benefit from access to a single, up-to-date, and accurate digital tax parcel layer. In addition, other geo-spatial data products derived from parcel data need to be consolidated and centrally distributed to eliminate duplicate and disparate versions of the same data (this includes geo-spatial data maintained for department specific projects). In order to seamlessly distribute tax parcel data to appropriate City of West Sacramento users, the tax parcel layer, or a copy of the tax parcel layer, should be maintained in an ESRI ArcGIS enterprise geodatabase or as ESRI Shapefiles. Although the Drafting Services Section will continue to maintain the parcel layer in the AutoCAD environment, the distribution of this layer to other departments, especially via an Intranet GIS Data browser, will require that the layer and its corresponding attributes be maintained in a central data store that can be easily read and accessed by a variety of GIS applications.

An enterprise geodatabase format is the native spatial data format used in ESRI and ESRI-based applications. This format stores all spatial and attribute data in one centralized location, within a commercial relational database management system (RDBMS). The City's existing SQL Server database is ideal for establishing a geodatabase. It should be noted that enterprise geodatabases require ESRI's ArcSDE to access spatial and attribute data stored within the RDBMS, thus continued the City will need to acquire and maintain ArcSDE; ArcSDE will be required as long as the City intends to maintain data in the geodatabase format. One of the great advantages that the City will gain in utilization of a geodatabase is the ability to perform high-end queries of attribute data in an enterprise database system. In addition, much of the attribute data can be integrated into web applications that do not necessarily need a mapping interface—the Information Technology Division could develop standalone applications utilizing web development tools such as Cold Fusion.

There are several workflows that may be used for the maintenance and dissemination of the parcel layer (as well as other base map layers). One potential workflow is based on integration of the parcel layer to a centralized geodatabase through the implementation of Haestad Methods' GISConnect software. GISConnect is a software module that allows users to view and modify geodatabase layers in the AutoCAD environment. Although the layer is maintained in a geodatabase, it is loaded seamlessly as a CADD layer; this seamless integration will allow the Drafting Services Section to continue to utilize AutoCAD to maintain the parcel layer and other base map layers (see Street Centerlines below). GISConnect also works with Shapefiles (i.e., it does not require a geodatabase).

Another potential workflow is based on the utilization of a data translation application (or utility) that will convert CADD data to Shapefile or geodatabase format. A data translation application, such as Safe software's FME, can be utilized to do nightly conversion of the CADD-based parcel layer to Shapefile or geodatabase format; the derivative layer(s) can be maintained in a central directory that is accessed by various applications, including an Intranet GIS data browser. FME is an ETL (Extract, Transform, and Load) application that can convert data to and from a multitude of spatial and non-spatial formats. This workflow will

enable the Drafting Services Section to continue to maintain base map layers in the AutoCAD environment, while providing an intermediary set of data that can be used to fulfill the GIS data needs of various departments. This workflow relies on having the attributes (object data) stored within the Shapefiles or geodatabase.

A variation of the aforementioned workflow is the conversion of CADD layers to the Shapefile format and the maintenance of attributes in SQL Server. This workflow will rely on a data conversion application, but will maintain feature geometries and attributes in separate formats. A database relate, or a set of derivative Shapefiles, will allow for the joining of attributes to feature geometries. This workflow allows for the database functionality of SQL Server to be leveraged, without the need for a spatial data gateway such as ArcSDE.

Subject to the potential acquisition and implementation of a geodatabase, proper training on the installation, configuration, maintenance, and management of the City's geodatabase will be critical. It is recommended that the GIS Specialist work with staff in the Information Technology Division to ensure that relevant technical staff receives adequate training. After implementation of the enterprise geodatabase, other GIS users may need training and guidance on access and data management within the geodatabase context.

☑ Consolidation of Tax Assessment Data with the City's Parcel Layer

A potential means of augmenting the parcel layer is to consolidate the County's tax assessment data with the parcel layer more frequently. This consolidation will create a comprehensive tax parcel layer that provides more up-to-date ownership and assessment information. As aforementioned, at present the City receives a tax roll database extract from the County Assessor on a bi-annual basis; the City is required to pay for this data.

It is recommended that the City explore the possibility of acquiring the assessment data on a more frequent basis, either by working with the GIS Cooperative to determine if a cost-sharing strategy, or a subsidy, can be established to enable the City to acquire the data without paying on an incidental basis. The rationale for payment for this data is to support the County Assessor's work in maintaining the information. This issue may be politically sensitive, and thus the recommendation is provided with the qualification that additional support and assistance may be required from the City Attorney and/or City Manager. The objective of consolidation of tax assessment data with the City's parcel layer may be reached in the long term.

☑ Implementation of Standards for All Geo-Spatial Data

Another critical issue in the City's GIS efforts is the implementation of geo-spatial data standards. In addition to the standards established by the GIS Cooperative, it is recommended that the GIS Specialist and the Drafting Services Section develop standards for the maintenance of the City's parcel layer. Using a common standard will enable the City to operate more efficiently by providing a common structure for the layer and its derivative products, as well as by enabling streamlined data distribution internally and externally.

The City will need to develop geo-spatial data standards, including layer and directory naming conventions, directory structures, metadata, and index conventions. It should be noted that these standards do not apply solely to parcel data and its derivative products, but rather that these standards will apply and support all enterprise geo-spatial data.

Layer Naming Convention: LD_<SCALE>_<LAYER NAME>_<VERSION>_<REVISION>

*Example:* *LD_24000_FIRESTATIONS_2_1*

Directory Naming Convention:

🗀**<DEPARTMENT>**
- 🗀 <THEME A>
- 🗀 <THEME B>
  - 🗀 <SUBTHEME A>
  - 🗀 <SUBTHEME B>

*Example:*

🗀***FIRE***
- 🗀*FIRE_STATIONS*
- 🗀*RESPONSE_AREAS*
  - 🗀*CITY_AREAS*
  - 🗀*WILDLAND_AREAS*

***Layer and Directory Naming Conventions***

Implementation of an Alternate Key for the Parcel Layer

Given the lag in time between the approval of a parcel map and the assignment of a parcel ID (APN), it is recommended that the City implement an alternate key for the management of the parcel layer. At present, the APN is relied upon as the primary key; the addition of a secondary key, will allow t he Drafting Services Section to assign a unique internal ID. In doing so, the Drafting Services Section will facilitate the tracking and oversight of changes to the parcel map, without requiring an APN that may not yet have been assigned. This alternate key can be referenced within the layer itself (object).

# Orthophotography

## History and Current Status

Digital orthophotography (aerial photographs) can be useful as a backdrop to a GIS, with overlays of parcel, street centerline, or other thematic data. Digital orthophotography is a valuable asset to an organization such as the City of West Sacramento.

Digital orthophotography is inherently disk-consuming and process-intensive. These files can be difficult to manipulate and they have the potential to slow down networks significantly. The most up-to-date orthophotography available to the City of West Sacramento is color aerial orthophotography, acquired in April of 2004 for the City of West Sacramento by AirPhoto USA. 1":400' (2' pixel resolution) color orthophotos were acquired for the City of West Sacramento. Deliverables included digital data in TIFF format. The City has since converted this data to MrSID format as well (compressed for speed with ArcIMS).

***City of West Sacramento Orthophotography Data Sets***

| Month | Year | Color/B&W | Resolution | Format(s) | Extent |
|---|---|---|---|---|---|
| April | 2004 | Color | 2'/ pixel | TIFF, MrSID | West Sacramento (approx. 80 square miles) |
| April | 2000 | B&W | 1'/ pixel | TIFF | West Sacramento |

## Recommendations

The City intends to continue acquiring high-resolution color orthophotos of the City from AirPhoto USA every two years. Although the data storage requirements are large for such

data, it is recommended that the City continue to acquire orthophotographs as scheduled. Although not required, an optimal resolution for digital orthophotography is 0.5' per pixel; acquiring digital orthophotography at this resolution may be cost prohibitive, especially if the City procures this data by itself. However, City personnel indicated that it may be possible to acquire higher resolution imagery by cost-sharing through the GIS Cooperative. It is recommended that the City work with the GIS Cooperative to determine if acquisition of higher resolution digital orthophotography (either 1.0' per pixel or 0.5' per pixel is feasible). The acqusition of higher resolution imagery will provide a more accurate and detail set of base data from which other layers can be produced.

***Figure 4-2: Example of color orthophotography***

It is recommended that the City utilize this type of spatial data to derive and generate new GIS data layers, including planimetrics (see Figure 4-3 below). In addition, it is recommended that the City explore the possibility of performing change detection analysis using chronologically sequential digital orthophotgraphs (see Figure 4-4 below). Change detection analysis can be used to assess and evaluate physical changes with regard to physicial geography and land use.

| | |
|---|---|
| Alley | Paved Road |
| Bridge | Playground |
| Building | Pool |
| Cemetery | Railroad |
| Construction Area | Railroad Signal |

| | |
|---|---|
| Culvert | Recreation Area |
| Culvert Inlet | Recreation Court |
| Dam | Recreation Path |
| Drainage | Sidewalk |
| Driveway | Sign |
| Electrical Pole | Slab |
| Fire Hydrant | Stream |
| Golf Course | Street Light |
| Gravel Parking | Traffic Light |
| Gravel Road | Trail |
| Heliport | Trees |
| Lake | Wall |
| Mobile Home | Wash |
| Paved Parking | |

***Figure 4-3: Typical Planimetrics Derived from Digital Orthophotography***

*Past*

*Present*

***Figure 4-4: Example of change detection using sequential orthophotography***

It is recommended that the City of West Sacramento continue to utilize existing digital orthophotography in a compressed format (MrSID). Traditional digital orthophotography formats, such as TIFF, are inherently large and take up much disk space. Compressed orthophotography aids the end user in the quick retrieval of information. In addition, the use of the digitally re-sampled orthophotography enables quicker printing and plotting. The display of compressed orthophotography can be configured to be scale-dependent. Using this configuration, end users view a map that displays the appropriate, higher-resolution imagery at a certain scale threshold. By maintaining orthophotography in a compressed format, the City will be able to distribute its digital orthophotography to remote sites more efficiently.

***Figure 4-5: Example of black and white orthophotography***

# Street Centerlines

## History and Current Status

The City of West Sacramento currently has a digital street centerline layer with associated address range attributes. The layer is maintained in the CADD environment by the Drafting Services Section. The street centerline layer historically was maintained by the Drafting Services Section as a line layer with associated text. Working with SACOG, the City has acquired a new street centerline layer that is a derivative product of the City's street centerline. The SACOG-based street centerline layer is part of a GIS Cooperative effort aimed at developing a layer that can be used for the US Census Tiger Line files. SACOG's data processing is aimed at re-attributing address ranges and rectifying geographies, as needed, to fall within Right of Ways (ROWs). The street centerline layer exists as a dynamic master layer that remains static when the layer is submitted to SACOG; essentially there is a moratorium on data editing by the Drafting Services Section, until a revised street centerline layer is returned by SACOG. Although the layer is maintained as a CADD file, it is exported for delivery to SACOG as a Shapefile, and received from SACOG as a personal geodatabase (see Figure 4-4).

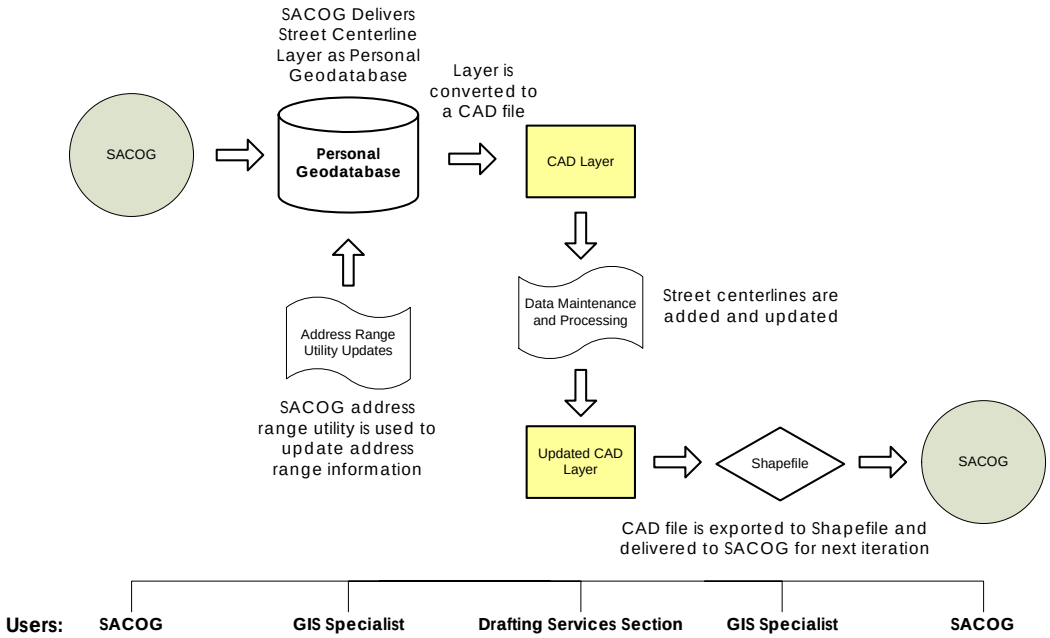


***Figure 4-6: Street Centerline Data Thread***

SACOG recently delivered the latest version of the street centerline layer to the City, along with a custom-developed tool that allows for the updating of address ranges in the ArcGIS environment (see Figure 4-5). Updates to this layer are performed on a frequent basis by the GIS Specialist; it is expected that a GIS Intern will assist with the effort of updating and rectifying the street centerline layer.

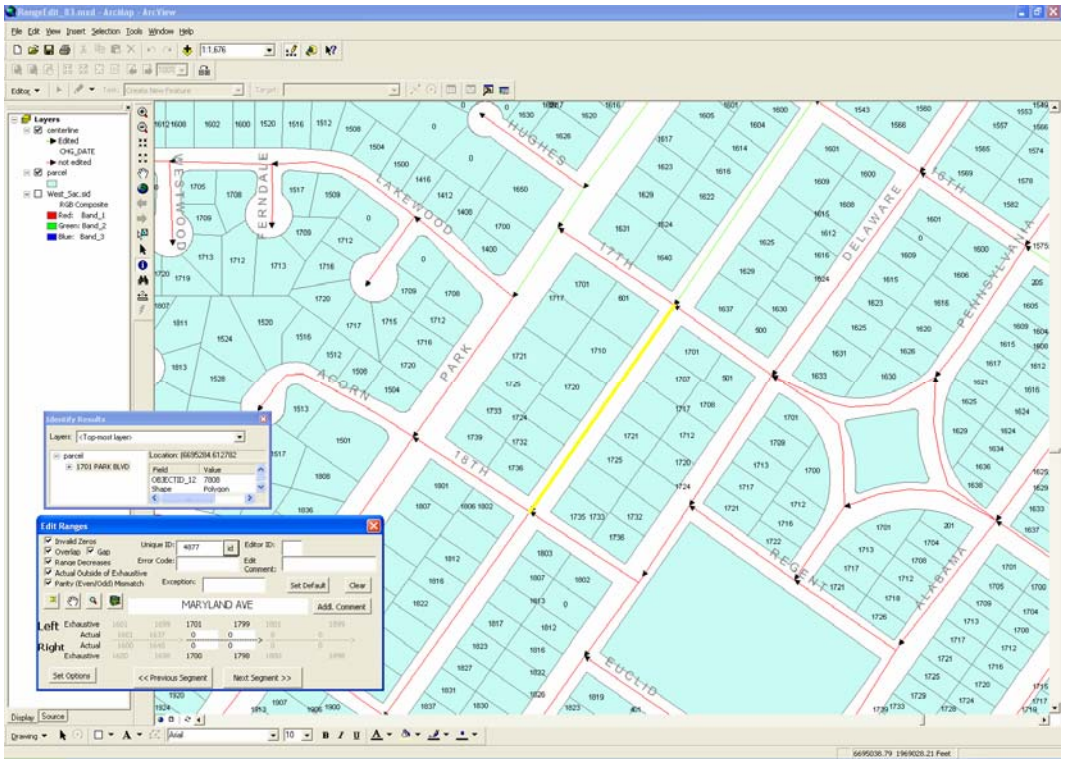


***Figure 4-7: The Street Centerline Layer Editing Tool Developed by SACOG***

It should be noted that the City's current cooperation with SACOG, as well as internal efforts by the GIS Specialist, have served to produce a solid foundation for the development of a high-quality, highly accurate street centerline layer.

## Recommendations

It is recommended that the City of West Sacramento continue to work with SACOG on the maintenance and improvement of its existing digital street centerline layer. Along with the parcel layer, the street centerline layer comprises one of the most important datasets for the City.

There are two primary recommendations for the City's street centerline layer

1. Integration of Geo-Spatial Data to a Centralized Data Store
2. Population of Attributes to Support Routing

☑ <u>Integration of Geo-Spatial Data to a Centralized Data Store</u>

As with the parcel layer, all City of West Sacramento departments will benefit from access to a single, up-to-date, and accurate street centerline layer. In order to facilitate this access, it will be necessary to integrate the street centerline layer to a centralized data store. The street centerline layer will continue to be maintained as a CADD layer by the Drafting Services Section; however, the layer should be integrated to a centralized data store by one of the workflows described for the parcel layer. The workflow may include utilization of GISConnect in conjunction with a geodatabase, the maintenance of a CADD layer with a parallel version in Shapefile format, or the maintenance of a CADD layer with a composite version distributed between SQL Server (attributes) and Shapefile (geometries).

***Figure 4-8: Example of Street Centerlines Overlaying Aerial Photography***

SACOG has produced two documents that provide comprehensive and detailed information on the standards, specifications, and procedures for maintenance of the street centerline layer: "GIS Cooperative Street Centerline Database Standards and Specifications" and "GIS Cooperative Street Centerline Maintenance Procedures." These two documents should continue to be relied upon for the maintenance and management of the City's street centerline layer. SACOG's specification for the street centerline layer includes a unique field (key) by which all City of West Sacramento street segments can be tracked (the City has a predefined range of 10,000-19,999 for the key). This key should be utilized to track any internal changes made to the street centerline layer.

## Population of Attributes to Support Routing

SACOG's street centerline data model includes the following attributes (fields):

| Field Name | Type | Description |
|---|---|---|
| Shape | ESRI_SHAPE (Binary) | The shape field contains geometry information. |
| Unique_ID | Long Integer | System ID for records of this table. Each numeric value is unique. See the discussion below. |
| PrefixType | String | Prefixed street type (e.g. Avenida, etc.) |
| PrefixDir | String | Prefixed street direction (e.g. S in 'S Main St'). |
| StreetName | String | Primary name of the street segment. |
| StreetType | String | Type of street (e.g. st, ave, blvd, etc.) |
| SuffixDir | String | Street direction as suffix (e.g. West in 'Embarcadero West'). |
| FullStreet | String | Fully specified name of the street segment (e.g. 'S Main St.'). |
| LF_Actual | Long Integer | Beginning actual left address for the segment |
| LT_Actual | Long Integer | Ending actual left address for the segment |
| RF_Actual | Long Integer | Beginning actual right address for the segment |
| RT_Actual | Long Integer | Ending actual right address for the segment |
| LF_Exhaust | Long Integer | Beginning exhaustive left address for the segment |
| LT_Exhaust | Long Integer | Ending exhaustive left address for the segment |
| RF_Exhaust | Long Integer | Beginning exhaustive right address for the segment |
| RT_Exhaust | Long Integer | Ending exhaustive right address for the segment |
| CityLeft | String | City on the left of the segment |
| CityRight | String | City on the right of the segment |
| ZipLeft | String | Zip code on the left of the segment |
| ZipRight | String | Zip code on the right of the segment |
| CountyLeft | String | County on the left of the segment |
| CountyRight | String | County on the right of the segment |
| TravelDirection | String | Indicates allowable travel direction. FR for 'from node' to 'to node', TO for 'to node' to ' from node', and BH for both directions. |
| Status | String | Status of the segment (e.g. existing or planned). A segment entered in the database before the roadway is built would have the status of planned. |
| Length_Cal | Long | Calculated length of the segment. |
| LengthSource | String | Length collection method (e.g., GIS, field, other database, etc.) |
| NameValidation | String | Indicates whether, or not the street name used should be validated. When a street name is not found in the master street name table, users may be allowed to type in the name while entering a new record by indicating that the name must be validated later on. |
| IsBoundary | Short Integer | Indicates whether or not the segment runs along jurisdiction boundary. |
| Source | String | Indicates which agency/department has entered the data. This helps in identifying the responsible party for the data. |
| Method | String | Indicates how the data was collected. This information will help in understanding the quality of data. |
| CFCC | String | Functional classification of street segment based on census feature class codes (CFCC). |
| DateEntered | String | Date when the segment was first created in the database. |
| DateUpdate | String | Date in yyyymmdd format of most recent segment spatial change |
| Ac_Date | String | Date in yyyymmdd format of most recent segment attribution change |
| Qc_Exhaust | String | Flag indicating entity responsible for exhaustive range |
| Exh_Except | String | Exhaustive range exception codes (see section on address range standards). |

This set of attributes is adequate for use of the street centerline layer for geocoding and routing. Although the City has managed to maintain most of this information, it is recommended that the GIS Specialist (and the recommended GIS Intern) work on population and update of all attributes of this layer (TravelDirection and PrefixDir will need to be populated for routing). In doing so, the City will have ownership of a valuable street centerline layer that can be used for accurate routing. This routing in turn will support a variety of GIS needs and applications, including generation of optimal routes for a variety of needs, including emergency/incident response, work orders, and AVL.

A street centerline layer is necessary for many GIS analysis tasks; however, it does have some limitations. An address search on a street centerline layer will only locate the interpolated position of that address in relation to the centerline – in the middle of the street or at a designated offset. The interpolated location will not show the actual location of the address. Addresses with multiple units or structures may be ambiguously located, as a point may be used to represent a complex of buildings (e.g., a college campus). Additionally,

actual addresses may vary from their interpolated location based on address ranges; in turn, address ranges may not be correct or may be outdated.

A solution for preventing and addressing such discrepancies is to create an address point layer. Several local governments have created or plan on creating an address point layer to yield more accurate address search results. An address point can be placed in the center of each structure in the City, or at the entrance of the primary driveway. Structures with multiple units such as apartment complexes and condominiums can have one address point for each unit.

## Address Points

### History and Current Status

The City of West Sacramento currently does not have a digital point layer.

### Recommendations

It is highly recommended that the City of West Sacramento create a digital address point layer using the Finance Department's Springbrook database as the primary source for addresses. Address information for utility customers stored within the Springbrook database should be used as the source for address point creation; address information from the parcel layer should be used to create address points for any addresses that may not be in the Springbrook database. Addresses in the Springbrook database should be address-matched to the situs address of each parcel in the parcel layer; records that do not exist in the Springbrook database that do exist in the parcel layer should be verified and incorporated as address points as well. The centroid of each parcel will serve as the preliminary address point. Addresses that exist in the Springbrook database that do not exist in the parcel layer should be verified and reconciled to a valid City address. Figure 4-7 provides a general overview of the methodology to create and validate address points.

Use of the Springbrook database is recommended due to the fact that it contains records for multi-unit addresses that may only exist as a single address in the parcel layer. The creation of a comprehensive address point layer may require additional data sources, such as the permits database, should there be addresses that are not accounted for in the Springbrook database and in the parcel layer.

Once address points are created, they should be rectified to the appropriate location through use of digital orthophotography as well as GPS field work (as needed). The GIS Specialist, in conjunction with the recommended GIS Steering Committee, will need to develop business logic for the placement of multi-unit address points and other special case addresses, such as mobile homes. In addition, QA procedures will need to be utilized to identify addresses in the Springbrook database (and/or parcel layer) that are incomplete, inconsistent, or out of date. The creation of an address point layer is often an iterative process that requires multiple efforts before a comprehensive and up-to-date address point layer is created.

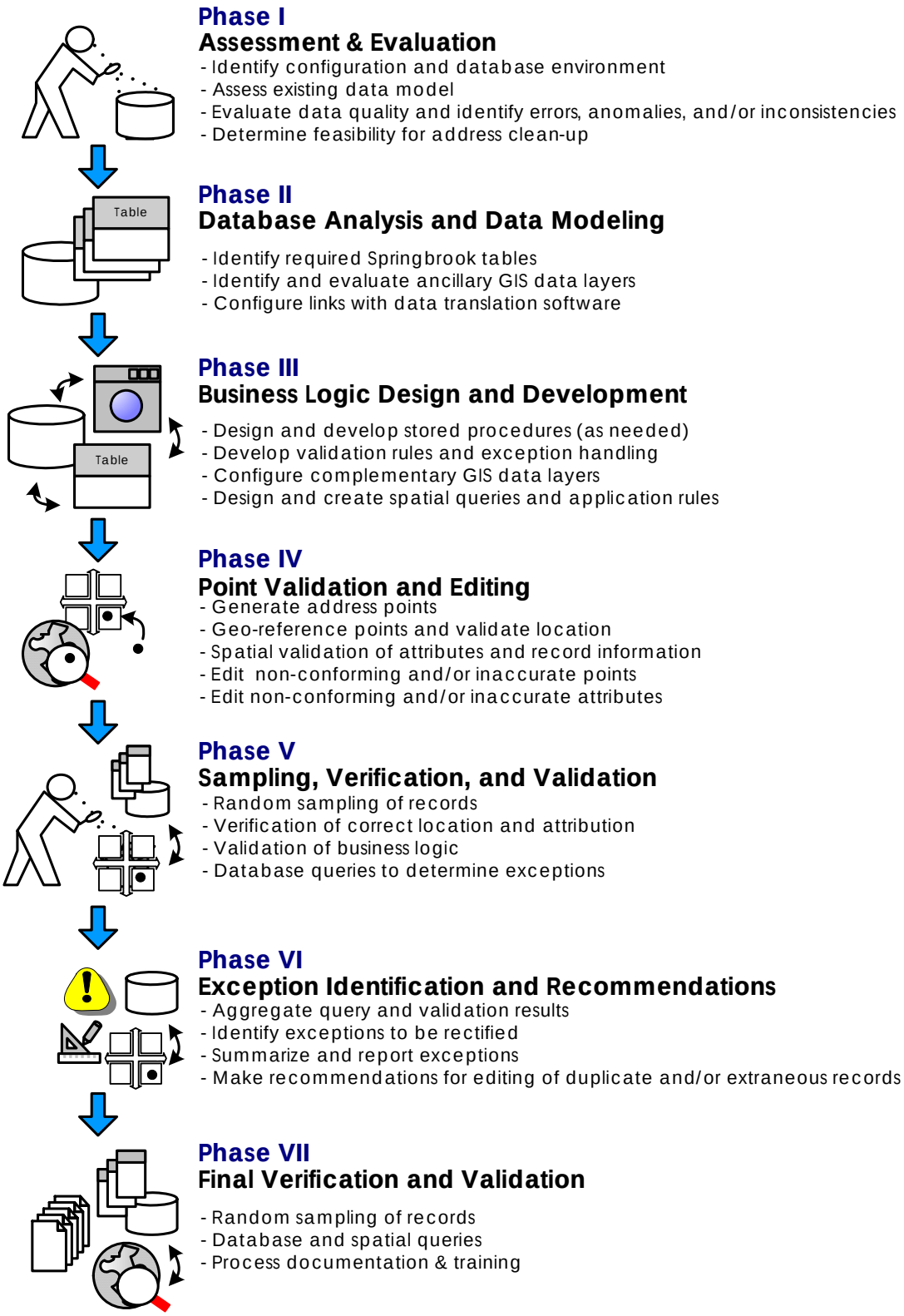


***Figure 4-9: Address Point Creation Methodology***

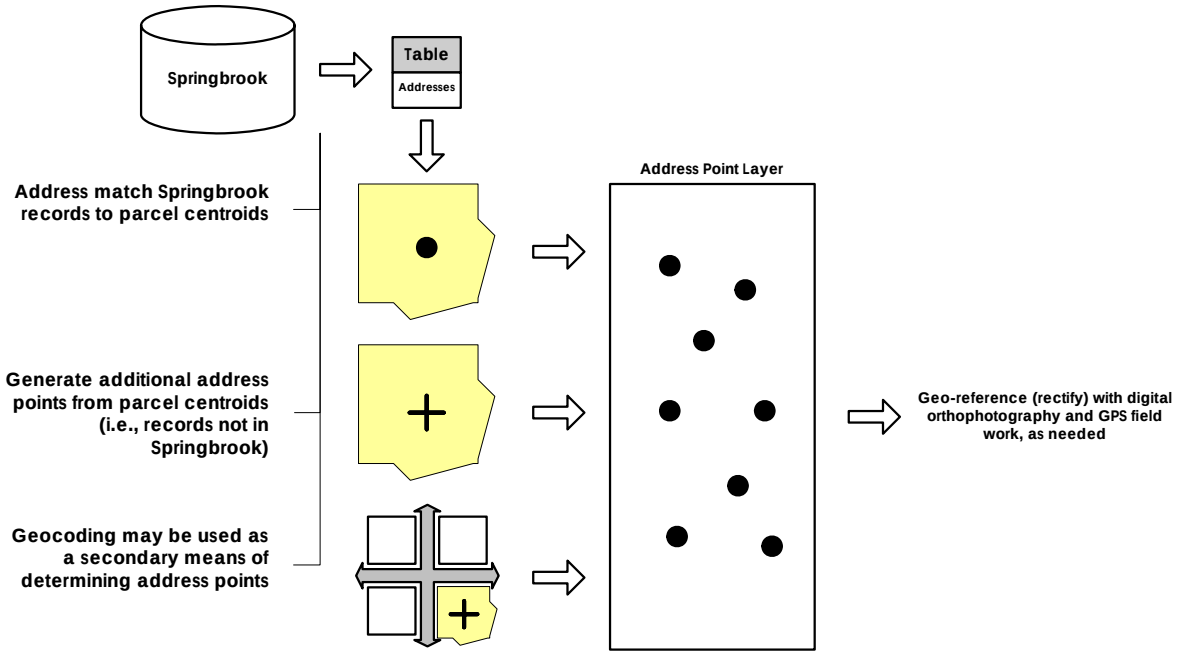


***Figure 4-10: Recommended Address Point Generation Workflow***

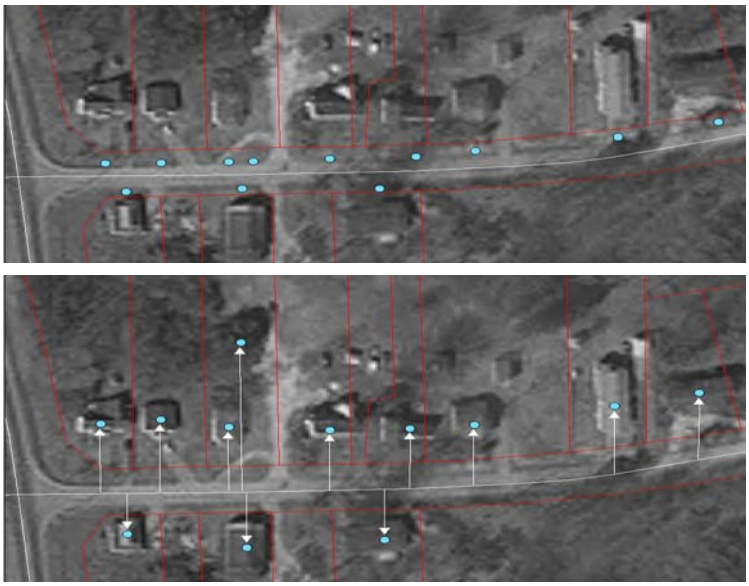

***Figure 4-11: Point Movement***

The address point layer should be maintained in a geo-spatial format, either as a Shapefile, geodatabase layer, or CADD file. It is recommended that the GIS Specialist be the primary resource responsible for maintenance and management of this layer; the Drafting Services Section should be a secondary resource (the Section should be cross-trained on the various methodologies used for creation, maintenance, and management of this layer). The City's address point layer should be updated to include a new point (record) each time that a new parcel polygon is added by the Drafting Services Section to the City's base map.

Address Points and Geocoding

An alternative means for generating address points is based on geocoding using the street centerline layer. Geocoding (also known as address matching) with the street centerline layer yields address points based on an interpolated value using address ranges for each line segment. Although this method is somewhat effective in creation of address points, it is not nearly as accurate as an address point layer as referenced above. In geocoding, points are offset from the street centerline by a set distance (typically 50 feet) in order to place them in relative proximity to each parcel's centroid (center point). While this methodology provides a quick means for generating address points, an inherent lack of positional accuracy for each point is problematic.

Interpolated locations, such as those yielded by geocoding, have traditionally been inaccurate and often times inconsistent—this depends both on the accuracy of the underlying street centerlines used as well as the configuration parameters used for geocoding. One of the key limitations of using an offset parameter in order to place points closer to their "true" location is that addresses close to an intersection or end of a line segment will not have the same offset as those near the center of a street segment. A diagram below illustrates how offsets can be misleading in such cases.

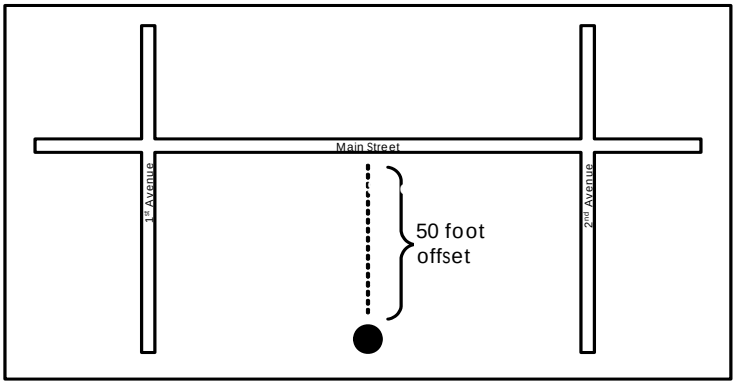


***Figure 4-12: An address interpolated to a street segment center will be placed at the specified 50 foot offset.***

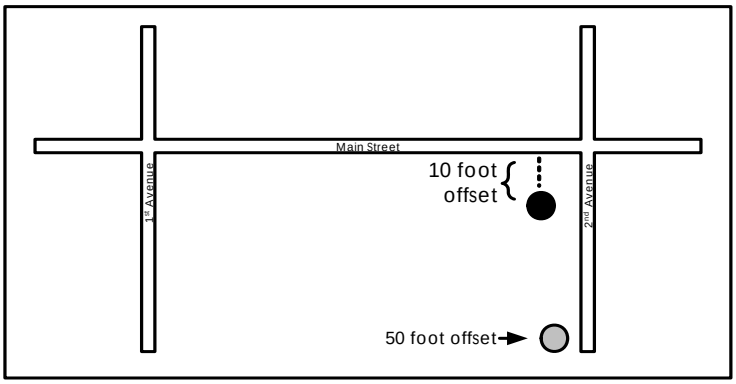


***Figure 4-13: Depending on address-matching logic used during geocoding, an address interpolated near an intersection (or street segment end) will be placed at a different offset. If the specified 50 foot offset were to be used in this case, the address point would be placed near the end of the line segment and offset by 50 feet, thereby placing the point close to the middle of the intersecting street.***

Other limitations of geocoding include the interpolation logic used for address matching. Interpolated addresses are subject to address matching rules, which in some instances may place a point within a block group centroid, or even within a Zip Code centroid, if address information is ambiguous and/or incomplete. For example, if a record does not have all relevant address information, such as an incomplete street number or a misspelled street name, that record may be geocoded to a Zip Code centroid.

# Chapter 5 – Database Design and Setup

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## Introduction

It is recommended that the City of West Sacramento conduct a full database design. The following components of the Database Design process are recommended for the City:

1. Logical Database Design
2. Physical Database Design
3. Data Migration
4. Database Setup and Administration

It should be noted that the City's current database infrastructure is quite robust. The Information Technology Division manages and maintains several enterprise database systems for use by various departments; in addition, the Division maintains a dedicated SQL Server database that is used in conjunction with Cold Fusion to provide dynamic web content and functionality on the City's web site. At present, the City does not maintain its geo-spatial data in a database environment—most geo-spatial data is maintained in Shapefile and/or CADD format.

As the City moves forward with its GIS implementation, geo-spatial data management and maintenance needs will grow, and the need to distribute data to various departments (as well as the public) will increase. There are several alternatives that the City may wish to pursue in terms of geo-spatial data management in the context of a database. Given the diverse and stratified workflows for data management inherent within each City department, the possibility of maintaining a hybrid environment, wherein geo-spatial data is managed as flat files (i.e., Shapefile and CADD) as well as in a database, is feasible. Technical staff in the Drafting Services Section may especially benefit from such an environment, as existing knowledge, processes and workflows would require little or no modification. However, such an environment presents some limitations in terms of the ability to leverage the relational and distributed capabilities of an enterprise database.

This chapter provides detailed information about logical and physical database design, as well as data migration and database setup and administration. This information is provided with the expectation that the City will initialize migration to a geodatabase environment during the second year of this GIS implementation. It is expected that a majority of the City's

geo-spatial data will reside in an enterprise geodatabase by the third year of this GIS implementation. However, based on the aforementioned context of the City's geo-spatial data management and maintenance opportunities, the City's eventual migration to a geodatabase may evolve to encompass a hybrid environment, wherein a majority of the City's geo-spatial data is distributed via a geodatabase, but actual data management and maintenance of select layers is conducted in different formats.

## Logical Database Design

### Why conduct a logical database design?

The logical database design process can be time consuming and produces no end-use applications. Therefore, the logical design process often receives limited attention, if any. However, there may be risks associated with not conducting a logical database design. By not going through the logical design process, the City of West Sacramento risks having a poorly constructed database that does not meet present or future requirements. Poor database design can result in duplicate, missing, or unnecessary data; inappropriate representation of data; or lack of proper data management techniques.

One of the key aspects of a successful GIS implementation is good database design. What makes a good database design is asking the right questions:

- How can GIS technology be implemented to streamline existing functions, or change the way a particular goal is achieved?
- What data will benefit the City of West Sacramento most?
- What data can be stored?
- Who is, or should be, responsible for maintaining the database?

How the City answers these questions will improve its understanding of GIS technology, as well as provide new insight into the organization and its functions. A good database design results in a well-constructed, functional, and operationally efficient database that:

- Satisfies objectives and supports organizational requirements
- Contains all necessary data without redundancy
- Organizes data for different users with various access levels
- Accommodates different views of data
- Identifies and distinguishes applications that maintain data from those that use it
- Appropriately represents, codes, and organizes geographic features
- Enforces rules for how geographic features interact

Benefits of the database design process include:

- Increased flexibility of data retrieval and analysis
- Distributed costs of data capture, storage, and use
- Versatile data that supports many different uses
- Maintained data that supports many different users
- Extendibility that readily and easily accommodates future functionality
- Reduced data duplication and data archiving

The key task in building a logical data model is to precisely define the set of objects of interest and to identify the relationships between these objects. Once an initial logical data model is developed, it should be validated against the City of West Sacramento users' requirements for entering, updating, and accessing data, and by testing it against the organization's practices and procedures (or business rules).

It is critical to involve representatives that will be utilizing the data from each City department. A logical data model built for a subset of users is guaranteed to have

deficiencies for unidentified users. Building a logical data model is an iterative process and an art that is acquired through experience. There is no single "correct" model, but there are good models and there are bad models. It is difficult to determine when a model is correct and complete, but an indication for this is when the City of West Sacramento can answer "yes" to these questions:

- Does the logical data model represent all data without duplication?
- Does the logical data model support the City of West Sacramento's business rules?
- Does the logical data model accommodate different views of data for distinct groups of users?

## Logical Database Design Methodology

The Logical Database Design should consist of four parts:

1. Kickoff Meeting
2. Existing data acquisition and review
3. Interviews
4. Logical Database Design

Kickoff Meeting

Kickoff meeting attendees should include all City of West Sacramento personnel that currently or will in the future:

- Create spatial data
- Provide input on the creation, updating or use of spatial data
- Use spatial data on a regular basis.

The kickoff meeting should introduce the goals and objectives of this project, outline how the project will be conducted, and inform attendees of what will be required of each of them.

Existing Data Acquisition and Review

Before the Logical Database Design process can move forward, the City of West Sacramento will need to ensure that it has a copy of all existing City data layers and source data from each department that will be included in the database design.

Interviews

All pertinent staff members from each City department should be interviewed. Interviews can be conducted separately for each department, or in logical groupings. The goal of each interview is to discuss in detail each data layer for which attendees are the Subject Matter Expert. Issues that should be discussed include:

- Deletion of existing attribute fields
- Addition of new attribute fields
- Allowable values for important attribute fields
- Relationship of layer to other layers
- Associated tables and cardinality
- Description or alias of each field (when not obvious)
- Subtypes
- Default values
- Whether null values are allowed or not
- Indexes

Several important metadata aspects (not documented or available from the earlier existing data acquisition) to include (but not limited to) should be documented, including:

- Feature Class Name
- Feature Class Type (point, line, polygon or raster)

- Feature Dataset
- Description
- Purpose
- Data source
- Primary and secondary data custodians
- Acquisition scale and accuracy
- Spatial information (projection, coordinate system, datum, units, etc.)
- Status of the data (complete, incomplete, etc.)
- Data update frequency
- Constraints on accessing and using the data
- Point of contact for each layer

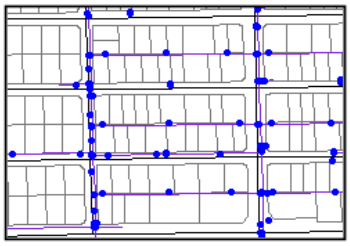
## Logical Database Design Products

The logical database design process should result in two products:

1. Printed documents
2. Flow Chart drawings

1. <u>Printed document</u>
   A printed and bound database design document should be developed. The database design document should individually document each data layer that will be included in the process. Important metadata about each layer should be documented at the top of each sheet, as well as a snapshot of what the layer looks like visually (Figure 5-1). Every attribute field should be listed, to include:
   - Field Name
   - Description (of the field)
   - Data Type (string, date, integer, etc,)
   - Allows Nulls (whether null values are allowed or not)
   - Default Value (if appropriate)
   - Domain (reference to domain that dictates allowed values for this field)
   - Length (number of characters allowed)
   - Precision (number of allowable significant digits)
   - Scale (number of allowable decimal places)
   - Index (whether a field is indexed)

***Potable Water Valves***



**Feature Class Name:** PotableWaterValves
**Feature Dataset:** PotableWaterDistributionSystem
**Feature Class Type:** Point
**Data Source:** 2002 GPS Data Collection
**Primary Custodian**: Michelle Wang – GIS Technician – EIS/GIS
**Accuracy:** +/- 1 meter
**Projection:** NC State Plane, NAD83, feet
**Status:** Complete as of April 23, 2003
**Data Update Frequency:** As changes are made in the field
**Constraints:** Data may NOT be released to the public
**Point of Contact:** Katherine O'Brien – EIS/GIS (919) 123-4567, KOBrien@fac.unc.edu
**Description:** Point layer of water valve locations.
**Purpose**: Inventory of all campus potable water valves

**Attributes:**

| Field Name | Data Type | Allows Nulls | Default Value | Domain | Precision | Scale | Length | Description |
|---|---|---|---|---|---|---|---|---|
| BypassValve | Small Integer | Yes | 0 | Boolean | 0 | 0 | 2 | Indicates if the valve has a bypass valve for maintenance |
| ClockwiseToClose | Small Integer | Yes | 1 | Boolean | 0 | 0 | 2 | Does the valve close in a clockwise direction? |
| CurrentlyOpen | Small Integer | Yes | 1 | Boolean | 0 | 0 | 2 | Is the valve currently open? |
| Motorized | Small Integer | Yes | 0 | Boolean | 0 | 0 | 2 | Is the valve motorized? |
| NormallyOpen | Small Integer | Yes | 1 | Boolean | 0 | 0 | 2 | Is the valve designed to be open under normal network circumstances? |
| PercentOpen | Integer | Yes | 100 | | 0 | None | None | Current percent open |
| PressureSetting | String | Yes | | | None | None | 20 | Current pressure setting |
| RegulationType | String | Yes | | WHSystemValveRegulationType | None | None | 20 | Type of pressure regulation performed (if applicable) |
| TurnsToClose | Integer | Yes | | | 0 | None | None | Number of full turns required to close the valve |
| Diameter | Integer | Yes | 10 | MainDistributionDiameter | 0 | None | None | Diameter of the valve |
| Elevation | Double | Yes | | | 0 | 0 | None | Elevation of the valve |
| WaterType | String | Yes | Potable | WaterType | None | None | 20 | Type of water flowing through the system |
| AdministrativeArea | String | Yes | N | AdministrativeArea | None | None | 200 | The administrative area that contains the object |
| FacilityID | String | Yes | | | None | None | 20 | A unique facility number for the object |
| InstallDate | Date | Yes | | | 0 | 0 | 8 | Date object was installed in the ground |
| LocationDescription | String | Yes | | | None | None | 200 | Text description of the location |
| OperationalArea | String | Yes | D1 | OperatingArea | None | None | 200 | Engineering or operational district for the feature |
| Rotation | Double | Yes | | | 0 | 0 | None | Rotation angle for map symbology |
| LifeCycleStatus | String | Yes | Active | LifeCycleStatus | None | None | 20 | Stage of the facility lifecycle |
| SubType | Integer | Yes | 1 | | 0 | None | None | Type of feature |
| WorkOrderID | String | Yes | | | None | None | 20 | |
| AncillaryRole | Integer | Yes | | | 0 | None | None | |
| Enabled | Small Integer | Yes | 1 | Enabled | 0 | 0 | 2 | Work Order that installed the object |

***Figure 5-1: Example Printed Logical Database Design Sheet***

2. Flow Chart drawings

   Data model flow charts for the organization of each data layer within the geodatabase should be developed. Developed products should include individual printed drawings, digital drawings in MS Visio format, as well as digital images of each drawing. Data should be logically organized into the following categories:

   - Geodatabase
   - Feature Datasets
   - Feature Classes

   All data should be organized into one geodatabase. Feature Datasets should be established to logically group Feature Classes of similar type or business process. The data model flow charts should document all Feature Datasets, and the Feature Classes within each Feature Dataset (Figure 5-2). Feature Classes should be displayed according to type: point, line, or polygon. Additionally, the organization of other types of data that will be stored within the geodatabase, including (but not limited to) rasters (such as aerial photography), and CADD data, should be documented.

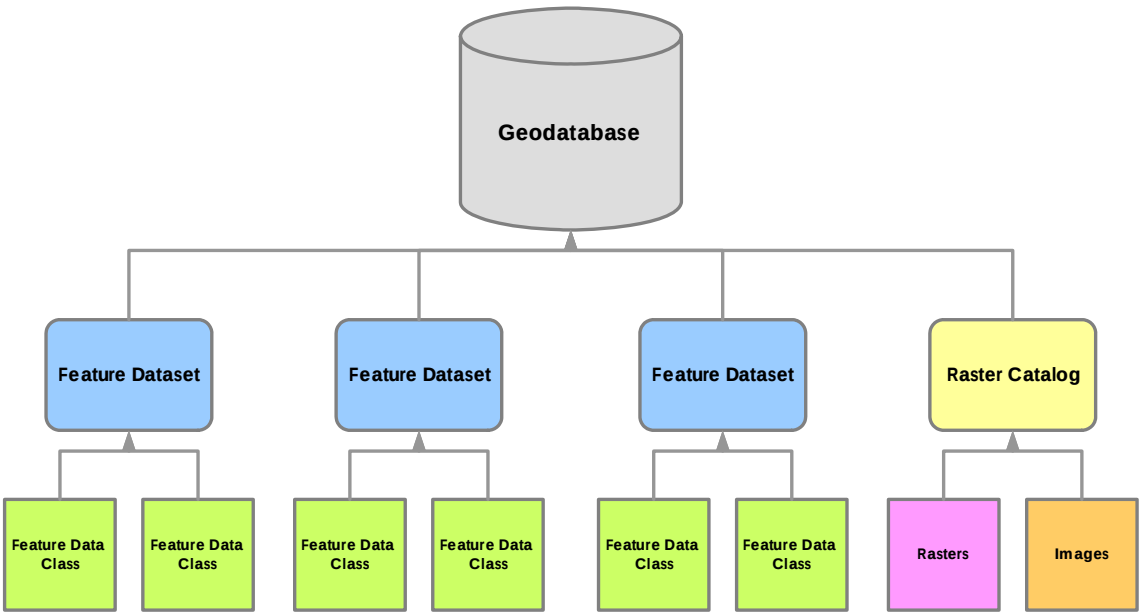



***Figure 5-2: Diagram of Overall Logical Database Design***

Each Feature Class in the Data Model Flow Chart should further display all attribute fields (Figure 5-3). Other information that should be documented, when necessary, includes:

- Abstract Classes – a device for documented common attribute fields used by more than one subsequent Feature Class, to avoid redundancy.
- Subtypes - variations of similar features
- Domains - allowable values for an attribute field
- Cardinality – relationships between feature classes, or between feature classes and objects (tables)

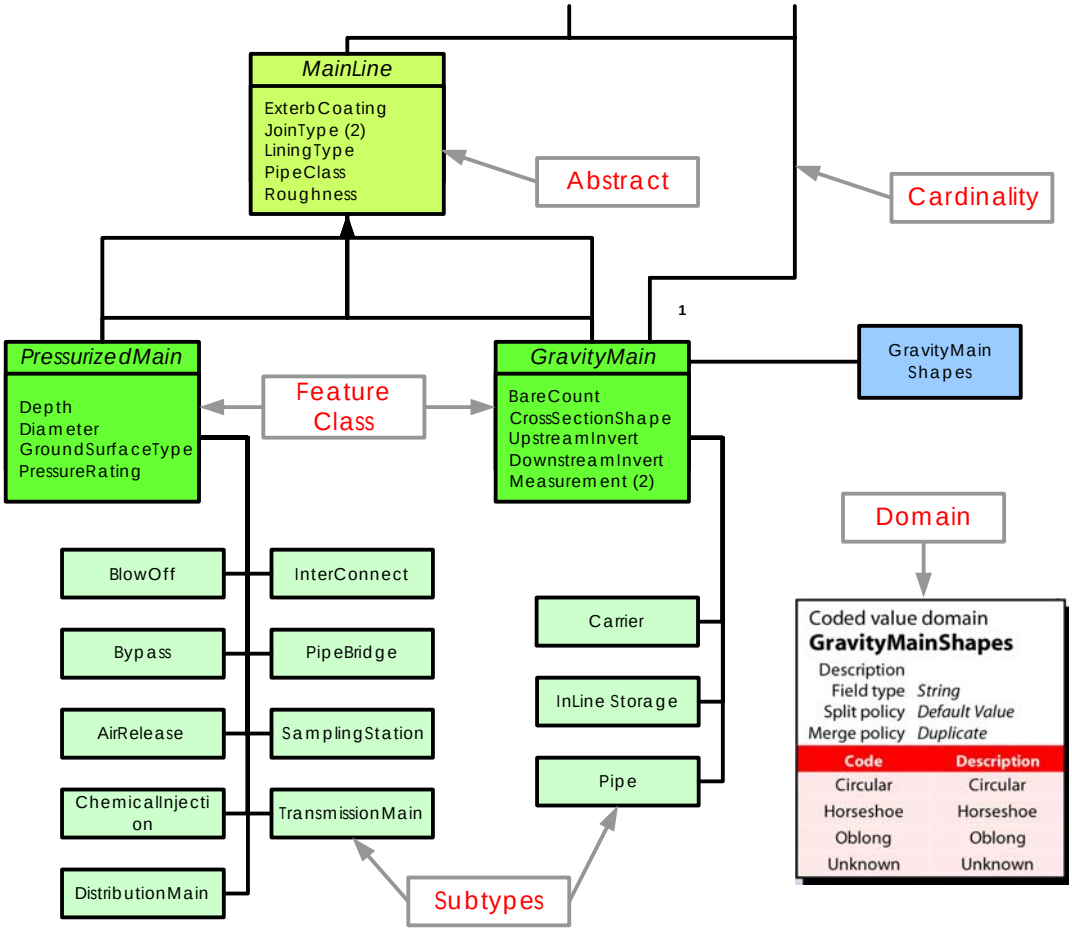



***Figure 5-3: Example Section of a Logical Database Design Data Model Flow Chart***

## Physical Database Design

A physical data model must be created after the logical data model is complete. The Physical Database Design consists of implementing the logical data model schema within the geodatabase. This entails physically creating all of the features designed in the Logical Data Model.

This is the final step before the migration of existing data to the geodatabase. Therefore, a decision must be made with regard to which data layers should be represented in the geodatabase once the initial geodatabase is created. The City currently has a considerable number of spatial data layers. Some of these data layers will be relatively easy to migrate, while others will require significant effort, including conversion and consolidation. The City of West Sacramento should consider the following criteria when it has identified layers to implement in the Physical Database Design during initial implementation:

- The City may wish to restrict access to some data layers until an agreed-upon level of completeness or accuracy is achieved
- Data layers may require a customized data model provided by a software vendor
- Users may be more comfortable with the existing format of data layers, or users may not have received training on utilizing data stored in a geodatabase

It is recommended that the City of West Sacramento assess all of the aforementioned points of consideration during the Logical Database Design prior to moving forward with the Physical Database Design for those layers that are deemed appropriate, based on the assessment. Once the City decides which data layers should be migrated to or created in the geodatabase, these features can be physically created within or migrated to the geodatabase. A data layer does not need to have been created for that layer's physical design to move forward. Empty Feature Classes can be created, which can be populated with actual data at a later point. Figure 5-4 shows many of the types of features that must be created within the Physical Database Design process. The geodatabase itself stores information on domains.

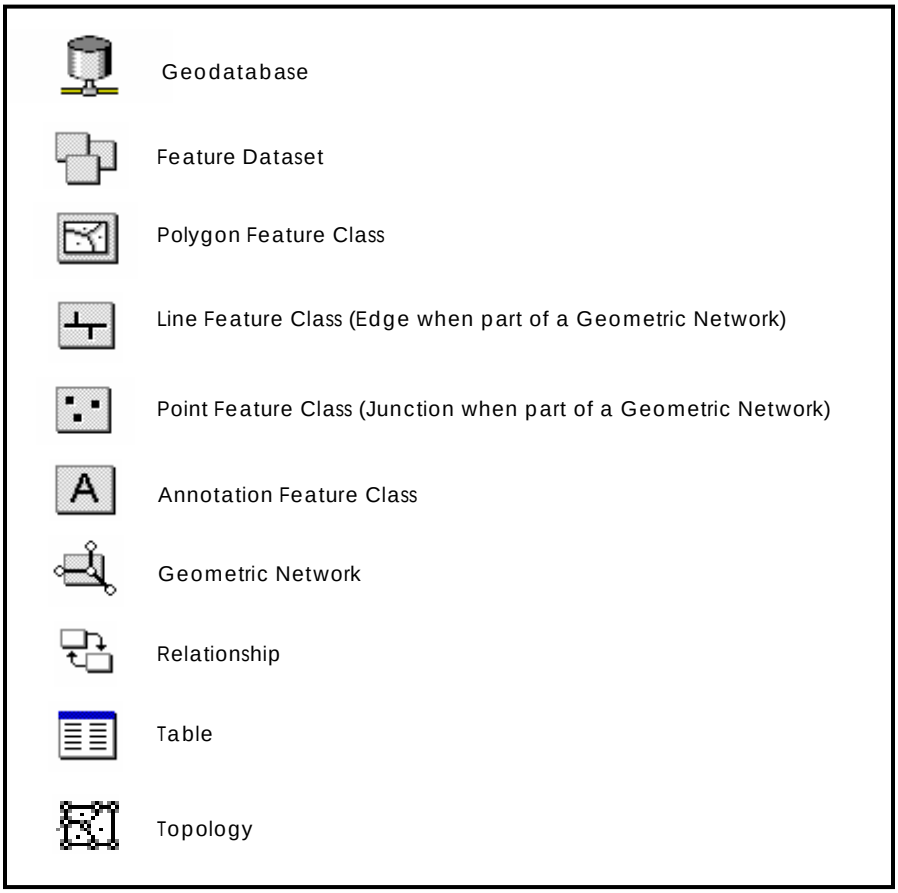



***Figure 5-4: Features that will be created during the Physical Database Design***

Domains should be created within the geodatabase according to the Logical Database Design specifications. According to the agreed upon Logical Database Design, Feature Datasets should be created. Figure 5-5 displays domains created for a geodatabase, domain properties, and values (in this case, coded values).

Feature Datasets should be created according to the agreed upon Logical Database Design. Within Feature Datasets, Feature Classes should be created. Feature Classes should be created according to the agreed upon Logical Database Design. Important information about each Feature Class that must be created includes: Name and Alias (Fig. 5-6); Fields – to include Field Name, Data Type, Alias, Allow Null Values, Default Value, Domain, Precision, Scale, and Length (Fig. 5-7); Indexes (Fig. 5-8); Subtypes (Fig. 5-9); and Relationships (Fig. 5-10).

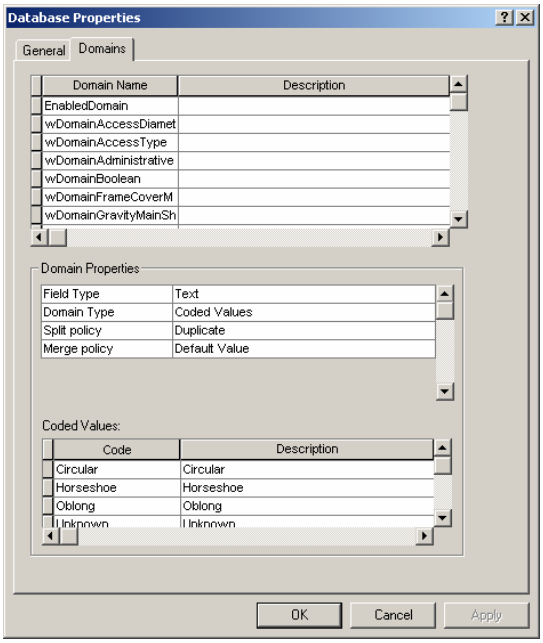



***Figure 5-5: Creating Domains***

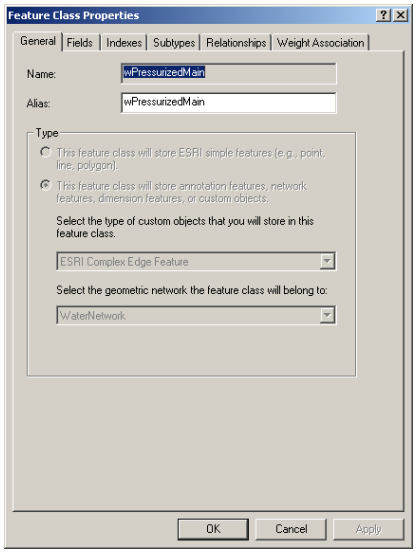



***Figure 5-6: Feature Class General Properties***

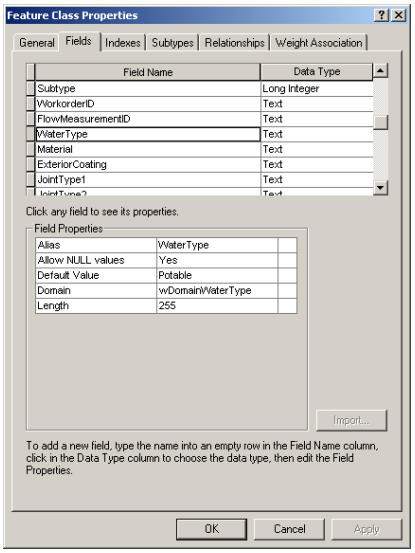



***Figure 5-7: Creating Feature Class Fields and Field Properties***

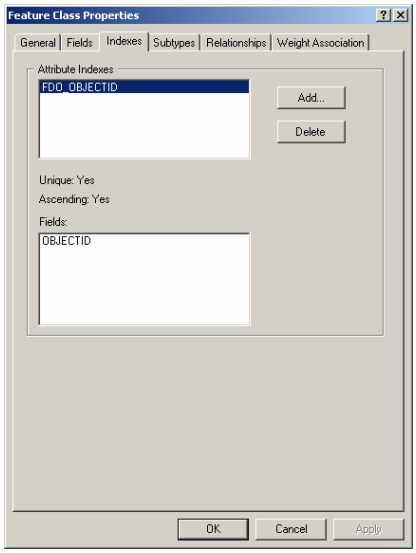



***Figure 5-8: Creating Feature Class Indexes***

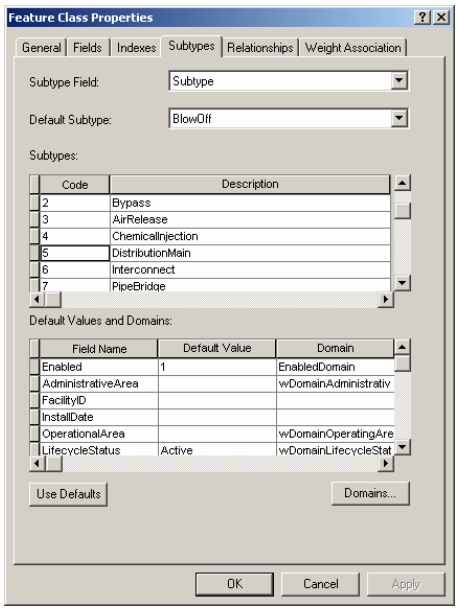



***Figure 5-9: Creating Feature Class Subtypes***

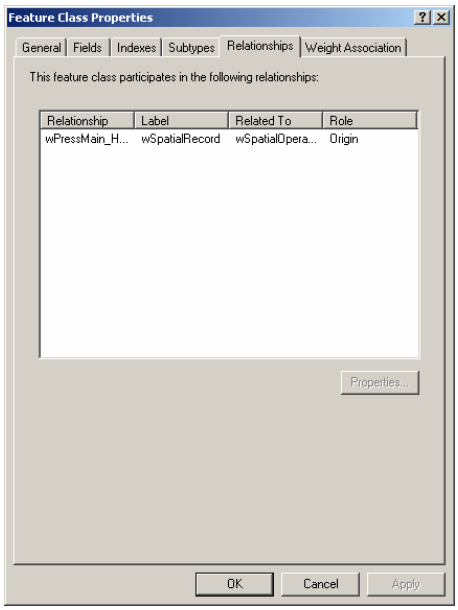



***Figure 5-10: Feature Class Relationships***

## Data Migration

Once the Physical Database Design process is complete, existing data can be migrated from its existing format to the geodatabase. It is highly recommended that this process occur simultaneously with the database design process. Some data manipulation will be part of the migration process. Attribute fields from the existing data are matched with its respective counterpart in a Feature Class in the Physical Database Design. Only fields of similar data type can be migrated. Once data layers are in a state conducive for migration, ArcCatalog should be used to physically migrate the data from its existing format to the geodatabase (Figure 5-11).

Based on citywide needs assessments, it is recommended that data conversion to the geodatabase format be implemented—as aforementioned in the introduction to this chapter, the City may decide to exclude some layers from migration to the geodatabase, such as the base map layers maintained in CADD format by the Drafting Services Section. The GIS Specialist will need to determine the most effective means of converting existing CADD data. Once CADD data has been converted to the Geodatabase, it is recommended that GISConnect be utilized to allow data custodians to continue to edit in a CADD environment. Haestad Methods' GISConnect allows users to edit data stored in a geodatabase using CADD software. This method of data maintenance will allow the City to take advantage of existing staff skills, thereby reducing the amount of training required (see the Drafting Services Section Needs Assessment in Chapter 1 for more information on GISConnect).

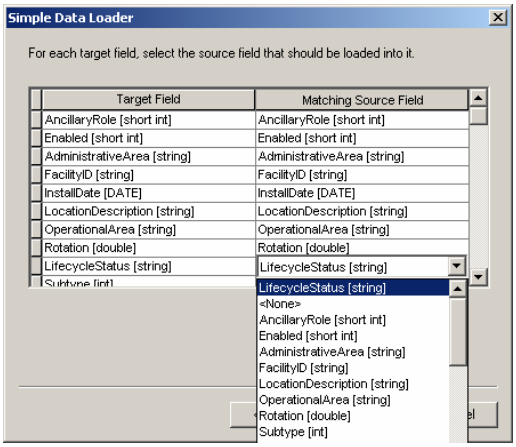



***Figure 5-11: Data Migration – Simple Data Loader in ArcCatalog***

Concurrent with the migration of data, all necessary metadata for each data layer (Figures 5-12 and 5-13) should be documented. Metadata information gathered during the data acquisition and interview process should be combined with any pertinent metadata information made available during the database design process.

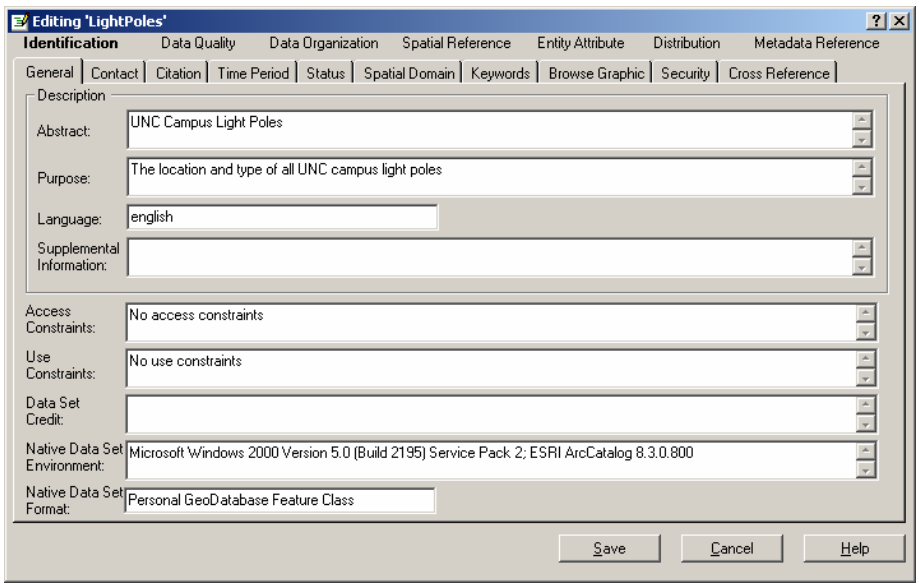



***Figure 5-12: Metadata Editor in ArcCatalog***

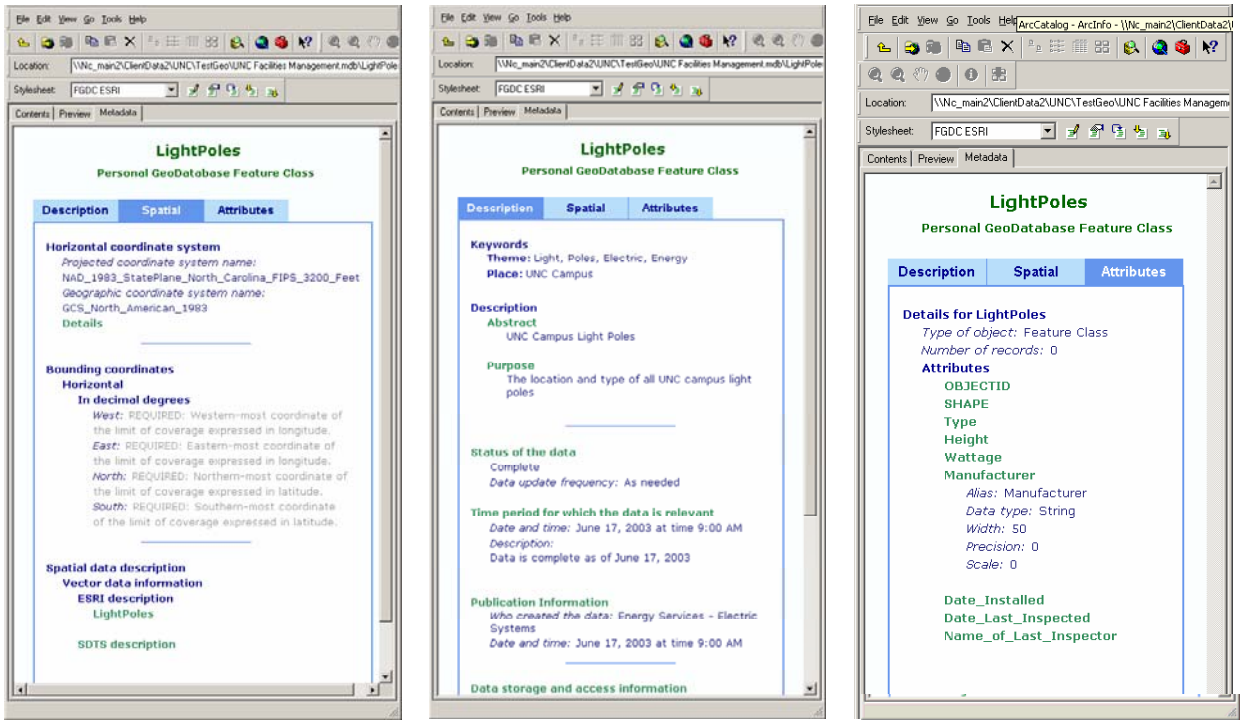



***Figure 5-13: Descriptive, Spatial, and Attribute Metadata Information of a Feature Class Displayed in ArcCatalog***

## Database Setup and Administration

Once the Physical Database Design is completed, versions and permissions must be established within the ArcSDE-enabled geodatabase.

<u>Versions</u>

With ArcGIS 9, multiple users can access geographic data in a geodatabase through versioning. Versioning lets users simultaneously create multiple, persistent representations of the database without data replication. Users can edit the same features or rows without explicitly applying locks to prohibit other users from modifying the same data.

The City can use versioning to manage alternative engineering designs, solve complex "what if" scenarios without impacting the corporate database, and create point-in-time representations of the database.

Primarily, versioning simplifies the editing process. Multiple users can directly modify the database without having to extract data or lock features and rows before editing. If, by chance, the same features are modified, a conflict resolution dialog box guides the user through the process of determining the feature's correct representation and attributes.

The ArcCatalog module of ArcGIS allows an administrator to create new versions, rename existing versions, delete versions, and modify version properties. These administrative tasks are accomplished using the Version Manager dialog box (Figure 14).

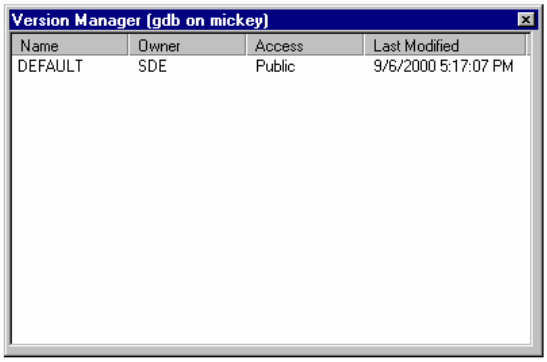



***Figure 5-14: Version Management in ArcSDE***

Initially, the database consists of one version named "DEFAULT", owned by the ArcSDE administrative user. The new versions that are created are always based on an existing version. When the new version is created, it is identical to the version from which it was derived. Over time, the versions will diverge as changes are made to the parent version and the new version. A version consists of several properties: an alphanumeric name, an owner, an optional description, the creation date, the last modified date, the parent version, and the version's permission.

<u>Available permission settings</u>

Various permissions for access to data layers and datasets within the geodatabase must be created. A version's permission can only be changed by its owner. The available permission settings are:

- Private - the owner may view the version and modify available feature classes.
- Protected - user may view the version, but only the owner may modify available feature classes.
- Public - user may view the version and modify available feature classes.

Only the version's owner can rename, delete, or alter the version. A parent version can't be deleted until all dependent child versions are deleted.

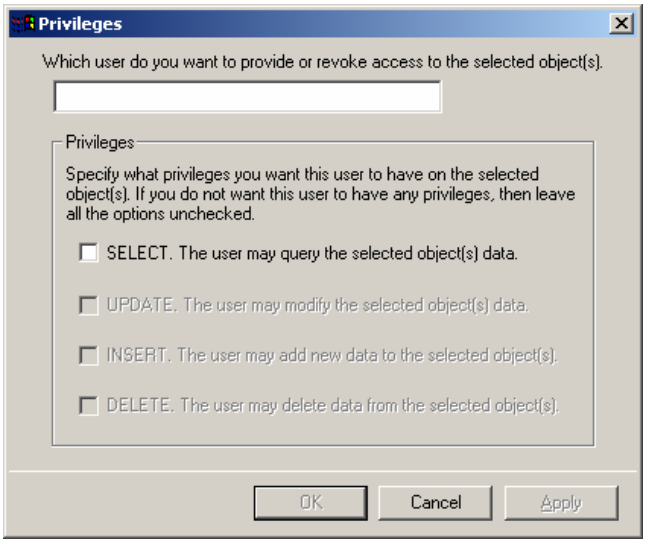



***Figure 5-15: Defining Privileges in ArcSDE***

# Chapter 6 – Data Standards and Transfer

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## Introduction

As noted in *Appendix II - Seven Keys to a Successful GIS Implementation,* there is a compelling need to establish good relationships with other organizations to facilitate sharing of data. No successful municipal GIS can be an island unto itself. Forging partnerships and deciding to share data with other organizations is only the first step. The next step involves the technical issues of data sharing.

Once the City of West Sacramento has identified data that can be shared, it needs to determine the mediums, media, and formats that will be used to share that data.

## Data Formats, Coordinate Systems, and Transfer Media

As the City of West Sacramento proceeds with its GIS implementation, it will find that many organizations are willing to share data. However, getting viable, quality data may prove to be a challenge.

There are three discrete issues that must be addressed whenever sharing digital GIS data with other organizations:

- **Data Format**
- **Coordinate System and Datums**
- **Transfer Media and Backup**

### Data Format

GIS data can be maintained in a number of formats. The format depends on the type of software used to create the data and the output format an organization uses to distribute its information. The combination of ArcGIS and AutoCAD software recommended for use by the City of West Sacramento offers considerable flexibility. There are only a few data formats that these applications cannot read (or import).

Some formats are easier to use than others. The following is a list of common data formats, their derivation, their ease of use, and whether they can contain tabular (attribute) data as well as geographic data.

*Data Formats Table*

| Data Format | Derivation | Ease of Use | Tabular | Notes |
|---|---|---|---|---|
| **ArcGIS Enterprise Geodatabase** | ArcGIS: ArcInfo, ArcEditor | High | Yes | Format of choice. ArcGIS data model. Can be exported as geodatabase, coverage, export file, shapefile, or others. Consists of feature datasets, feature classes, tables, etc. Stored in commercial RDBMS, and accessed with ArcSDE as an SDE layer. Allows multi-user editing and limitless storage capacity |
| **ArcGIS Personal Geodatabase** | ArcGIS: ArcInfo, ArcEditor, ArcView | High | Yes | ArcGIS data model. Can be exported as geodatabase, coverage, export file, shapefile, or others. Consists of feature datasets, feature classes, tables, etc. Stored in MS Access database. Limited storage capacity |
| **ArcInfo Coverage** | ArcInfo | High | Yes | Previous format of choice for polygonal data, such as tax parcels. Native ArcInfo Workstation file format. Is comprised of many files, tabular and geographic. All files must be copied if this type of file format is to be used. Utilizes topology. Not supported by ArcGIS 8.3 Desktop. |
| **ArcInfo Export File (.e00)** | ArcInfo | High | Yes | Format of choice for distribution of coverages. Contains all of the data in an ArcInfo coverage in one file. This file format has to be imported but makes transport of data very efficient. |
| **ArcView Shapefile** | ArcView | High | Yes | Format of choice. Native ArcView file format. Easily converted to an ArcInfo Coverage or Geodatabase. |

| | | | | |
|---|---|---|---|---|
| **DXF** | CADD Products | Medium | Yes | Hard to transfer tabular data. Usually obtained from engineering firms and surveyors. |
| **DWG** | AutoCAD | Medium | Yes | Native AutoCAD format. ArcInfo and ArcView can read these files without conversion. |
| **DGN** | Intergraph | Low | Yes | Must be converted to a different format for use with ArcInfo or ArcView |
| **DLG** | USGS | Low | Yes | Digital Line Graph data used by the USGS. Often DLG files have been converted already into a more usable format. |
| **SDTS** | USGS | Low | Yes | Spatial Data Transfer Standard. Developed by the National Mapping Division of the USGS. Primarily used as a cross-platform distribution format. Point and Raster formats |
| **Tiger Files** | Census Bureau | Low | Yes | Contains valuable demographic data. Should be acquired. But the native tiger file format is cumbersome and difficult to translate. Try to find a state agency that has done the conversion already. |
| **DEM Digital Elevation Model** | Various Sources | Low | Very Little | Used for the generation of elevation contours. Cumbersome to use but often necessary. Requires ArcGIS Spatial Analyst to utilize raster data. |
| **TIFF, Sun Raster, JFIF, BMP, BIL, GIF, JPEG, MrSID** | Various Sources | Low | No | Various image formats that can be displayed directly in ArcGIS and AutoCAD. Useful for display, aerial imagery and photographs. |

Whenever possible, data should be obtained in ArcGIS geodatabase, ArcView Shapefile, or AutoCAD (with object data) format. These formats are the easiest to use. GIS datasets are usually large and will require data transfer by tape, compact disc, or via the Internet. Data can be supplied on CD as an ArcView Shapefile or ArcGIS personal geodatabase. It should be noted that surveyors and engineers usually utilize a computer aided drafting or CADD product. The optimal means of transferring data from or to a CADD system is to utilize the Digital Exchange Format or DXF.

## Coordinate Systems and Datums

### Coordinate Systems

GIS layer spatial information is stored in a coordinate system, defined by the projection of the map. The coordinate system of the digital map is important. If digital data are obtained and the coordinate system is unknown, then the user may or may not be able to convert the data to the correct units. It is best to inquire about the coordinate system before receiving data. ArcGIS software includes tools to convert between coordinate systems. Because coordinate conversion can be cumbersome and time consuming, requesting or providing all map projection information with exchange files is crucial. This information should be provided as a standard in all metadata files that accompany City of West Sacramento data, or are requested from outside sources (see Metadata section below). The existing standard utilized by the City of West Sacramento is NAD 83, zone II, US Feet (this is the same as the recommended coordinate system presented below; see “Recommended Coordinate for the City of West Sacramento” below).

### Datums

Another consideration along with the coordinate system is datum. There are two horizontal datums used almost exclusively in North America. These are the North American Datum of

1927 (NAD27) and the North American Datum of 1983 (NAD83). It is recommended that Cadastral maps in California be based upon state plane coordinates adjusted to the 1983 horizontal datum. Other projections and coordinate systems may be used to satisfy special requirements.

The North American Datum of 1927 uses the Clarke spheroid of 1866 to represent the shape of the Earth. The origin of this datum is a point on the Earth referred to as Meades Ranch in Kansas. Many NAD27 control points were calculated from observations taken in the 1800s. These calculations were done manually and in sections over many years. As a result of this process, errors varied from station to station. Many technological advances in surveying and geodesy since the establishment of NAD27 - electronic theodolites, GPS satellites, Very Long Baseline Interferometry, and Doppler systems - revealed weaknesses in the existing network of control points. Differences have become particularly noticeable when linking existing control with newly established surveys. The establishment of a new datum allowed for a single datum to cover consistently North America and surrounding areas.

The North American Datum of 1983 is based on both Earth and satellite observations, using the GRS80 spheroid. The origin for this datum is the Earth's center of mass. This affects the surface location of all latitude-longitude values enough to cause locations of previous control points in North America to shift, sometimes as much as 500 feet. A ten-year multi-national effort tied together a network of control points for the United States, Canada, Mexico, Greenland, Central America, and the Caribbean.

NAD27 and NAD83 should not be used in conjunction with one another. If any NAD27 derived data exists then convert it to NAD83. Tools within GIS software make this a relatively easy process. The City of West Sacramento does not currently have a standard.

> **Technology Tip –** If two GIS layers used in conjunction with each other are consistently offset by approximately 8-10 feet, it is probable that there is a datum mismatch. It is likely that one layer is utilizing NAD27 datum and the other NAD83 datum. The NAD27 layer should be converted to NAD83.

### Coordinate Conversion

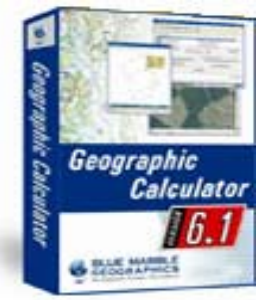
A GIS layer's spatial information is stored in a coordinate system, defined by the projection of the map. The coordinate system of the digital map is important. If digital data are obtained without a specified coordinate system, it may not be readily possible to determine the projection. Various map projection and coordinate conversion tools are available in the ESRI product suite, as well as other commercial and governmental applications (Blue Marble, Corpscon, etc.). Most of the routine coordinate conversions can be performed in ESRI software, yet the following software is also available for other custom and batch coordinate processing as well as for conversion of other data formats that may be useful.

**FME Desktop Suite**
http://www.safe.com

FEATURE MANIPULATION ENGINE

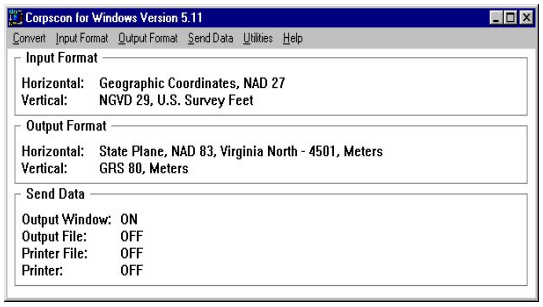
FME Desktop Suite supports many popular data formats including MapInfo TAB, DGN, DXF, DWG, SDTS, SHP, and TIGER.
FME Suite 2004 contains a gallery of over 2000 supported coordinate systems, based upon a wide variety of projections, ellipsoids and datums. Users can also define and include their own custom coordinate systems. Coordinate conversion is now included with the Desktop Suite.

**Blue Marble Geographics**
http://www.bluemarblegeo.com/




The Geographic Calculator converts individual coordinates, point databases, and map files from virtually any coordinate system, datum, and map projection to any other. Users can transform between coordinate systems, calculate the distance and azimuth between coordinates, and calculate coordinates at a known distance and azimuth from known coordinates. The Geographic Calculator also computes grid convergence, point scale factor, datum shifts, and grid shifts. The Geographic Calculator is professionally documented and supported.

**U.S. Army Engineer Topographic Engineering Center CORPSCON**
http://crunch.tec.army.mil/software/corpscon/corpscon.html




Corpscon is a MS-Windows-based program which allows the user to convert coordinates between Geographic, State Plane and Universal Transverse Mercator (UTM) systems on the North American Datum of 1927 (NAD 27), the North American Datum of 1983 (NAD 83) and High Accuracy Reference Networks (HARNs). Corpscon uses the National Geodetic Survey (NGS) program Nadcon to convert between NAD 27, NAD 83 and HARNs.

Recommended Coordinate System for the City of West Sacramento

Given the City's participation in the Yolo GIS Cooperative, it is recommended that the City adopt the Cooperative Coordinate System as the citywide standard for GIS data.

The Cooperative's Coordinate System is the California State Plane Coordinate System, Zone 2, based in the North American Datum of 1983 with adjustments to the High Precision Geodetic Network (NAD83/HPGN).

| Parameter | *Value* |
|---|---|
| Zone | *California II* |
| 1st Std. Parallel* | *38 20 00* |
| 2nd Std. Parallel* | *39 50 00* |
| Central Meridian** | *-122 00 00* |
| Origin(Latitude)*** | *37 40 00* |
| False Easting (m)**** | *2,000,000* |
| False Northing(m)***** | *500,000* |

***Figure 6-1: Recommended Coordinate System for City of West Sacramento***

***** Line of constant latitude at which the surface of the Earth and the plane or developable surface intersect.

** The line of longitude at the center of a map projection generally used as the basis for constructing the projection.
*** Latitude chosen as the origin of rectangular coordinates for a map projection.
**** The value added to all "x" values in the rectangular coordinates for a map projection. This value frequently is assigned to eliminate negative numbers.
***** The value added to all "y" values in the rectangular coordinates for a map projection. This value frequently is assigned to eliminate negative numbers.

## Transfer Media and Backup

### Transfer Media

One of the greatest challenges in sharing data is the transfer of data from one computer system to another. One computer may have data that is in a specific format and coordinate system, yet there may be no common way to transfer the data to other computers. There are several ways to provide access to data between computers, but few standards to do so exist. Floppy disks were the traditional method of data transfer for years. However, the sheer size of data has significantly reduced the usefulness of diskettes. Given that an average GIS data file can require up to thirty diskettes or more worth of disk storage, determining other alternatives for data transfer is necessary.

The table below lists some standard transfer media and their characteristics.

| Transfer Media | Platform | Storage Capacity | Notes |
|---|---|---|---|
| **Compact Media** | Unix and PC | 700 MB | Excellent media for transferring large files. |
| **DVD-R** | Unix and PC | 4.7 GB-9.4 GB | Comparable to the CD, but has larger storage capacity. Included on most new PCs. |
| **ZIP Drives** | PC | 100 MB | As standard as comes with a PC. Good for data transfer with other PCs |
| **Ditto or Jaz** | PC | 100 MB - 2 GB | Good for PCs but no standards exist. Data sharing between machines is difficult |
| **Diskette** | Unix and PC | 1.4 MB | Excellent for small files. Standard drives allow for data sharing between all types of computers. Not good for big files. Many new computers no longer include diskette drives. |
| **8mm** | Unix and PC | 2GB - 20GB | Is used extensively on Unix computers. Stores much data. Also, used on PCs but backup methods vary by drive. Backup speeds are fast. |
| **4mm** | Unix and PC | 2GB - 20GB | Same as the 8mm. Only difference is cartridge is physically smaller. |

It is recommended that the City of West Sacramento utilize compact discs (CD-ROM) and DVD-R discs as the transfer media of choice. Writeable CDs and DVDs should be utilized for data sharing and distribution, depending on which type of media can be utilized by those receiving the data. Using these two types of media will allow for flexibility when sharing data with or receiving data from other entities. Writeable CDs can be used for data sharing between all types of computers, as almost all computers today come standard with a CD-ROM drive. Therefore, any data written with the writeable CD-ROM drive can be used on any PC with a CD-ROM drive. While DVDs are not used as commonly as CDs, DVDs offer greater storage capacity and the ability to transfer large data sets that would usually need to be divided into multiple CDs. DVD-R use is increasing, and it is expected that this type of media will become as popular as CDs in the future.

A majority of internal data sharing at the City of West Sacramento will be done through the city's high-speed network. Data sharing through the network eliminates the need for sharing via disk or tape.

Sharing Data via the Internet

An excellent way of sharing data is via the Internet. Sharing data through the Internet precludes the need to use tape drives and tape formats to transfer data. However, there are some limiting factors to this type of data transfer, primarily data transfer speed. Data transfer speed will be slow when using a modem connection to the Internet. Transferring large GIS files by modem is not a good idea and may even be impossible. A single GIS file could take hours and possibly days, to transfer via a modem. Additionally, modem connections to the Internet can often be lost during file transfer, requiring the restart of the file transfer process. Files that would typically take hours to transfer with a modem take only a few minutes to transfer using a high-speed (broadband) connection and file transfer protocol (FTP) software. It is recommended that the City's FTP site include a public access section for transferring files with the public, consultants, etc.

## Data Creation and Maintenance

This section provides two recommended Standard Operating Procedures for the City of West Sacramento, one for maintaining or updating existing data resources, and one for adding new data resources to the GIS.

Roles

This section describes the roles and responsibilities of Requestors, the GIS Specialist, subject matter experts (SMEs), and department supervisors with respect to modifying existing or adding new resources to the GIS.

*Requestor*

A Requestor is a person who wants to modify or add a data resource to the GIS. If the data resource meets minimum requirements, or if the GIS Specialist authorizes the submittal, the requestor must complete the appropriate Request Form (Examples A and B in this section).

*GIS Specialist*

The GIS Specialist is responsible for tracking all resource submittals and providing some initial quality assurance (QA) of the data. The GIS Specialist is in charge of layers that are used by all departments. The GIS Lead or Subject Matter Expert (SME) is a person who accepts or is assigned the responsibility of maintaining GIS data in his or her own department. This person should have sufficient technical expertise to be assigned with this responsibility. Regardless of who makes a request, the GIS Specialist has the authority to refuse requests from a Requestor; the GIS Specialist also acts as the point of contact for requestors and SMEs for particular submittals. He or she provides guidance in converting file formats, data cleanup, and compatibility of proposed resources with existing GIS resources. If a resource is accepted, the GIS Specialist will install the resource and make changes to any relevant documentation.

*Subject Matter Experts*

*Subject Matter Experts (Also Referred to as Departmental GIS Lead)* are responsible for particular data resources. If a proposed resource is similar to, or has a potential impact on, an existing resource, the SME for the existing resource needs to review the submittal. The SME will make or oversee the changes to the data resource when updates are required. The SME should provide guidance to the GIS Specialist as to whether or not the proposed resource

conflicts with, enhances, or will result in changes to an existing resource or resources. The SME is further responsible for updates to a modified data resource's metadata file.

*Supervisor*
The Supervisor for each SME is responsible for ensuring that the SME is qualified and has enough time as well as resources (i.e., training, computer system, or other resources) to perform the duties required.

☑ Data Maintenance Procedure for Existing Data

Three types of spatial data layers will be utilized by the City of West Sacramento:

1. Layers used and maintained by only one department
2. Layers maintained by one department, but used by many
3. Layers updated by the GIS Specialist

The following guidelines do not apply to layers that are used and maintained by only one department.

Any GIS user may request changes or updates to an existing data resource. The request is made to their SME using the Data Maintenance Request form (see Example A below). The SME will review the request and approve it, if deemed appropriate, and forward the request to the GIS Specialist. The GIS Specialist will review the request to ensure that the layer is in compliance, and if it is, the request will be sent back to the SME.

Because specific departments continually maintain some layers, it is not feasible to require that each change be approved through the full chain of command. In such cases it is recommended that blanket annual approval of these updates should be granted. The GIS Specialist should create an application that will audit, test, and validate these data layers to check for consistency and validity. Semi-annual testing of these data layers should be implemented.

The SME is responsible for completing all of the corrections and/or updates, including updates to the metadata file. Corrections should be made to copies of the data resource files as required. The GIS Specialist may assist the SME in this effort by providing technical support, staff resources, CADD to GIS conversion, and other tasks as required; however, it is ultimately the SME's responsibility to ensure that the new data is correct.

Once a request is approved and new files are finalized, the SME will return the completed request form to the GIS Specialist along with the updated data. Data files may be on separate media (CD, floppy, etc.), or corresponding network location(s) may be indicated on the request form. The intended final disposition of the original data resource files should also be indicated on the form.

The GIS Specialist will be responsible for validating new data. This responsibility includes:

- A final check to ensure that the new spatial data has not been corrupted or changed, except where intended
- Verifying that topology and attribute structure of the new data matches that of the old
- Verifying that attribute record data are intact
- Verifying that all links and joins used by the GIS system are still functional with the new data
- Verifying that the new data and metadata are in agreement
- Verifying that the new dataset conforms to City of West Sacramento data standards

(as referenced above: format, coordinate system, and media/medium)

Any discrepancies found must be resolved with the SME prior to the implementation of the updated data resource within the GIS.

Once the GIS Specialist and the SME have approved the updated data, the GIS Specialist will move the old data resource files (including the old metadata file) to an archive directory for temporary storage, and copy the updated files to the network GIS server. The GIS Specialist will be responsible for updating any other relevant GIS documents, such as File Lists, Layer Lists, and Metadata Indices.

Each department will need a SME regardless of whether he or she will update data. For example, the Police Department would need an SME to inform the GIS Specialist that data needs to be updated, but the GIS Specialist would be responsible for the updates.

### New Data Resource Procedure

This Standard Operating Procedure relates to the addition of new data resources to the GIS. It does not address changes to existing GIS data. To update or amend any existing GIS data, contact the GIS Specialist. Example A of this section contains a submittal form that provides some guidelines on data requirements.

### Criteria for Acceptance or Rejection of New Data

The City of West Sacramento is interested in seeing its GIS grow and become more sophisticated. This requires that new data resources be added to the system so that a wider group of users will use the GIS productively. To achieve this objective, the acceptance process has not been made overly rigid. The GIS Specialist is authorized to accept or reject a submittal based on some basic criteria, with additional discretionary flexibility.

The GIS Specialist may accept new resources only if all of the following criteria are met:

- Resource is ready "as-is" and requires no updates or modifications (with the exception of CADD and ArcInfo files, which may be converted to SHP files)
- It conforms to City of West Sacramento GIS Data Standards (as referenced above: format, coordinate system, and media/medium)
- The SME is already assigned and has signed off on the submittal
- Future update and maintenance requirements are minimal or the requestor accepts responsibility for the needed updates and/or maintenance

The GIS Specialist may reject new resources if:

- No one needs access to the data
- Significant maintenance of the data will be required and no one can assume responsibility for this task

### Procedure

The procedure for submitting new resources for inclusion in the GIS is outlined in Figure 2. The requestor is encouraged to consult with the GIS Specialist if one or more requirements are not met. The GIS Specialist may grant an exception, allowing the process to continue. This exception does not imply that the resource has been accepted; the resource must still go through the normal review process.

After the requestor determines that the resource is eligible for consideration, the submittal form entitled "Request to Add New GIS Data Resource" must be completed (see Example B

below). The requestor should have the request reviewed and approved by his or her supervisor. If the requestor is not the designated SME, the SME's agreement needs to obtained and authorized by his or her supervisor.

The aforementioned process needs to be complete before the request package is submitted to the GIS Specialist. The GIS Specialist should receive the following three items:

- A completed "Request to Add New GIS Data Resource" document with authorizing signatures
- A copy of the proposed data resource on transfer media, or a copy transferred electronically via email or ftp
- A hard-copy printout of the electronic file (if practical)

The GIS Specialist will perform an initial review. If the submittal is not complete, it will be sent back to the requestor with the deficiencies identified. Otherwise, the SMEs for affected resources must be consulted to determine if the proposed resource duplicates or overlaps existing resources.

If all SMEs and the GIS Specialist approve the submittal, the GIS Specialist will assign a staff member to place the new data resource on the GIS server and update any affected documentation.

*Example A: GIS Data Maintenance Request Form*

## Request to Update Existing GIS Data Resource

### SUMMARY INFORMATION

Submitted by:_____Date:_____
Department:_____Phone:_____
City of West Sacramento Name of Data Set:_____
Description:_____
Update to Data Type: ☐Vector ☐Raster
(Check all that apply) ☐Tabular ☐Documents
☐Other_____

Subject Matter Expert (SME): _____
Describe the corrections, updates, or additions to the data resource you are requesting:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

List (or attach) any additional documents that are related to this update:

_____

_____

_____

_____

_____

_____

The SME shown above has examined this request to update an existing GIS data resource, and has determined that the updates or corrections are needed. The SME has acquired copies of the data resource files, made the appropriate changes or additions, and has duly modified the associated metadata files. These corrected files are provided to the GIS Specialist with authorization to replace the existing data resource files on the network GIS server with the updated data resource files attached or referenced in this form.

_____

(SME Signature) Date

**SME Use:**

Provide the network location of the updated data resource files related to this update request:

_____

_____

Final disposition of existing data resource files ☐Archive ☐Delete

The GIS Specialist for the City of West Sacramento GIS has received all required files and approvals from the SME regarding this data resource maintenance request, and implemented the updated files on the network GIS server. All other affected GIS files have been updated to reflect the changes in this data resource.

_____

(GIS Specialist Signature) Date

***Example B: New Data Resource Form***

**Request to Add GIS Data Resource**

**1. SUMMARY INFORMATION** *(all information in Section 1 is required)*

Submitted by:_____Date:_____

Department:_____Phone:_____

Title of Data Set:_____

Description:_____

Type: ☐Vector ☐Raster
☐Tabular ☐Document
☐Other_____
(Complete checklist for the appropriate type)

Frequency of Update: ☐Never ☐Annually ☐Quarterly ☐Monthly ☐Weekly ☐Daily

Subject Matter Expert (SME): _____

The SME shown above agrees to be responsible for updating, creating and maintaining this layer at the frequency shown above. The SME's supervisor, by signing below, acknowledges that SME is authorized to perform this function as collateral duty (unless otherwise designated).

_____
(SME Signature)

_____
(SME Supervisor's Signature)

Who are the potential users of this layer (list by name, department, and/or position)?

_____

_____

_____

Why do you think this resource should be added to the GIS?

_____

_____

_____

_____

Does this data replace (yes/no) or duplicate (yes/no) any data set currently in the GIS? If answer to either is "yes," explain here:

_____

_____

_____

**2. SPATIAL DATA ATTRIBUTES** *(all information in Section 2 is required)*
These questions should be answered for spatial data only (i.e., CADD, GIS, orthorectified photos).

How are the data georeferenced? ☐Projected (X,Y) ☐Geographic (Lat/Long) ☐N/A

If Projected:

What projection system was used?

State Plane ☐ FIPS Zone: _____

Other (Specify) ☐ _____

What datum was used?

NAD83 ☐

NAD27 ☐

Other (Specify) ☐ _____

What units are distances in?

US Feet ☐

Int'l Feet ☐

Meters ☐

Other (Specify) ☐ _____

If Geographic,

What datum was used?

NAD83 ☐

NAD27 ☐

Other (Specify) ☐ _____

What units are distances in?

Dec. Deg. ☐

Deg. Min Sec. ☐

Other (Specify) ☐ _____

Does the data have a vertical component? ☐Yes ☐No

If Yes:

What datum was used?

NGVD29 ☐
NAVD88 ☐
ELLIPSOID ☐ Spheroid Used:_____
Other (Specify) ☐ _____

What units are the elevations in?

US Feet ☐
Int'l Feet ☐
Meters ☐
Other (Specify) ☐ _____

## 3. DATA FORMAT

Answer as many of the following questions as possible for all data types. Questions with an asterisk (*) *must* be answered.

What software was used to generate this data set (include version or release number)?

_____

_____

_____

***Vector Data***

**GIS**

ESRI Personal Geodatabase ☐
Autodesk .DWG Release 14 – 2000 – 2005 ☐
ESRI Geodatabase ☐
ESRI Shapefile ☐
ArcInfo Coverage ☐
Other ☐ specify_____
Include attribute specifications for GIS spatial data

***Raster Data***

**Type**

Scanned Photos ☐ Choose one: *Projected* ☐ *Un-projected* ☐
Scanned Documents ☐ Choose one: *Projected* ☐ *Un-projected* ☐
Satellite Imagery ☐
Data Surface (single) ☐
Data Surface (stack) ☐
Other ☐ specify_____

**Format**

TIF/TFW ☐
GeoTIF (TIF 6) ☐
BIL, BIP, BIF (raw) ☐
GIF, JPG, BMP ☐
MR. SID ☐
ArcInfo GRID ☐
Other ☐ specify_____

Is the data compressed? ☐NO ☐YES (Algorithm used: _____)

How many bands? ☐ 1 (binary or gray) ☐ 3 (color) ☐ >3 (satellite or stack)

If >3, specify the bands and their content: _____

_____

_____

Radiometric Resolution: ☐ 6-bit ☐ 8-bit ☐ Other_____

***Tabular Data***

**Spreadsheets**

Excel ☐
Lotus 1-2-3 ☐
QuattroPro ☐
Other ☐ _____

**Databases**

AS400 ☐
Access (MDB) ☐
Paradox ☐
Oracle ☐
SQL Server ☐
Other ☐ _____

**Text**

Delimited ☐ Specify Delimiter:_____
Fixed Length ☐ (Attach file specification)

***Document Data***

**Format**

Word Pro ☐
Ami Pro ☐
Word ☐
WordPerfect ☐
PDL ☐
HTML ☐
Other ☐ _____

## 4. DATA QUALITY

Answer as many of the following questions as possible for all data types. Questions with an asterisk (*) *must* be answered.

Why were these data collected (i.e., for what purpose)?

_____

_____

_____

*How were these data collected?

_____

_____

_____

*When were these data collected?

_____

_____

_____

Have these data been updated since their original creation? If so, how often and what was the nature of the update?

_____

_____

_____

When was the last update and what percentage of the data were affected (estimate if unknown and indicate it is approximate)?

_____

_____

_____

_____

(GIS Specialist Signature) Date

## Data Indexing Strategies

☑ Metadata

Metadata is simply "data about data." Metadata gives detailed information about all aspects of geospatial data.

Metadata can give background information about:

- Source
- History
- Content
- Quality
- Condition
- Availability
- Processing
- Technical Details

Although metadata is usually developed and obtained in a digital format, metadata can be posted as part of a paper map, primarily as part of the map legend. In this form, metadata is readily apparent and easily transferred between map producers and map users. This data is usually fairly simple and short, maybe just a few sentences, conveying the generalities about the data. For example: "This flood plain map was created with data obtained from USGS, was created in 1998, is in California State Plane, Central projection, and the datum is NAD83."

Digital data requires more effort and detail in development and maintenance on the part of data producers. However, this data is valuable in two ways:

1. The primary creator of the data benefits because metadata maintains the value of the data set, enabling its continued use over time

2. Metadata helps other users to find and use geo-spatial data, especially if the data are stored in a GIS clearinghouse or general repository

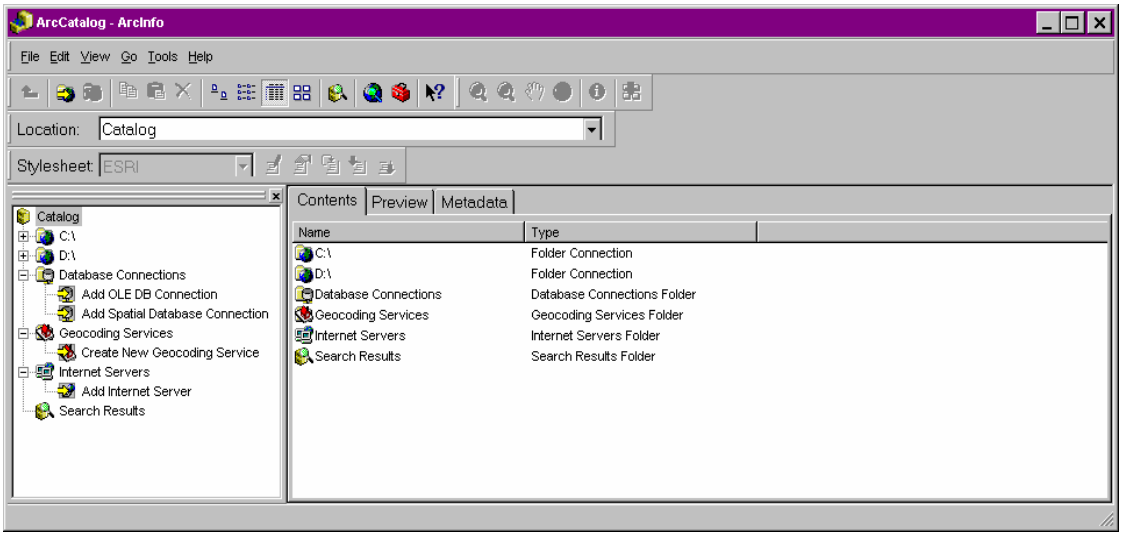
Various metadata standards have been developed over the years. One standard in wide use and acceptance is the Federal Geographic Data Committee (FDGC) "Content Standards for Digital Geospatial Metadata" in use by all Federal data producing agencies. The comprehensive metadata example provided below (see Example C) complies with Federal guidelines. However, there are minimum content standards that greatly simplify this standard, and alternatives are also presented.

☑ ArcCatalog

It is strongly recommended that the GIS Specialist implement a data indexing system to logically organize and share data. For immediate expanded use of GIS throughout the organization, metadata, storage location, and maintenance processes should be documented so all potential users of the GIS data will have a better understanding of the dataset they are using.

Integrating metadata into a GIS in a way that is readily accessible to users of all experience levels has proven to be a major challenge. Additionally, many government and private agencies have found the metadata system to be a bit cumbersome; consequently, these entities have not proactively updated or created this base information which is so crucial for end-users. With ESRI's latest release of ArcGIS 9, GIS data indexing has greatly improved and

as a result has allowed GIS users charged with managing data to update and edit metadata easily. ArcCatalog provides an intuitive and effective approach to previewing data, metadata, and managing data locations.




***Arc Catalog Interface***

Through the use of ArcCatalog, users can easily view directory structure, preview actual geodatabases, coverages, shapefiles, CADD files, and orthophotography files, as well as other file types. Previously created Metadata is automatically linked to these files, and is referenced with a click of the Metadata button. Metadata that has not been previously created can either be imported or created in one of many formats chosen by the user. These types are explained in detail below.

## Data Access in ArcCatalog

The Catalog is where users can assemble connections to data sources. When a connection is selected, the user accesses the data to which the file is linked. The connection might access a folder on a local disk, a database on the network, or an ArcIMS Internet server. Together, the connections create a catalog of geographic data sources. Once the desirable data has been found, the preview and metadata tabs can be clicked to show a view of the data, as well as the metadata describing the file.

## Creating and accessing geodatabases

To manage a spatial database, users can create a personal geodatabase, which stores data in Microsoft Access format. For an enterprise geodatabase, ArcSDE lets many people in an organization update data stored in a centrally located RDBMS.

### Data Organization in ArcCatalog

ArcCatalog manages maps and geographic data in a similar style as Windows Explorer. All standard Windows shortcuts and drag/drop techniques for copying, moving, renaming, or deleting items work in ArcCatalog. These features make it easy to organize not only data sources on disk (such as coverages and shapefiles), but data stored in databases as well. The user can copy or move database connections and coordinate systems from those folders in the Catalog to any other folder in any location; for example, SDE geodatabase connections and custom coordinate systems can be placed in a shared folder on the network where everyone in the organization can access them.

> **Note:**
> When a user copies, renames, or deletes data sources with ArcCatalog, auxiliary files and other data sources that are linked to the datasets are also copied, renamed, or deleted. For example, metadata, projection, and index files all accompany a file-based data source. A file-based raster's auxiliary files will accompany the raster. When copying a feature class from one personal geodatabase to another, any feature classes and tables that are linked to it through relationship classes will also be copied to the destination geodatabase.

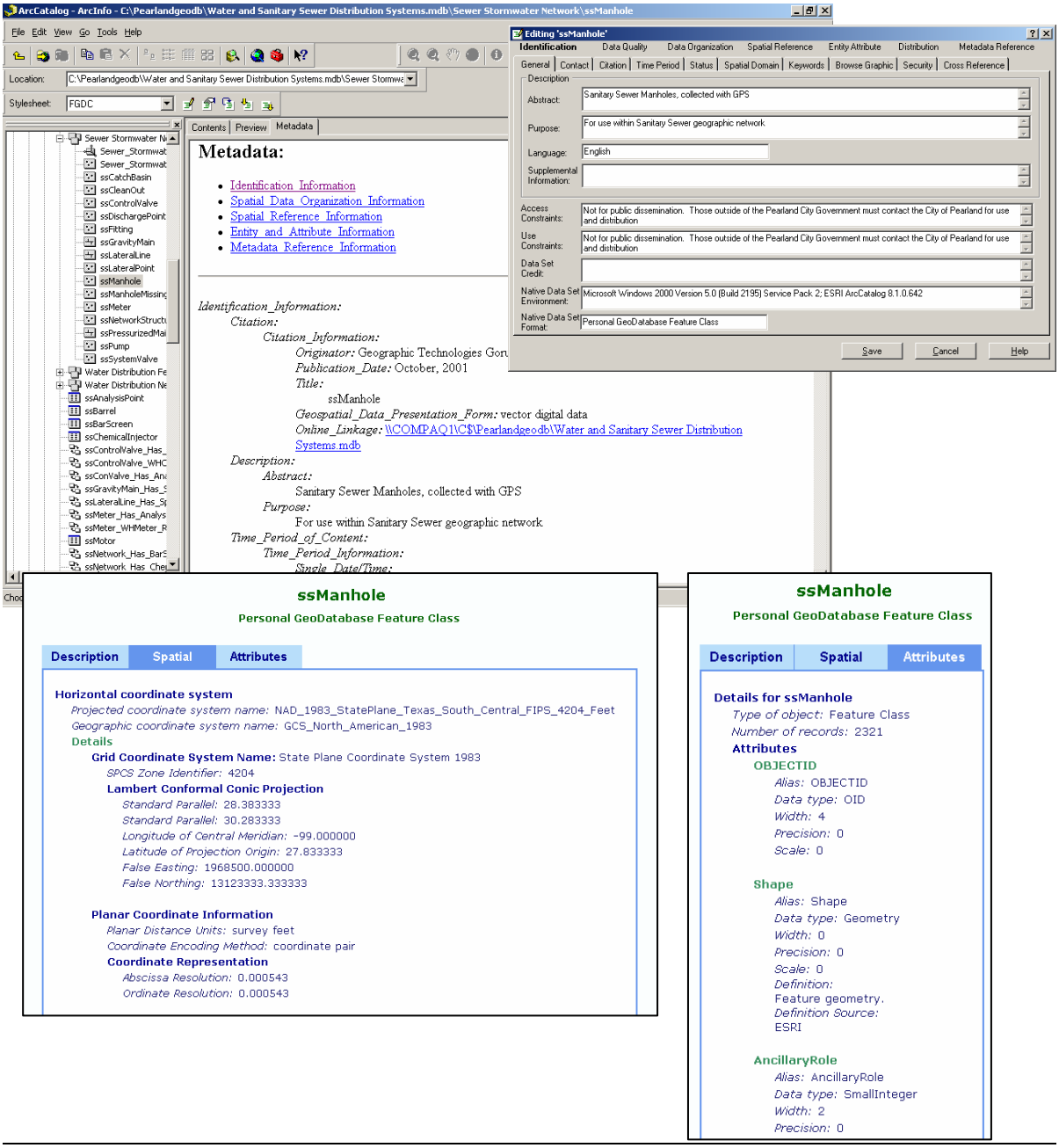
### How metadata is stored

Metadata created with ArcCatalog is stored as XML, either in a file alongside the item, or within its geodatabase. XML is a structured markup language similar to hypertext markup language (HTML). HTML defines both the data and how it is presented. XML, on the other hand, lets the user define data using tags that add context and meaning.

XML is an emerging industry standard that is being used to transfer data across the Internet. For example, it is often used in e-commerce transactions. Many different applications can be used to view or edit metadata XML files.

### Metadata for folders and geodatabases

Another new option of ArcCatalog is that the user can document the *contents* of a folder or geodatabase. This metadata is created in the same way as shapefile, coverage, or geodatabase layer metadata. The benefit of this type of documentation is to track important information such as date of creation, description of file contents and their purpose, and the status of completion. This type of information is helpful to other users when they are browsing for data.




***ArcCatalog's Metadata Documentation Functionality***

About importing and exporting metadata

Metadata that exists in earlier ESRI formats can be easily imported into ArcCatalog. The formats that are easily importable are:

- Text
- XML
- SGML - Standard Generalized Markup Language (SGML) format defined by the FGDC's metadata parser utility

ArcCatalog uses the FGDC's metadata parser utility itself to import and export metadata in its supported formats. The XML format can be used to import metadata that was created with ArcCatalog. The importers provided with ArcCatalog will overwrite all of an item's existing metadata.

Note: if ***Enable automatic update of metadata*** is unchecked, ArcCatalog will not overwrite any existing values.

FGDC Metadata Workbook

The FGDC Metadata Workbook, Version 2.0 is in electronic form (Adobe PDF - book marked enabled). The workbook is free of charge and is easily down loadable (size 130 pages, 1Mb). The workbook complies with the latest version of the FGDC Content Standard for Digital Geo-spatial Metadata (CSDGM), FGDC-STD-001-1998 and contends both textual and color graphical information about the FGDC CSDGM including background information, how to read and use the Standard, a color graphical and textual representation of the content information of the Standard, a description of Profiles and User Defined Metadata Extensions, and some metadata examples. The workbook is free to download and can be distributed among organizations. To access this workbook, visit the following link:
http://www.fgdc.gov/metadata/meta_workbook.html

*Why Metadata?*

The major uses of metadata are:

- Help organize and maintain an organization's internal investment in spatial data,
- Provide information about an organization's data holdings to data catalogues, clearinghouses, and brokerages
- To provide information to process and interpret data received through a transfer from an external source.

*The Standard*

What do internal and external organizations need to know about The City of West Sacramento's datasets? The standard provides a common set of terminology and definitions for the documentation of geo-spatial data, including data elements for the following topics:

- *Identification Information:* basic information about the data set. Examples include title, geographic area covered, currentness, and rules for acquiring or using the data.
- *Data Quality Information:* an assessment of the quality of the data set. Examples include positional and attribute accuracy, completeness, consistency, sources of information, and methods used to produce the data. Recommendations on information to be reported and tasks to be performed are in the Spatial Data Transfer Standard (Federal Information Processing Standard 173 - 1992).
- *Spatial Data Organization Information:* the mechanism used to represent spatial information in the data set. Examples include the method used to represent spatial

positions directly (such as raster or vector) and indirectly (such as street addresses or city codes) and the number of spatial objects in the data set.

- *Spatial Reference Information:* description of the reference frame for, and means of encoding, coordinates in the data set. Examples include the name of and parameters for map projections or grid coordinate systems, horizontal and vertical datums, and the coordinate system resolution.
- *Entity and Attribute Information:* information about the content of the data set, including the entity types and their attributes and the domains from which attribute values may be assigned. Examples include the names and definitions of features, attributes, and attribute values.
- *Distribution Information:* information about obtaining the data set. Examples include a contact for the distributor, available formats, information about how to obtain data sets online or on physical media (such as cartridge tape or CD-ROM), and fees for the data.
- *Metadata Reference Information:* information on the currentness of the metadata information and the responsible party.

The standard has sections that specify contact information for organizations or individuals that developed or distribute the data set, temporal information for time periods covered by the data set, and citation information for the data set and information sources from which the data were derived. The standard does not specify how this information is organized in a computer system or in a data transfer, nor the means by which this information is transmitted or communicated to the user. At this point in time, these formats are optional.

*Additional Information*

The standard and other metadata materials, along with the implementation guidelines for the clearinghouse, are available from the FGDC at the above address or from the FGDC server connected to the Internet via:

Anonymous FTP Metadata - www.fgdc.gov under the subdirectory /pub/metadata
Clearinghouse - www.fgdc.gov under the subdirectory /pub/clearinghouse

The README files in the subdirectories give detailed information about the available files.
FGDC Web Server http://www.fgdc.gov/

***Example A : FGDC- Compliant Metadata***

Identification_Information:
  Citation:
    Citation_Information:
      Originator:
        U.S. Department of Commerce
        Bureau of the Census
        Geography Division
      Publication_Date: 2001
      Title: TIGER/Line Files, Redistricting Census 2000
      Edition: Redistricting Census 2000
      Series_Information:
        Series_Name: TIGER/Line Files
        Issue_Identification: Version (MMYY) represents the month and year file created
      Publication_Information:
        Publication_Place: Washington, DC
        Publisher:
          U.S. Department of Commerce
          Bureau of the Census
          Geography Division
  Description:
    Abstract:
      TIGER, TIGER/Line, and Census TIGER are registered trademarks of the Bureau of the Census. The Redistricting Census 2000 TIGER/Line files are an extract of selected geographic and cartographic information from the Census TIGER data base. The geographic coverage for a single TIGER/Line file is a county or statistical equivalent entity, with the coverage area based on January 1, 2000 legal boundaries. A complete set of Redistricting Census 2000 TIGER/Line files includes all counties and statistically equivalent entities in the United States and Puerto Rico. The Redistricting Census 2000 TIGER/Line files will not include files for the Island Areas. The Census TIGER data base represents a seamless national file with no overlaps or gaps between parts. However, each county-based TIGER/Line file is designed to stand alone as an independent data set or the files can be combined to cover the whole Nation. The Redistricting Census 2000 TIGER/Line files consist of line segments representing physical features and governmental and statistical boundaries. The Redistricting Census 2000 TIGER/Line files do NOT contain the ZIP Code Tabulation Areas (ZCTAs) and the address ranges are of approximately the same vintage as those appearing in the 1999 TIGER/Line files. That is, the Census Bureau is producing the Redistricting Census 2000 TIGER/Line files in advance of the computer processing that will ensure that the address ranges in the TIGER/Line files agree with the final Master Address File (MAF) used for tabulating Census 2000.
    Purpose:
      In order for others to use the information in the Census TIGER data base in a geographic information system (GIS) or for other geographic applications, the Census Bureau releases to the public extracts of the data base in the form of TIGER/Line files. Various versions of the TIGER/Line files have been released; previous versions include the 1990 Census TIGER/Line files, the 1992 TIGER/Line files, the 1994 TIGER/Line files, the 1995 TIGER/Line files, the 1997 TIGER/Line files, the 1998 TIGER/Line files, and the 1999 TIGER/Line files. The Redistricting

Census 2000 TIGER/Line files were originally produced to support the Census 2000 Redistricting Data Program.
Supplemental_Information:
To find out more about TIGER/Line files and other Census TIGER data base derived data sets visit http://www.census.gov/geo/www/tiger.
Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 2000
Currentness_Reference: 2000
Status:
Progress: Complete
Maintenance_and_Update_Frequency:
TIGER/Line files are extracted from the Census TIGER data base when needed for geographic programs required to support the census and survey programs of the Census Bureau. No changes or updates will be made to the Redistricting Census 2000 TIGER/Line files.
Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: +131.000000
East_Bounding_Coordinate: -64.000000
North_Bounding_Coordinate: +72.000000
South_Bounding_Coordinate: -15.000000
Keywords:
Theme:
Theme_Keyword_Thesaurus: None
Theme_Keyword: Line Feature
Theme_Keyword: TIGER/Line
Theme_Keyword: Topology
Theme_Keyword: TIGER/Line Identification Number (TLID)
Theme_Keyword: Street Segment
Theme_Keyword: Coordinate
Theme_Keyword: Boundary
Place:
Place_Keyword_Thesaurus:
FIPS Publication 6-4
FIPS Publication 55
Place_Keyword: United States
Place_Keyword: Puerto Rico
Place_Keyword: County
Access_Constraints: None
Use_Constraints:
None. Acknowledgment of the U.S. Bureau of the Census would be appreciated for products derived from these files. TIGER, TIGER/Line, and Census TIGER are registered trademarks of the Bureau of the Census.
Native_Data_Set_Environment:
TIGER/Line files are created and processed in a VMS environment. The environment consists of two Alpha Server 8400s clustered together running OpenVMS version 6.2-1H3 used for production operations.
Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:

Accurate against Federal information Processing Standards
(FIPS), FIPS Publication 6-4, and FIPS-55 at the 100% level for the codes and base names. The remaining attribute information has been examined but has not been fully tested for accuracy.
Logical_Consistency_Report:
The feature network of lines (as represented by Record Types 1 and 2) is compete for census purposes. Spatial objects in TIGER/Line belong to the "Geometry and Topology" (GT) class of objects in the "Spatial Data Transfer Standard" (SDTS) FIPS Publication 173 and are topologically valid. Node/geometry and topology (GT)-polygon/chain relationships are collected or generated to satisfy topological edit requirements. These requirements include:
* Complete chains must begin and end at nodes.
* Complete chains must connect to each other at nodes.
* Complete chains do not extend through nodes.
Completeness_Report:
Data completeness of the TIGER/Line files reflects the contents of the Census TIGER data base at the time the TIGER/Line files (Redistricting Census 2000 version) were created.
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
The information present in these files is provided for the purposes of statistical analysis and census operations only. Coordinates in the TIGER/Line files have six implied decimal places, but the positional accuracy of these coordinates is not as great as the six decimal places suggest. The positional accuracy varies with the source materials used, but generally the information is no better than the established national map Accuracy standards for 1:100,000-scale maps from the U.S. Geological Survey (USGS); thus it is NOT suitable for high-precision measurement applications such as engineering problems, property transfers, or other uses that might require highly accurate measurements of the earth's surface. The USGS 1:100,000-scale maps met national map accuracy standards and use coordinates defined by the North American Datum, 1983.
Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator:
U.S. Department of Commerce
Bureau of the Census
Geography Division
Publication_Date: Unpublished material
Title: Census TIGER data base
Edition: Redistricting Census 2000
Type_of_Source_Media: On line
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 2000
Source_Currentness_Reference: Date the file was made available to create TIGER/Line File extracts.
Source_Citation_Abbreviation: TIGER
Source_Contribution:

Selected geographic and cartographic information (line segments) from the Census TIGER data base.
Process_Step:
Process_Description:
In order for others to use the information in the Census TIGER data base in a GIS or for other geographic applications, the Census Bureau releases periodic extracts of selected information from the Census TIGER data base, organized as topologically consistent networks. Software (TIGER DB routines) written by the Geography Division allows for efficient access to Census TIGER system data. TIGER/Line files are extracted from the Census TIGER data base by county or statistical equivalent area.
Source_Used_Citation_Abbreviation: Census TIGER data base
Process_Date: 2000
Spatial_Data_Organization_Information:
Indirect_Spatial_Reference:
Federal Information Processing Standards (FIPS) and feature names and addresses.
Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Geographic:
Latitude_Resolution: 0.000458
Longitude_Resolution: 0.000458
Geographic_Coordinate_Units: Decimal degrees
3) Locations of KGLs
Distribution_Information:
Distributor:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization:
U.S. Department of Commerce
Bureau of the Census
Geography Division
Products and Services Staff
Contact_Address:
Address_Type: Physical address
Address: 8903 Presidential Parkway, WP I
City: Upper Marlboro
State_or_Province: Maryland
Postal_Code: 20772
Contact_Voice_Telephone: (301) 457-1128
Contact_Address:
Address_Type: Mailing address
Address: Bureau of the Census
City: Washington
State_or_Province: District of Columbia
Postal_Code: 20233-7400
Contact_Voice_Telephone: (301) 457-1128
Contact_Facsimile_Telephone:
(301) 457-4710
Contact_Electronic _Mail_Address: tiger@census.gov
Resource_Description: Redistricting Census 2000 TIGER/Line Files
Distribution_Liability:

No warranty, expressed or implied is made and no liability is
assumed by the U.S. Government in general or the U.S. Census Bureau in specific as
to the positional or attribute accuracy of the data. The act of distribution shall
not constitute any such warranty and no responsibility is assumed by the U.S.
Government in the use of these files.
Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Format_Name: TGRLN (compressed)
Format_Version_Number: Redistricting Census 2000
Format_Version_Date: 2000
File_Decompression_Technique: PK-ZIP, version 1.93A or higher
Digital_Transfer_Option:
Online_Option:
Computer_Contact_Information:
Network_Address:
Network_Resource_Name: www.census.gov/geo/www/tiger
Fees:
The online copy of the TIGER/Line files may be accessed without charge. See
http://www.census.gov/geo/www/tiger for information on availability on CD-ROM/DVD
and associated costs for these products.
Ordering_Instructions:
To obtain more information about ordering TIGER/Line files visit
http://www.census.gov/geo/www/tiger.
Metadata_Reference_Information:
Metadata_Date: 2000
Metadata_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization:
U.S. Department of Commerce
Bureau of the Census
Geography Division
Products and Services Staff
Contact_Address:
Address_Type: Physical Address
Address: 8903 Presidential Parkway, WP I
City: Upper Marlboro
State_or_Province: Maryland
Postal_Code: 20772
Contact_Voice_Telephone: (301) 457-1128
Contact_Electronic_Mail_Address: tiger@census.gov
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: 19940608

### *Example B : FGDC- Compliant Metadata Table*

| Type | Example |
|---|---|
| ***Name*** | q3flood |
| ***Metadata date*** | 1998 |
| ***Feature*** | Polygon |
| ***Originator*** | Federal Emergency Management Agency |
| ***Description*** | The Q3 Flood Data are derived from the Flood Insurance Rate Maps (FIRMs) published by the Federal Emergency Management Agency (FEMA). The file is georeferenced to the earth's surface using the Universal Transverse Mercator (UTM) projection and a zonal coordinate system (units in meters). Specifications for the horizontal control of Q3 Flood Data files are consistent with those required for mapping at a scale of 1:24000. |
| ***Purpose*** | Purpose: The FIRM is the basis for floodplain management, mitigation, and insurance activities for the National Flood Insurance Program (NFIP). Insurance applications include enforcement of the mandatory purchase requirement of the Flood Disaster Protection Act, which "requires the purchase of flood insurance by property owners who are being assisted by Federal programs or by Federally supervised, regulated, or insured agencies or institutions in the acquisition or improvement of land facilities located or to be located in identified areas having special flood hazards" (Section 2 (b) (4) of the 1973 Flood Disaster Protection Act). In addition to the identification of Special Flood Hazard Areas (SFHAs), the risk zones shown on the FIRMs are the basis for the establishment of premium rates for flood insurance coverage offered through the NFIP. Q3 Flood Data files convey certain key features from the existing hard copy FIRM. Edge-matching errors, overlaps and deficiencies in coverage, and similar problems are not corrected during digitizing or post-processing. The Q3 Flood Data files are intended to provide users with automated flood risk data that may be used to locate SFHAs. More detailed information may be obtained from the paper FIRM. |
| ***Time Period of Content*** | Calendar Date: 1998 |
| **Status** | Progress: Complete<br>Maintenance and Update Frequency: Irregular |
| **Point of Contact** | Contact Organization: Federal Emergency Management Agency, Mitigation Directorate<br>Contact Address<br>Address: 500 C Street, S.W.<br>City: Washington<br>State or Province: District of Columbia<br>Postal Code: 20472<br>Contact Voice Telephone: 1-800-358-9616 |
| **Attribute Definitions** | *Fips:* County code.<br>*Long:* Longitude<br>*Lat:* Latitude<br>*State:* State code<br>etc. |
| **Process Steps** | *Q3 Flood Data were produced by either scanning and vectorizing or manually digitizing a hardcopy version of the graphic materials. The scanning and vectorization process captured the digital data as raster data that were vectorized and attributed on an interactive editing station. The manual digitizing process used a digitizing table to capture the digital data; attribution was performed either as the data were digitized or on an interactive edit station after the digitizing was completed. The determination of the production methodology was based on various criteria, including availability of production systems. Four to nine control points per FIRM panel were used for registration during manual digitizing. A projective transformation was performed on the coordinates used in the data collection and editing systems to register the digital data to the Universal Transverse Mercator (UTM) grid coordinates. An ARCINFO coverage of the Q3 Flood Data was generated and used to create the Q3-DLG file. The Q3 Flood Data were checked for position and attribute accuracy by comparing plots of the digital data to the source graphic and by symbolized display on an interactive computer system. Selected attributes that could not be visually verified were individually queried. In addition, an ARCINFO Arc Macro Language (AML) software program was applied to the dataset to test the attributes against a master set of valid attributes for the specific data category and a complete set of valid attribute combinations. Source graphics were revised to reflect updates effected by Letters of Map Change (Letter of Map Revision [LOMR], Letter of Map Amendment [LOMA]). These revisions were included in the Q3 Flood Data if they were mappable at the publication scale of the source graphic.* |

## Metadata Recommendations

It is recommended that the City of West Sacramento adopt the metadata standard used by Yolo County. Maintaining the same standard as the County will facilitate data sharing between the City and the County. Additionally, it may prove valuable for both the City and County to collaborate on modifying metadata standards in the future with other local governments to ensure that metadata is homogenous both locally and regionally.

There are a number of third party software applications that make standardization and production of metadata a much simpler task. ESRI ArcGIS also includes metadata tools (as detailed above) that are recommended. Regardless of the metadata standard and production method selected, it should be:

- adopted for Citywide use
- documented for distribution
- readily accessible with any GIS layer
- a "living" document that can be modified
- distributed with data
- required for new data additions/submissions

# Chapter 7 – External Entities and Organizations

In This Chapter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## Introduction

The level of success obtained through the implementation of GIS often relies heavily on the cooperation of other government agencies and private sector organizations. This is particularly true for the City of West Sacramento. There is a tremendous amount of GIS data that currently exists for the City of West Sacramento. Federal, state, regional and local government agencies, engineering and surveying firms, local utility companies, and private developers and data vendors all may possess data that could prove valuable to the City of West Sacramento. Much of this information can be obtained at a nominal cost or free of charge. Many of these data layers have been developed over the years by other entities through their own GIS and related mapping projects. The City of West Sacramento should continually monitor external sources for applicable data.

Throughout the United States, Geographic Information Systems have served to break down not only the traditional barriers that exist between departments within an organization, but also barriers that have existed for years between other organizations. The technology serves as a catalyst for cooperation and will provide opportunities for inter-agency collaboration and cooperation. The most successful GIS programs have seized the opportunity for cooperation and data sharing, often highlighting this as one of the most important benefits derived from the implementation of GIS.

Establishing a good working relationship with other organizations early in the project is crucial. The City of West Sacramento should inform these organizations about the data and expertise that the City is developing; in addition it should make these organizations aware of the mutual benefit derived from this effort. Establishing and maintaining mutually beneficial relationships with other organizations may facilitate and expedite data sharing as well as reduce costs.

### Engineering and Surveying Firms

Most civil engineering, land development, and survey firms have automated their subdivision plat and mapping capabilities, utilizing a computer-aided drafting (CADD) package (usually Microstation or AutoCAD) for highly detailed plat and construction drawings. CADD data features are compatible with GIS features, sharing many common topological relationships. Nearly all CADD applications can export map data to the digital exchange format (DXF) and, in the case of Microstation, Design (DGN) files. GIS applications can often import digital data directly from the CADD package's native format. DXF files can be read directly by the GIS applications being recommended for the City of West Sacramento. These files can

remain in DXF format or converted to a GIS format. As aforementioned in various Community Development sections of the Needs Assessment, the City of West Sacramento has establisjed a formal protocol that requires the delivery of electronic drawings files by development, engineering, and survey firms as a compliment to paper maps. Subsequently, new and proposed development data should be incorporated into the City's GIS. Most regional civil engineering and land development firms create subdivision plats and construction drawings in GIS-supported CADD formats fully capable of meeting this requirement.

## Yolo GIS Cooperative

Yolo County, California

Yolo County serves as the lead agency for the Yolo GIS Cooperative. The cities and county government of the County of Yolo, California in conjunction with the Sacramento Area Council of Governments (SACOG) formed a cooperative to develop GIS procedures, tools, and data that are shared between agencies in the cooperative in order to improve the effectiveness and efficiency of GIS programs in each agency. The Yolo GIS Cooperative, consisting of the County of Yolo, SACOG, the City of Davis, the City of West Sacramento, the City of Woodland, and the City of Winters, was formed to implement GIS projects that would benefit each agency and the region.

The Yolo GIS Cooperative retained a consultant to prepare a base map management plan that would form the blueprint for creating a County-wide base map that could be used with GIS and CADD programs. The plan provides specifications and procedures for the creation of a County-wide parcel base map that is maintained and distributed through the Information Technology Division of the County of Yolo.

In 2002, the Cooperative acquired shared licenses of digital orthophotography and software through an agreement between SACOG and AirPhoto USA, a private vendor of digital imagery and viewing software. A second set of digital orthophotography, taken in April 2002, will form the basis for compiling and adjusting existing digital files and digitizing new parcel lines where needed.

It is recommended that the City continue to collaborate on Cooperative efforts and initiatives. The City's existing collaboration and data sharing efforts with regards to its parcel and street centerline layers have proven to be valuable to the City, and it is expected that the City will continue to benefit from the data, tools, processes, and standards produced and maintained by the Cooperative. It should be noted that the cost-sharing structure for aerial photography acquisition is ideal for reducing the often expensive cost of procuring high-resolution digital orthophotography.

## County of Yolo

Woodland, California

| | |
|---|---|
| Contact: | Mike Martinez, GIS Coordinator |
| | 625 Court Street, Rm. B-01 |
| | Woodland, CA 95695 |
| Telephone: | (530) 666-8040 |
| Email: | mmartinez@yolocounty.org |
| Web Site: | http://www.yolocounty.org |

The County of Yolo has a formal GIS Section in the County's Information Technology Division. The County and the City of West Sacramento have an existing relationship based on exchange of geo-spatial data and complementary GIS documentation. In addition, the Yolo GIS Cooperative serves as a common link between both organizations.

The County has managed to implement GIS extensively, and it has made significant progress in leading the Yolo GIS Cooperative in its mission to standardize parcel layer management. The City and the County have a complementary working relationship, which provides a mutually beneficial context for GIS data sharing.

The County of Yolo's GIS infrastructure is robust. It utilizes several enterprise GIS applications, including ArcGIS and ArcIMS.

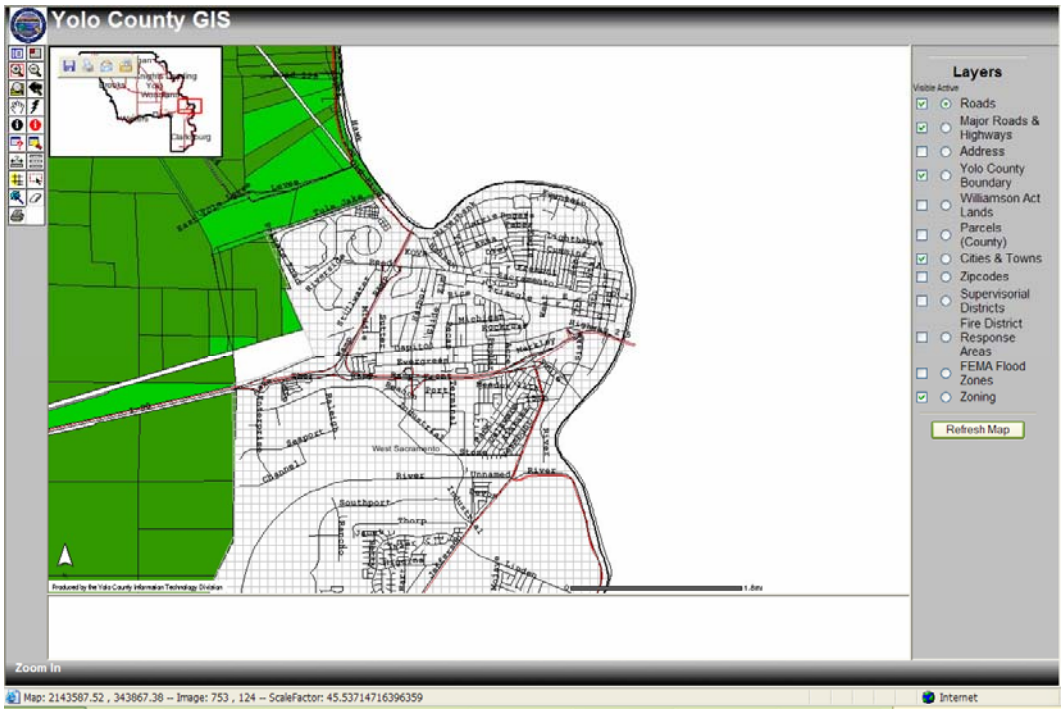


***Figure 7-1: Yolo County ArcIMS Application***

In addition to SmartMap, the County of Yolo has invested in the development of several GIS layers. The table below provides a summary listing of most of the data maintained by the County.

| LAYER | DESCRIPTION |
|---|---|
| CCSHEDS | cache creek watersheds |
| CHANLTMA | long term mining along cache creek |
| COMMROUTE | proposed communication routes |
| CSA11 | county service area 11(dunnigan) |
| CSA11BOUND | county service area 11 boundary |
| DWRCROP97 | 1997 dwr crop data |
| FARM98-2002 | 1998-2002 DOC important farmlands map |
| FUGA | future urban growth areas (cities) |
| GPDISS | generalized general plan areas - dunnigan |
| LEADRA | high risk areas for lead paint exposure(woodland) |
| LEADSITES | lead paint case sights(woodland) |
| MADISONSD | madison service district |
| MINERAL | mineral resource zones |

| | |
|---|---|
| NDDBPNT | CDFG NDDB species locations |
| RAILROAD | railroad(incomplete) |
| SPHERE | spheres of influence |
| STATELANDS | lands held by the state of California |
| UCDLAND | lands held by UC Davis |
| WILLOWSA | Willowbank service area |
| YCFCWCD | Yolo county flood control and water conservation district boundary |
| ZONEDISS | generalized zoning map |
| ZONING | |
| ADDGRID | Addressing Grid - used to assign addresses |
| ADDRESS | Addresses in Unincorporated County |
| ARCHEO | archeological sites in Yolo County |
| BLM | Bureau of Land Management lands |
| BOS | Board of Supervisors districts |
| BYPASS | sacramento river bypass |
| Cellular | Cellular Phone Tower locations |
| CENSUS | census tracts |
| CHANNELS | creeks and waterways |
| CITIES | Incorporated city boundaries |
| COMMLINE | communications backbone |
| COMMPOINT | |
| COUNTIES | state of california county boundaries |
| DUNLIGHT | dunnigan lighting district |
| EXPANSIVE | expansive soils(subset of soils) |
| FIRE | fire districts |
| FIREORA | fire department Operational response areas |
| FLOOD | fema flood zones - unincorporated area |
| FLOODWAY | fema designated floodway |
| FREQFLOOD | frequently flooded areas (anecdotal) |
| HABITAT | HCP delineated habitat from 1989 aerial photos |
| HISTSITE | state historical sites |
| MDROAD | road data |
| MJRROAD | major roads and highways |
| MJRROADTXT | text coverage for mjrroad |
| PANEL | fema flood panels |
| PARCELS | assessor's parcel boundaries |
| PARKS | yolo county parks |
| ROAD | county roads |
| ROADTXT | text coverage for roads |
| Roadcl | Road centerlines from SACOG |
| SCHOOL | school district boundaries |
| SECTION | township, range and sections |
| SOILS | soil mapping units from soil survey |
| TOWNS | unincorporated town boundaries |
| WILDLAND | CDF wildlands |
| YLTEASE | easements held by the Yolo Landtrust |
| YOLOCO | county boundary |
| ZIPCODE | yolo county zipcodes |

| | |
|---|---|
| ZONING | zoning for unincorporated area |
| PUEA | potential urban expansion areas |

Relevant County staff should be included in the membership of the recommended City of West Sacramento GIS Users Group.

## Sacramento Area Council of Governments (SACOG)

Sacramento, CA

Contact: Joe Concannon, Senior GIS Analyst
1415 L Street, Suite 300
Sacramento, CA 95814
Telephone: (916) 340-6234
Email: jconcannon@sacog.org
Website: http://www.sacog.org

The Sacramento Area Council of Governments (SACOG) has several dedicated GIS staff that work in the organization's Mapping Center. The Mapping Center coordinates Local, State and Federal Geospatial Information in the six-county SACOG Region. These information layers support the Geographic Information Systems (GIS) used by all levels of government.

Coordinated base map programs developing among the local governments in El Dorado, Placer, Sacramento, Sutter, Yolo and Yuba Counties now manage the parcel and street layers. SACOG is working with State and Federal agencies to move their planning overlays to these new base maps. SACOG is actively involved in the Yolo GIS Cooperative, and it has been pivotal in facilitating the exchange of data between the City of West Sacramento and other Cooperative members. SACOG was responsible for establishing a cost-sharing digital orthophotography contract with AirPhoto USA.

The City is currently working with SACOG on the revision of its street centerline layer. SACOG has been responsible for facilitating the City's standardization of its street centerline layer based on SACOG's standards. SACOG has released several documents on the street centerline layer maintenance process, as well as the standards to be implemented in conjunction with this maintenance. SACOG has developed a centerline attribute editing tool that works as an extension of ArcGIS (see Chapter 4: Base Map Creation and Consideration for more information).

SACOG also maintains a Regional GIS Clearinghouse, Reference Maps, and Interactive Maps.

*Regional GIS Clearinghouse*

This clearinghouse contains metadata, file owner-maintainer information, and in some cases ESRI based shape files for the basic mapping layers in our region. In most cases, these GIS infrastructure layers have been developed on either the County parcel base map or SACOG's 2000 Census base map. Users should read each metadata file to determine the appropriate uses and related layers that can be used each file.

SACOG maintains the following layers as part of the clearinghouse:

| **Administrative Boundaries** |
|---|
| Region |
| City Limits as of December 2004 |
| Counties of the SACOG Region |
| SACOG Planning Area |
| Spheres of Influence July 2004 |
| Yuba-Sutter Ozone Planning Area |
| |
| Special Districts |
| Sacramento Urban Services Boundary |

| **Demographic** |
|---|
| Census |
| Region Blocks 1990 |
| Region Blocks 2000 |
| Region Census Designated Places 2000 |
| Region Tracts 1980 |
| Region Tracts 1990 |
| Region Tracts 2000 |
| Urbanized Davis 2000 |
| Urbanized Galt-Lodi 2000 |
| Urbanized Sacramento 1990 |
| Urbanized Sacramento 2000 |
| Urbanized Yuba City-Marysville 2000 |
| |
| Parcels |
| El Dorado County - metadata only |
| Placer County - metadata only |
| Sacramento County - metadata only |
| Sutter County - metadata only |
| Yolo County - metadata only |
| Yuba County - metadata only |
| |
| SACOG |
| Region Minor Zones 1990 |
| Region Minor Zones 2000 |
| Region MinorZones 2004 |
| Region Regional Analysis Districts |
| Region Traffic Analysis Zones 2004 |

| **Land Classifications** |
|---|
| General Plan |
| Region Generalized General Plan land use data |
| |

| |
|---|
| Special |
| Sacramento County Destinations |

| **Physical Geography and Resource Information** |
|---|
| Water |
| Region Flood Control Bypasses |
| Region River Centerlines |
| Region Significant Creeks |
| Region Significant Lakes & Reservoirs |

| **Transportation** |
|---|
| Airport Land Use Commission |
| Executive Airport noise contours |
| Franklin Field noise contours |
| Mather Field airport noise contours |
| Rio Linda Airport noise contours |
| Sacramento International Airport noise contours |
| Sunset SkyRanch noise contours |
| Sutter County Airport - Airport bounds |
| Watts Woodland Airport - Airport bounds |
| Yolo County Airport - Airport bounds |
| Yuba County Airport - Airport bounds |
| |
| Region |
| Airports - all airports |
| Rail - Heavy & light rail lines |
| |
| Street centerlines |
| El Dorado January 2001 |
| Placer January 2001 |
| Sacramento July 2004 |
| Sutter August 2003 |
| Yolo September 2004 |
| Yuba September 2004 |
| |
| Transit |
| Region Park and Ride lots |
| Sacramento Regional Light Rail lines |
| Sacramento Regional Light Rail stops |
| Sacramento Regional Transit bus routes |

*Reference Maps*
SACOG maintains reference maps showing US Census Bureau geographies such as tracts and blocks. Other reference maps available are Regional Analysis Districts-Minor Zone maps for use with Projections, or for Population, Housing and Employment estimates. Maps are available for SACOG's six county region containing El Dorado, Placer, Sacramento, Sutter, Yolo, and Yuba Counties.

*Interactive Maps*
SACOG's Interactive Maps allow users to zoom in, pan and identify the features of online map. Census Data Maps include Population, Employment, Age and Vehicles Available. There is also a Parks and Open Space Map.

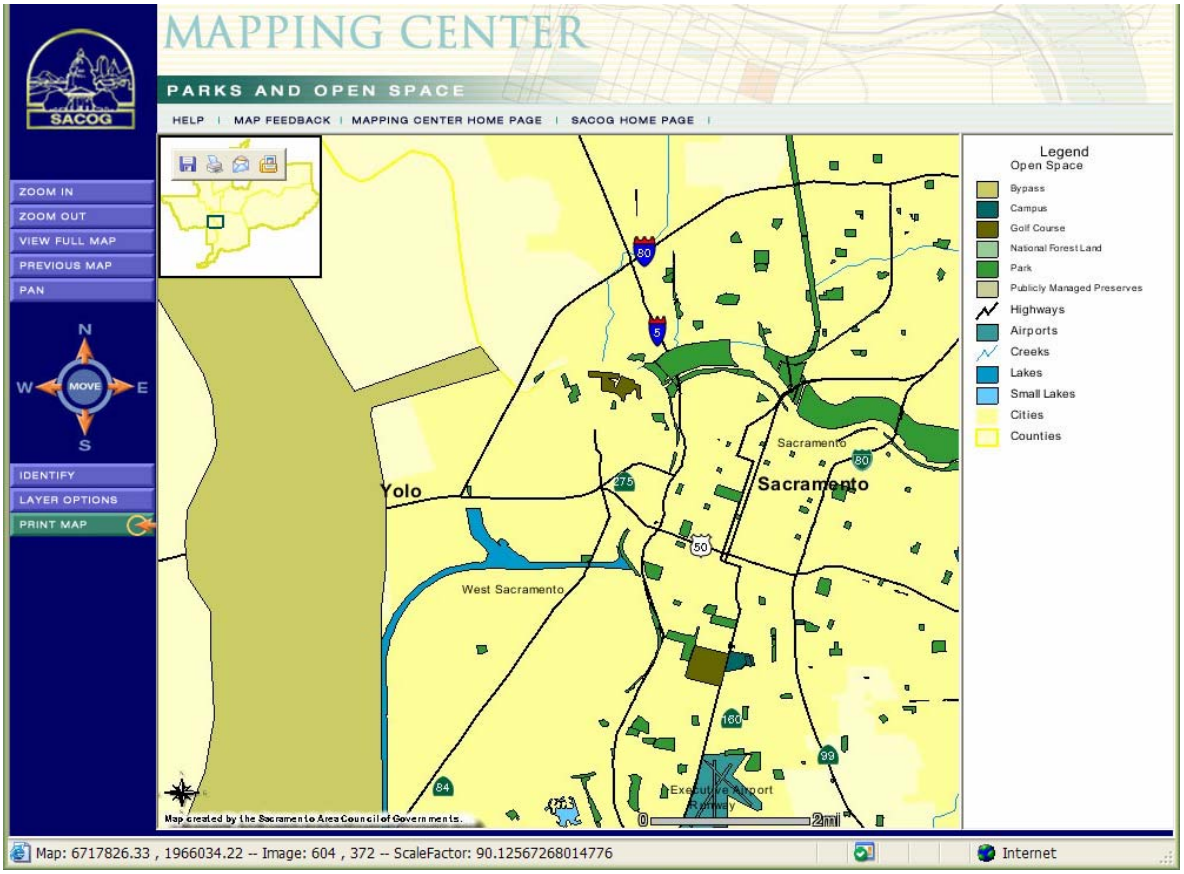


***Figure 7-2: SACOG's Park and Recreation Interactive Map (Web-Based)***

## Yolo County Communications Emergency Services Agency (YCCESA)

Woodland, CA

Contact: Martin L. Jones, Regional Information Systems Manager
YCCESA
35 N. Cottonwood St.
Woodland, CA 95695
Telephone: (530) 666-8911
FAX: (530) 666-8909
Email: martin.jones@yccesa.org
Website: http://www. yolo.net/yolocomm (or http://www.yccesa.org)

YCCESA provides dispatch services in a centralized operation for Sheriffs' Office, Woodland Police, West Sacramento Police, Winters Police and Fire Departments, (Municipal and Volunteer) for the majority of Yolo County. Davis Police Department maintains a separate dispatch center operating on the same hardware and software as YCCESA. They are connected via a pair of T1 circuits for bandwidth and redundancy.

The communications center is located in Woodland, it is equipped with eight (8) fully redundant workstations for call taking and dispatching for law and fire. Minimum staffing is 5 personnel, 4 call takers/dispatchers and a supervisor. A second center is located in Davis, it is equipped with three (3) fully redundant workstations for call taking and dispatching for law and fire for Davis Police and Fire. Communications staff at YCCESA includes a Communications Manager, IT Manager and two IT Technicians.

YCCESA has just completed installation of PLANT Vesta Pallas and runs a Northrup Grumman (PRC) Computer Aided Dispatch System. The CAD is the ALTARIS version 30.7 running on UNIX. YCCESA play a critical role in many of the City's emergency response activities. The Agency is responsible for generation of several map books, including those utilized by the Fire Department; it is expected that SACOG will assume future responsibility of generating these map books.

YCCESA's information technology infrastructure is fairly complex, although its GIS infrastructure is still in development. The Agency's "Pepper White" system, which provided mapping capabilities in patrol cars is being phased out, due in part to the lack of accuracy for the maps utilized in the system. The Agency is interested in implementing an AVL solution in the future, although at present it has no AVL capabilities. Many of the Agency's GIS needs lie in the acquisition, consolidation, and integration of geo-spatial data with its existing platform.

It should be noted that the Agency's CAD system utilizes an "atom" based model for location; an atom can be defined in a variety of ways, including a single address, block range, or multiple blocks. As a result, it is difficult to standardize a location as a single unit—one of the key efforts for future CAD/GIS integration will be migration to a discrete address model, whereby location is tracked at the address level. In addition, the Agency expressed the need for frequent integration of SACOG's updated street centerline layer as part of the dispatch system. The City's current work on updating the street centerline layer can be leveraged for this need. YCCESA has identified a need for maintenance of the street centerline layer that is segmented by Emergency Service Zones and Police Beats—the maintenance of such a layer presents several challenges, as the data model required for use by YCCESA does not coincide with that of the street centerline layer currently maintained by SACOG. In the short term, it is recommended that the existing workflow/environment that has been established by SACOG and its various member cities should be maintained until such a time when a street centerline layer model that meets the needs of YCCESA is developed.

YCCESA released an RFP for a "Dispatch Map Display System" in August, 2004. The proposed dispatch map display system will fulfill the Agency's need for Phase I and Phase II Wireless 911 call mapping. At present, YCCESA is deliberating on proposed solutions, and it is expected that the Agency will make a final decision by the end of 2004. This system will include the capabilities for tracking cellular telephone calls in a hybrid capacity, including GPS, triangulation from cellular towers, and cellular sector centroid.

It is recommended that the City continue to cooperate and coordinate the City's emergency dispatch with YCCESA. As part of the JPA, the City's GIS implementation will yield various benefits for YCCESA's operations, including improved data sharing, maintenance of an accurate and functional street centerline layer, and technical oversight and participation in YCCESA's internal GIS implementation.

## Utilities

PG&E

Contact: 1410 Merkley Ave
West Sacramento, CA 95691
Telephone: 1-800-743-5000
Email: http://www.pge.com/contact_us/contact_us_form.jsp?ref=null
Web Site: http://www.pge.com

Pacific Gas and Electric Company is one of the largest combination natural gas and electric utilities in the United States. The company, a subsidiary of PG&E Corporation, serves approximately 14 million people throughout a 70,000-square-mile service area in northern and central California.

Many electric and natural gas utilities acquire spatial data about the infrastructure they are responsible for operating and maintaining. The City of West Sacramento should contact PG&E to inquire whether they are willing to share any of the spatial data they may have acquired.

## State of California

California GIS Council

Contact: California GIS Council
900 N St.
Sacramento, Ca. 95814

Telephone: (916) 653-1369
Email: ray@ceres.ca.gov
Web Site: http://gis.ca.gov/council

The California GIS Council (CGC) met for the first time Wednesday, August 13, 2003. Made up of representatives from local, tribal, state and federal government agencies and the private sector, this council was formed to collaborate on the planning, implementation and maintenance of a California GIS infrastructure. The term "infrastructure" is used here in a holistic sense to encompass systems, organizational programs, policy, standards, procedures, and any other factors that affect the ability of member organizations to jointly develop or acquire, share and maintain spatial data adequate to their needs.

A key element of the CGC is the formation and participation of local collaboratives (e.g., Regional GIS Councils) composed of representatives of county, city and tribal governments, resource conservation and other special districts, private and public utilities, local colleges and universities and private sector organizations the local government agencies deem appropriate. Input from local government and those private sector entities that provide support services is seen as essential to council success.

California Mapping Coordinating Committee (CMCC)

Web Site: http://gis.ca.gov/cmcc.epl

The California Mapping Coordinating Committee (CMCC) is comprised of both management and technical representatives from various boards, departments, offices, conservancies, and commissions (BDOCCs) throughout California State government that use geographic information system (GIS) technology. The Resources Agency resurrected the CMCC in 1999 after several years of inactivity, and increased participation by reaching out to other agencies. It is the intent of the CMCC to continue to reach out to other State agencies and foster collaboration within and outside of State government, on the development and use of geographic data, services and technologies in pursuit of better public service.

The following agencies have participated on the CMCC to date:

- Dept. of Forestry
- Office of Emergency Services
- State Water Resources Control Board
- Dept. of Fish & Game
- Resources Agency
- Health and Human Services Agency
- Coastal Commission
- Integrated Waste Mgmt. Board
- Dept. of Transportation
- State Board of Equalization
- Teale Data Center
- Dept. of Conservation
- Dept. of Pesticide Regulation
- Office of Planning & Research
- Dept. of Water Resources
- Air Resources Board
- Department of General Services
- Department of Food and Agriculture
- State Library
- Dept. of Parks and Recreation
- Office of Statewide Health Planning & Development
- State Lands Commission

California Spatial Information Library (CaSIL)
Web Site: http://gis.ca.gov

CaSIL is a Library of Spatial data products of importance to the State of California, providing a simple interface to the largest audience. CaSIL has over one terabyte of spatial data available. CaSIL serves as a node of the National Spatial Data Infrastructure (NSDI) Clearinghouse. In addition, CaSIL is partially supported and maintained by the University of California at Davis.

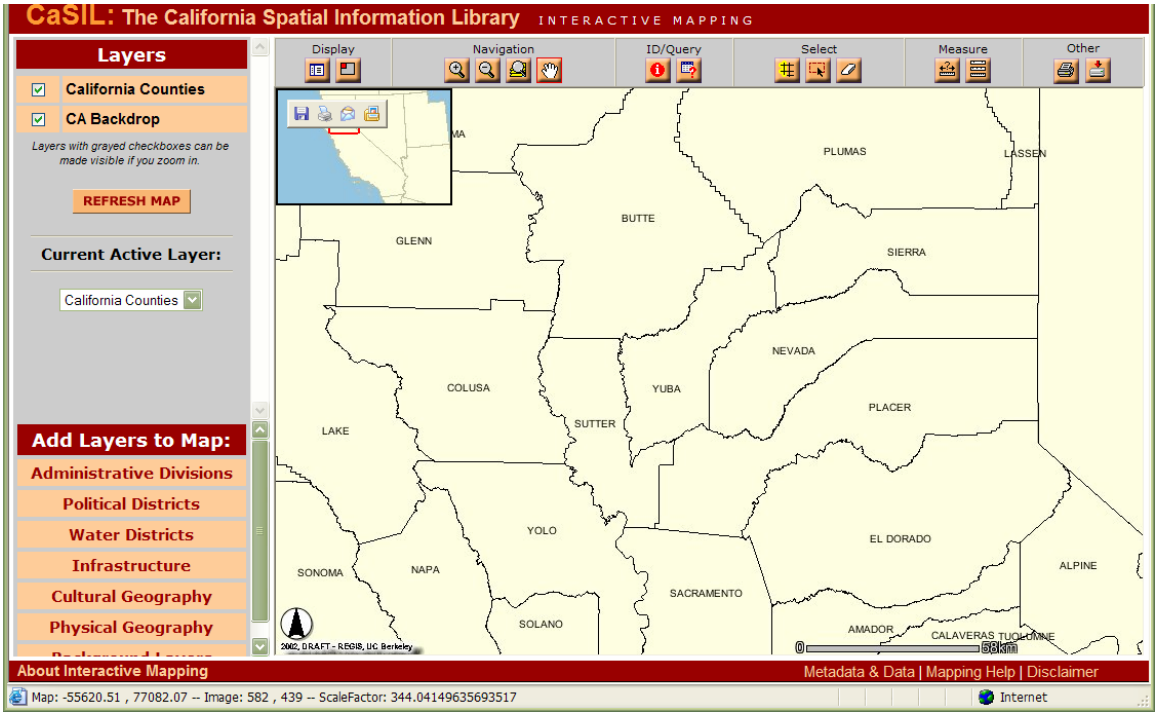


***Figure 7-3: CASIL Interactive Mapping (Web-Based)***

## GIS User Groups

California/Guam/Hawaii/Nevada Regional User Group

Contact: Chuck Johnson—Chairperson
U.S. Bureau of Reclamation
2800 Cottage Way (MP-400)
Sacramento, CA 95825
Telephone: (916) 978-5266
Email: cbjohnson@mp.usbr.gov
Web Site: http://www.cahinv.org

Sacramento Regional ArcGIS Users Group

Contact: Bruce Boyd
City of Davis
23 Russell Blvd.
Davis, CA 95616
Telephone: (530) 757-5654
Email: bboyd@city.davis.ca.us
Web Site: http://www.dcn.davis.ca.us/~arcview/

ESRI International User Group-Annual Meeting
http://www.esri.com

The largest, worldwide, gathering of GIS professionals, meets in San Diego each summer. Open to users of ArcGIS software, current in annual maintenance payments, who receive free admission based on the number and type of licenses held. The conference provides extensive new product information and software development updates, real-world application seminars and success stories.

## Private Sources (Free and Low-Cost GIS Data)

ESRI has developed a web site called ArcData Online (http://www.arcdataonline.com) that has a variety of geographic data available. After you register, you will gain access to both free and commercial data sets that may be licensed and downloaded. An example of some of the free data includes census TIGER data.

- Alternate Street Names
- Census Block Demographics (2000)
- Census Block Group Demographics (2000)
- Census Block Groups
- Census Blocks
- Census Tract Demographics (2000)
- Census Tracts
- Census Transportation Areas
- Congressional Districts
- County (1990 Boundaries)
- County (2000 Boundaries)
- Key to Geographic Locations
- Land and Water Outlines
- Landmark Areas
- Landmark Points
- Line Features
- Line Features, Railroads
- Line Features, Ridges/Fences
- Line Features, Streams
- Line Features, Streets
- Line Features, Utility Lines
- Minor Civil Divisions (1990)
- Minor Civil Divisions (2000)
- Places (1990)
- Places (2000)
- School Districts, Unified
- Traffic Analysis Zones
- Urban Areas
- Urban and Rural Outlines
- Voting Districts (1990)
- Water Bodies

Some other datasets that are available through the ESRI site for free or at a low cost include:

- US Road Data
- US Digital Imagery
- US Flood Data
- US Environmental Data

The Geography Network (ESRI)
http://www.geographynetwork.com

The Geography Network is a global network of geographic information users and providers. It provides the infrastructure needed to enable the sharing of geographic information between data providers, service providers, and users around the world. The Internet is used to deliver geographic content to the user's browser and desktop. Through the Geography

Network, you can access many types of geographic content including live maps, downloadable data, and more advanced services.

The Geography Network content is distributed at many locations around the world, providing you access to the latest information available directly from the source. Along with the use of ArcGIS 8 the geography network allows direct connection to the data with out any downloading required.

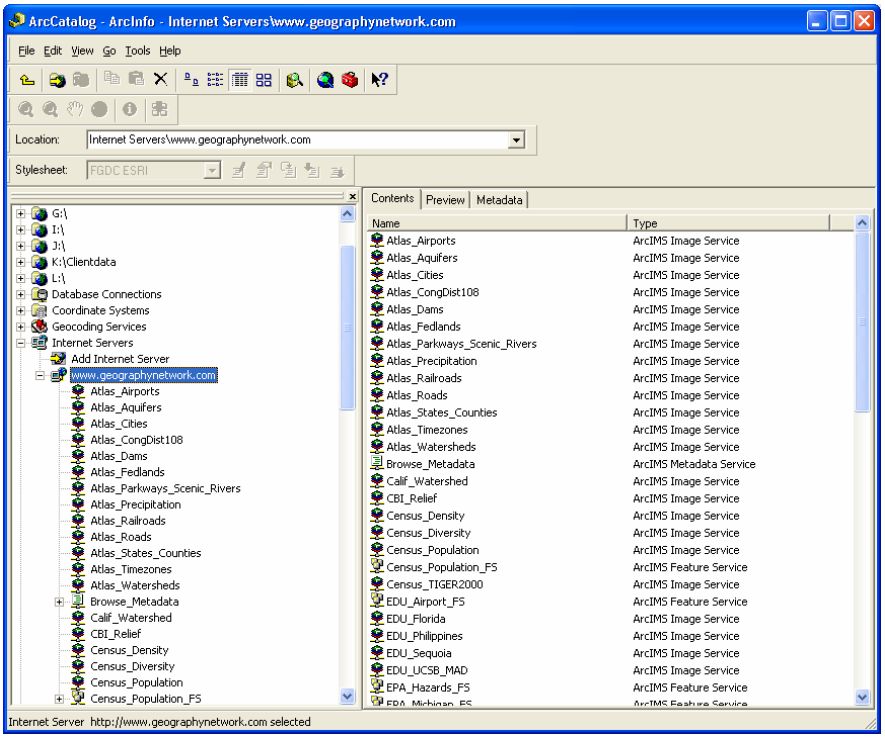


***Figure 7-4: ArcGIS Live Connection to Geography Network Datasets in ArcCatalog***

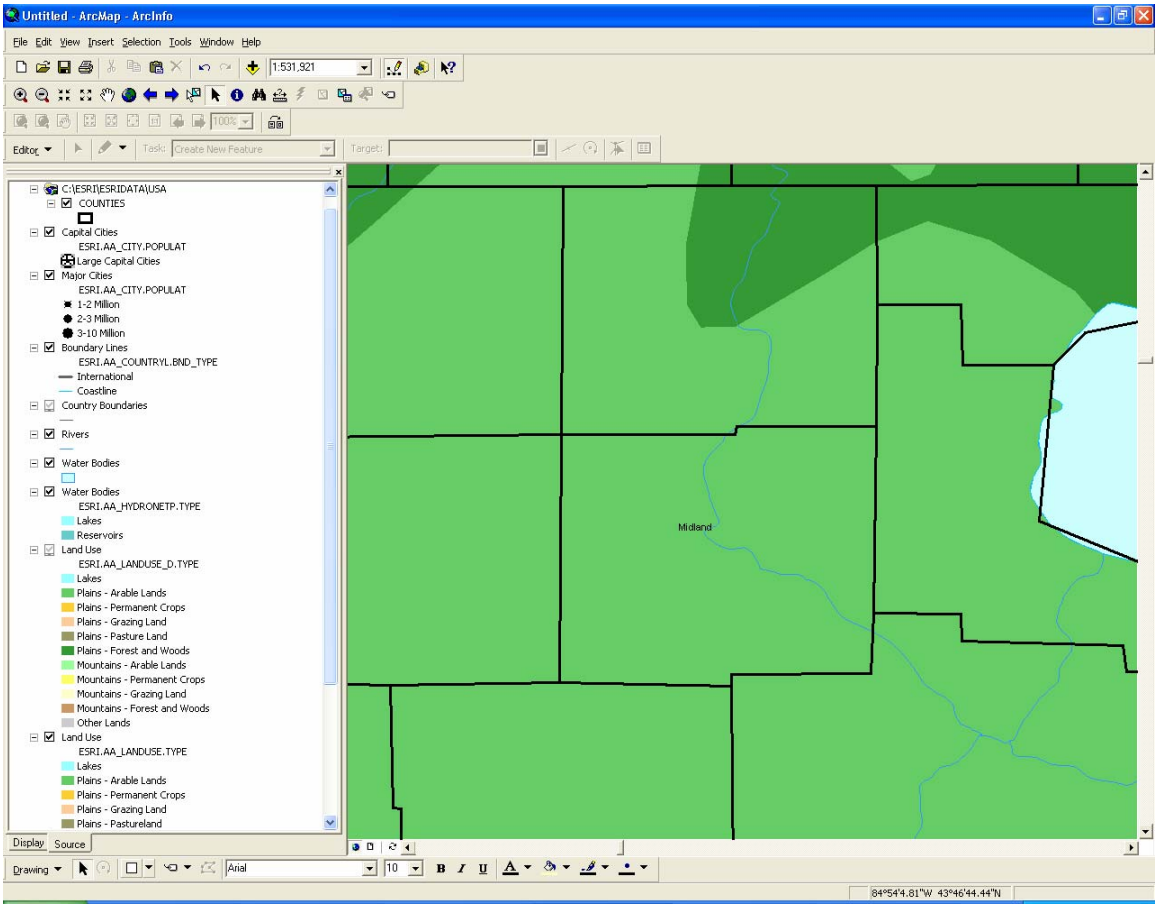


***Figure 7-5: ArcGIS Live Connection to Geography Network Datasets in ArcMap***

**Summary**

The City of West Sacramento's GIS implementation is mutli-faceted, and the City's interaction with external entities will have a significant impact on this implementation. The City has the opportunity to foster greater communication and understanding with these entities about its GIS mission and objectives. In addition, as the City's GIS utilization and expertise continue to improve, the City can lead and/or contribute to local and regional efforts aimed at improved data sharing, formal data standards, data processing and maintenance workflows, and spatial analysis.

It should be noted that these entities are inherently inter-related, and existing interaction among these entities may be leveraged to establish interaction that focuses on GIS. For example, the City's GIS implementation may be improved by leveraging Yolo County's existing relationship with the State and its California GIS Council.

How closely and frequently the City interacts with these entities remains to be determined. However, in general, it is recommended that the City of West Sacramento maintain a close relationship with Yolo County, SACOG, the Yolo County GIS Cooperative, and YCCESA. It is expected that the City will have moderate interaction with the State of California, and Regional GIS Users Groups. Interaction with Utilities such as PG&E, and other private entities will likely be less frequent.

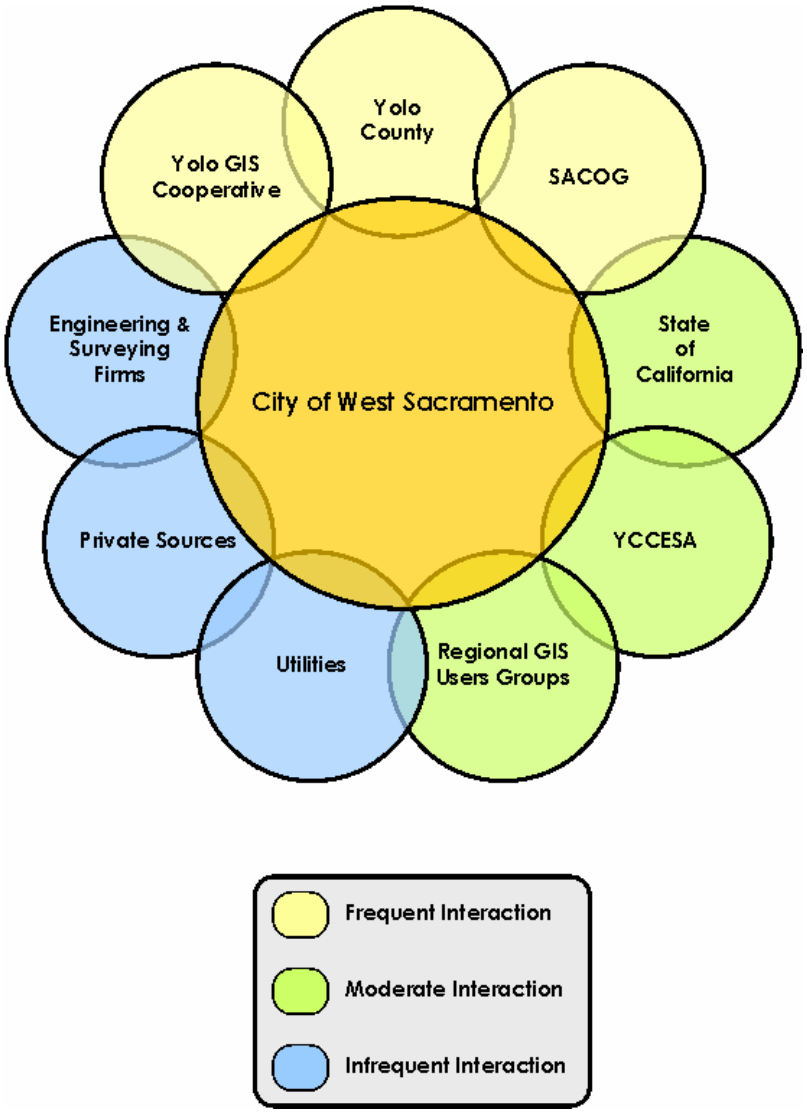


***Figure 7-6: City of West Sacramento Interaction with External Entities***

# Chapter 8 – GIS Training and Education

In This Chapter


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| GIS Applications Training Matrix | 8-13 |
| Recommended Number of Personnel (by Department) for ArcGIS I and II Training | 8-13 |
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## Enterprise-wide Training on Three Tiers of Geographic Information Systems (GIS)

Training will be an integral part of the City of West Sacramento's GIS implementation strategy. Staff members responsible for the creation/maintenance of GIS databases in the ArcGIS 9 environment should take the weeklong ArcGIS class (ArcGIS I and ArcGIS II). The ArcGIS classes teach functionality for ArcInfo 9, ArcEditor 9, and ArcView 9. ArcGIS I classes can be provided on-site by ESRI or ESRI Authorized Instructors. The ArcGIS II class is currently only available through ESRI, onsite or at ESRI offices. In addition, the GIS Specialist and staff in the Drafting Services Section should acquire AutoCAD Map and FME training.

Tier 2 users (ArcView 9) should be provided, at a minimum, with the two-day ArcGIS I training class. This will include an introduction to the base functionality of the software, from data management to desktop level analysis. Students can either travel to an ESRI office for this training, or hire an ESRI Authorized Instructor to teach ArcGIS I on-site (recommended – more cost efficient).

Tier 3 users will receive customized training sessions on each individual application that is developed. These applications are very intuitive and user-friendly. One to two hours of training on each application will be sufficient. This training can be performed either on or off-site.

### Training Classes

A catalog for all ESRI-based GIS training can be found at:
http://www.esri.com/training/course-catalog-jj05.pdf

A schedule of ESRI-based GIS classes (updated daily) can be found at:
http://myesri.com/HAHTsite40/hsrun.exe/HS40/TEM/TEM.htx;start=HS_D2_Schedule

**Introduction to ArcGIS I – for ArcView 9, ArcEditor 9, and ArcInfo 9 (two days)**

Overview

This two-day course introduces participants to ArcGIS and provides the foundation for becoming a successful ArcView, ArcEditor, or ArcInfo user. Participants learn how to use ArcMap, ArcCatalog, and ArcToolbox and explore how these applications work together to provide a complete GIS software solution. The course covers fundamental GIS concepts as

well as how to create, edit, and work with georeferenced spatial data. Participants learn how to manipulate tabular data, query a GIS database, and present data clearly and efficiently using maps and charts.

Audience

This course is for those who are new to ArcGIS or to geographic information systems in general.

Goals

- Display feature and tabular data
- Work with georeferenced spatial data
- Query features using logical expressions
- Find features using spatial relationships
- Edit spatial and attribute data
- Associate tables with joins and relates
- Produce maps, reports, and graphs

Topics covered

- ArcGIS overview: Capabilities and applications; Interacting with the interface; Basic display
- Spatial data concepts: Representing spatial data and descriptive information
- ArcGIS data model: Geodatabases; Shapefiles; Coverages; Feature types; Attributes
- GIS software: Components; Functions; Applications
- Spatial coordinate systems and map projections: Georeferencing data; What map projections are; How ArcMap works with map projections
- Querying data: Selecting and identifying features; Creating reports and graphs
- Map displays: Creating; Symbolizing; Scaling; Adding map elements

Prerequisites and recommendations

Participants should know how to use windowing software. This course provides the fundamental ArcGIS knowledge and experience needed to enroll in *Introduction to ArcGIS II (for ArcView 9, ArcEditor 9, and ArcInfo 9)* as well as several other ESRI courses. Many of the topics covered in this course are similar to those in *Migrating from ArcView 3.x to ArcView 9*. Participants who complete this course should not enroll in *Migrating from ArcView 3.x to ArcView 9*. Participants who have worked with prior versions of ArcView and want to learn about ArcView 9 applications should take *Migrating from ArcView 3.x to ArcView 9*.

Price: $850 per student. Reduced rates may apply for onsite training.

A course description can be found online at:
http://myesri.com/HAHTsite40/hsrun.exe/HS40/TEM/TEM.htx;flag=restart;start=HS_D1a_CourseDescription?courseid=D+50006053&btnGetDetails=Get+Details

**Introduction to ArcGIS II – for ArcView 9, ArcEditor 9, and ArcInfo 9 (three days)**

Overview

This three-day course follows *Introduction to ArcGIS I (for ArcView 9, ArcEditor 9, and ArcInfo 9)* and continues to present important concepts and functionality for successfully working with ArcGIS. With further exploration of ArcMap, ArcCatalog, and ArcToolbox, participants focus on spatial analysis, automation of spatial and attribute data, editing, and advanced options for cartographic display and reports. Hands-on exercises teach ArcGIS procedures in the context of solving real-world problems. Examples and exercises use data from a variety of application areas. A portion of the class is reserved for carrying out an analysis project

and applying many of the new skills and techniques learned in this course. Participants conduct queries, perform spatial analysis, and present their results in a hard-copy map and report.

Audience

This course is designed for those with fundamental knowledge of ArcGIS and geographic information systems in general.

Goals

- Perform spatial analysis
- Manage geographic data
- Perform geocoding
- Automate data through heads-up digitizing
- Convert data from other formats
- Edit spatial and attribute data
- Create and use metadata
- Produce high-quality maps and reports

Topics covered

- Spatial analysis and data management: Buffers; Spatial overlays; Extracting features for analysis; Analytical methods and tools
- Geocoding and display of locations from tabular data: Address geocoding; Display of points from x,y coordinates
- Editing: Tools for creating and editing spatial data; Editing attribute data; Spatial adjustment
- Data automation: Data sources; Digitizing; Data conversion
- Project management: Database organization; File and directory naming conventions; Creating and using metadata
- Cartography: Advanced symbology and labeling

Prerequisites and recommendations

This course is for those who have completed *Introduction to ArcGIS I (for ArcView 9, ArcEditor 9, and ArcInfo 9)* or *Migrating from ArcView 3.x to ArcView 9* (instructor-led or Web-based course). If one of the prerequisite courses is not completed, a participant should have comparable experience with ArcGIS before taking this course. The course also provides participants with the fundamental ArcGIS knowledge and experience needed to enroll in *Building Geodatabases I (for ArcEditor 9 and ArcInfo 9)*.

Price: $1,275 per person. Reduced rates may apply for onsite training.

A course description can be found online at:
http://myesri.com/HAHTsite40/hsrun.exe/HS40/TEM/TEM.htx;flag=restart;start=HS_D1a_CourseDescription?courseid=D+50006054&btnGetDetails=Get+Details

**Building Geodatabases I (three days)**

Overview

This three-day course details the capabilities of the geodatabase and how to migrate existing data to build a geodatabase for ArcGIS 9. Participants learn how to create, use, edit, and manage spatial and attribute data stored in the geodatabase. Discussion topics include loading data into the geodatabase; defining appropriate topology rules; and maintaining data integrity through subtypes, attribute domains, and relationship classes. Instruction will be given on loading existing data from coverages, shapefiles, and computer-

aided design (CADD) formats to create new point, line, polygon, and annotation feature classes.

Audience

This course is for spatial data managers who have a basic understanding of ArcGIS desktop applications and are ready to use the geodatabase. New and existing data managers waiting to migrate to the geodatabase will benefit from this course.

Goals

- Load data into the geodatabase from a variety of formats
- Set spatial reference and spatial domain
- Build a topology in the geodatabase
- Apply the appropriate topological rules for data
- Use the appropriate attribute rules for data with subtypes and domains
- Edit topological data
- Generate relationship classes
- Create and use rules for relationship classes and attribute data entry
- Produce and edit annotation

Topics covered

- Introduction to the geodatabase: Data storage options; Geodatabase structures and permissions; Enterprise vs. personal geodatabase; Geodatabase tables in a database management system (DBMS)
- Building a geodatabase: Designing the geodatabase; Defining its structure; Creating a new schema; Loading data from shapefiles, CADD files, and coverage point, line, polygon, region, and annotation features
- Understanding spatial domain: Precision vs. accuracy; Geodatabase coordinate storage
- Geodatabase topology: Topology management in the geodatabase; Building a topology; Setting the properties of a topology; Setting appropriate topological rules; Fixing topological errors; Editing topological data
- Relationship classes: Creating relationship classes; Setting relationship class properties; Using relationships in ArcMap; Relationship rules; Validation; Simple vs. composite relationships
- Attribute validation rules: Subtypes and domains; Creating subtypes; Editing subtypes in ArcMap; Creating domains; Editing with domains in ArcMap; Coded value vs. range domains; Subtypes and relationship rules

Prerequisites and recommendations

Prior knowledge of the geodatabase is not required; however, participants should complete Introduction to ArcGIS I and II (for ArcView 9, ArcEditor 9, and ArcInfo 9), or What's New in ArcInfo 9 (previously offered instructor-led course or currently available Web-based course), or have equivalent knowledge. Participants should not take this course if they have completed the previously offered course, Creating and Managing Geodatabases (for ArcEditor 9 and ArcInfo 9).

Price: $1,275 per person, plus travel expenses

A course description can be found online at:
http://myesri.com/HAHTsite40/hsrun.exe/HS40/TEM/TEM.htx;flag=restart;start=HS_D1a_CourseDescription?courseid=D+50036963&btnGetDetails=Get+Details

### ☑ Building Geodatabases II (two days)

Overview

This new two-day course extends the content of *Building Geodatabases I (for ArcEditor 9 and ArcInfo 9)* by discussing the advanced capabilities for modeling and working with linear features in the geodatabase. Discussion topics include creating, editing, and performing analyses on geometric networks; managing linear referenced data for displaying data that occurs along linear features; and migrating coverage arcs, routes, and events to the geodatabase.

Audience

This course is for spatial data managers who work with linear features and are ready to take advantage of the geometric network and linear referencing capabilities of the geodatabase.

Goals

- Build and perform analyses on geometric networks
- Set rules for editing and analyzing on geometric networks
- Build route systems in the geodatabase
- Edit route systems
- Dynamically locate events on route systems

Topics covered

- Geometric networks: Storing a network; Simple vs. complex network features; Logical network; Flow on a geometric network; Performing network analysis; Network weights; Restricting the area of a trace; Complex edges; Building a geometric network; Setting network rules; Validating connectivity rules
- Linear referencing: Linear referencing basics; Creating routes; Storing routes in the geodatabase; Hatching routes; Rules for editing routes; Tools for editing routes; Displaying route anomalies; Reroute events; Advanced route events options; Transforming events

Prerequisites and recommendations

Participants should complete *Building Geodatabases I (for ArcEditor 9 and ArcInfo 9)* or have equivalent knowledge.

Price: $850 per person, plus travel expenses

A course description can be found online at:
http://myesri.com/HAHTsite40/hsrun.exe/HS40/TEM/TEM.htx;flag=restart;start=HS_D1a_CourseDescription?courseid=D+50036964&btnGetDetails=Get+Details

### ☑ ArcSDE Administration for SQL Server (5 days)

Overview

This five-day course prepares Microsoft SQL Server™ database administrators for implementing ArcSDE by building their own individual ArcSDE servers. Participants learn how to configure SQL Server to support ArcSDE, install and configure ArcSDE, load vector and raster data, monitor and optimize queries, and manage a multiversioned geodatabase. Topics from *Introduction to ArcSDE using ArcInfo 8* are included in this course; participants do not need to attend that class first.

Throughout the class, effective methods for planning and managing storage, memory, and I/O are emphasized. Participants learn to monitor access to their ArcSDE database by using

ArcSDE and DBMS tools. Based on these results, a discussion follows on the guidelines to adjust resource allocation as database usage changes. Management of ArcSDE for access from ArcInfo clients, including multiversioned viewing and editing, is highlighted, while managing ArcInfo geodatabases on an ArcSDE system is covered in detail. The course focuses on understanding how ArcSDE software interacts with SQL Server and proposes solid strategies for maintaining an enterprise GIS database.

Audience

This course is for experienced SQL Server database administrators who need to manage ArcSDE databases and clients. Participants should have at least six months prior experience working with Microsoft SQL Server.

Goals

- Configure SQL Server to support ArcSDE
- Install and configure ArcSDE
- Create vector feature classes and raster datasets
- Configure, create, and monitor application server, direct, and OLE DB connections
- Customize storage for ArcSDE vector and raster data
- Monitor and optimize query access
- Manage a multiversioned geodatabase

Topics covered

- ArcSDE installation: Evaluating the SQL Server configuration; Preparing SQL Server to use ArcSDE; Installing ArcSDE; Starting and stopping the ArcSDE server; Exploring ArcSDE system tables; Configuring ArcSDE and SQL Server on separate hosts
- Data loading: Creating storage space; Creating users and assigning privileges; Calculating a spatial domain; Creating vector feature classes from coverages and shapefiles; Creating raster datasets from image files; Building raster catalogs and mosaics; Estimating storage needs; Examining feature class components; Customizing storage with the DBTUNE table
- Monitoring data access: Creating application server, direct, and OLE DB connections; Monitoring connections with ArcSDE and SQL Server tools; Tracing client queries; Reporting system I/O
- Optimizing data access: Analyzing spatial index performance; Creating a group layer; Creating a spatial view; Working with overview and magnify windows, raster wire frames, scale-dependent layers, and thumbnails
- Managing a multiversioned geodatabase: Registering feature classes as versioned; Choosing version privileges; Reconciling and posting changes between versions; Compressing the state tree; Monitoring changes to the adds, deletes, and system tables

Prerequisites and recommendations

Participants in this course should have experience with the following:

- SQL Server database administration or application development
- Administering a Windows operating system
- Managing database storage
- Creating SQL Server users and assigning their privileges
- Designing tables, indexes, constraints, and triggers
- Using spatial and tabular data from a GIS application
- SQL

Price: $2,250 per person, plus travel expenses

A course description can be found online at:
http://myesri.com/HAHTsite40/hsrun.exe/HS40/TEM/TEM.htx;flag=restart;start=HS_D1a_CourseDescription?courseid=D+50007060&btnGetDetails=Get+Details

### Introduction to ArcIMS (three days)

Overview

This three-day course introduces participants to ArcIMS®—an integrated approach for creating and maintaining geography-based Web sites. ArcIMS offers powerful capabilities in an easy-to-use framework, changing the way users can access and interact with Internet mapping and GIS data. Class participants gain hands-on experience using ArcIMS to build, utilize, and customize Internet mapping applications. This course also empowers participants with a conceptual overview of how GIS mapping works on the Internet.

Audience

This course is for those who are new to ArcIMS and want to learn how to use ArcIMS to create and serve maps on the Internet.

Goals

- Author and design ArcIMS Viewers
- Utilize client functionality
- Introduce site administration
- Understand ArcXML structure
- Customize ArcIMS Viewers
- Install ArcIMS and explore its architecture

Topics covered

- ArcIMS overview: What is ArcIMS?; Introducing multitier architecture; Creating an ArcIMS Viewer; Using ArcIMS Manager Applications
- ArcIMS Author: Adding layers with Catalog; Supported data formats; Setting layer properties; Scale factors; Labeling; Rendering; Geocoding properties; Stored queries; Saving map configuration files
- Designing ArcIMS Viewers: Creating ArcIMS Services; Using ArcIMS Designer; ArcIMS Viewer output
- ArcIMS Viewers: HTML Viewer; Java™ Standard Viewer; Java Custom Viewer; ArcExplorer™—Java Edition; Client tools
- ArcIMS Administrator: ArcIMS Spatial Servers; Virtual Servers; Instances; Refreshing ArcIMS Services; Site properties and configuration; Introducing ArcMap Server, Metadata Server, and Route Server
- Collaborative tools: Adding layers; Changing layer properties; Viewer configuration files; MapNotes and EditNotes; Using Geography Network
- Understanding ArcXML: What is XML?; HTML vs. XML; ArcXML syntax; Map configuration files; Requests and responses; ArcXML Programmer's Reference Guide; Customizing map display using ArcXML
- ArcIMS Viewer customization: File structure; Frame layout; Customizing the interface (colors, titles, toolbars); Generic browser and user options; Editing ArcIMSparam.js; Using JavaScript™ with ArcIMS; Introducing the Java Viewer Object Model
- ArcIMS architecture and installation: ArcIMS components; Web servers; Servlets; ArcIMS Application Server and connectors; Configuring ArcIMS; ArcIMS installation process

Prerequisites and recommendations

Although prior use of ArcGIS, ArcView, ArcInfo, or MapObjects® is helpful in understanding GIS concepts, it is not a requirement. Similarly, those with an understanding of Internet programming and Web-based protocols have an advantage; however, experience with these is not required.

Price: $1200 per person, plus travel expenses

A course description can be found online at:
http://myesri.com/HAHTsite40/hsrun.exe/HS40/TEM/TEM.htx;flag=restart;start=HS_D1a_CourseDescription?courseid=D+50077572&btnGetDetails=Get+Details

### ☑ ArcIMS Administration (two days)

Overview

This two-day course teaches ArcIMS server administrators the things that make big differences in ArcGIS server performance, security, and reliability. Participants learn how to tune their ArcIMS Services, set up a secure server, apply hardware sizing considerations, perform distributed installations, and work with ArcSDE databases. Throughout the class, effective methods for planning and managing ArcIMS in an enterprise network environment are emphasized. Participants learn how to deploy ArcIMS to make their site a success. Participants also learn important networking skills and the knowledge needed to operate and maintain an ArcIMS server. A review of security strategies is supported with indepth discussions of ArcIMS interprocess communication necessary for firewall configuration. Hands-on exercises teach advanced installation and configuration techniques with distributed installations. Participants create, configure, and monitor connections to ArcSDE servers. The course describes how ArcIMS software interacts with ArcSDE and proposes solid strategies for improving performance.

Audience

This course is intended for ArcIMS server administrators who need more understanding of how ArcGIS server technology works behind the scenes to keep it running smoothly.

Goals

- Troubleshoot faulty ArcIMS Services
- Understand security issues
- Enable the Secure Sockets Layer (SSL) and HTTPS
- Authenticate ArcIMS Services
- Optimize map configuration files
- Perform a distributed installation
- Understand ArcSDE architecture and connections
- Work with vector and raster data in ArcSDE

Topics covered

- Network communication: Describe the Internet protocols that will be the vocabulary for the remainder of the course; Examine each from the standpoint of ArcIMS; How they work; How they can go wrong; Typical problems
- Security: Describe common security strategies using the inherent capabilities of the operating system; Discuss firewall technologies, packet filtering, proxy services, network address translation, and virtual private networks; Discuss firewall architecture best practices and implications to ArcIMS; SSL and HTTPS; ArcIMS Service authentication

- Installation and configuration: Practical distributed configurations; Load balancing spatial servers; Using multiple Web servers; Creating server clusters
- Service tuning: Response time; Scale-dependent rendering; Generalization; Image types; Map projections; Image directories; Spatial indexes
- ArcIMS sizing: Hardware considerations; Network bandwidth guidelines; Application server queuing
- ArcSDE architecture and connections: ArcSDE software architecture; Setting up an ArcSDE server using ArcIMS; Creating ArcSDE application server and direct connections; Serving a versioned geodatabase with ArcIMS
- ArcSDE vector data: ArcSDE feature class storage architecture; Serverside data loading using ArcSDE command line utilities; Organizing and managing privileges; Managing spatial and attribute indexes for optimal display and query performance; Presenting data using spatial views; Generalizing data for small-scale display using sdegroup
- ArcSDE raster data: ArcSDE raster data storage architecture; Loading images using ArcSDE command line utilities; Creating seamless mosaics; Creating multirow rasters

Prerequisites and recommendations

It is recommended that participants complete Introduction to ArcIMS or have equivalent experience with the terms and concepts used in ArcIMS. General knowledge of TCP/IP networking principles is assumed. No ArcSDE experience is required. Participants for this course should have experience with the following:

- Administering a Windows operating system
- Creating ArcIMS Services
- Authoring and designing ArcIMS Web sites
- Managing site administration
- Installing ArcIMS
- ArcIMS architecture

Price: $900 (Two days) plus travel expenses

A course description can be found online at:
http://myesri.com/HAHTsite40/hsrun.exe/HS40/TEM/TEM.htx;flag=restart;start=HS_D1a_CourseDescription?courseid=D+50077574&btnGetDetails=Get+Details

### AutoCAD Map

Overview

Autodesk Map is the premier solution for creating, maintaining, analyzing, exchanging, and presenting mapping information in a CADD environment. Autodesk Map incorporates powerful new data-management functionality, specialized mapping tools, and essential Geographic Information System functionality. With Autodesk Map, you will be able to digitize, maintain, Analyze, and plot your own maps and map sets, and create thematic maps and legends. You can work with multiple drawings and use information from external data sources for all you mapping tasks.

This course is a combination course incorporating all three of individual MAP classes - Introduction to Autodesk® MAP, the Intermediate Autodesk® MAP, and Advanced Autodesk® MAP under one part number and for a discounted price for the bundle.

- **Introduction:**
  - Workspace Palette
  - Civil Toolspace
  - Menus/Toolbars/Map Options

- **Tracking Coordinates:**
  - Displaying/Tracking Coordinates
- **Working with Coordinate Geometry:**
  - Input/Inquiry Commands
  - Using the Toolbar
- **Drawing Cleanup and Editing:**
  - Using the Drawing Cleanup Tool
  - Working with Anchors
- **Using Feature Classification:**
  - Understanding Feature Classes
  - Creating a Feature Definition File
  - Defining a Feature Class
- **Working with Raster Images:**
  - Understanding Raster Images
  - Supported Formats
  - Managing Raster Images
  - Other Ways to Modify Images
- **Working with Object Data:**
  - Understanding Object Data
  - Using Hyperlinks
- **Querying Data from Source Drawings:**
  - Introduction to Queries
  - Query Usage/Types/Modes
  - Using Compound Queries
  - Property Alteration
  - Saving Queries
- **Working with Civil Points:**
  - Importing I Styles
- **Working with Civil Surfaces:**
  - Creating /Points/Watershed
- **Plotting Maps:**
  - Plot Map Book Command
- **Using Topology and Spatial Analysis:**
  - Creating Topology
  - Best Route Analysis
  - Viewing Topology Properties

Price: $750 per person, plus travel expenses

A course description can be found online at:
http://www.cybertektc.com/Map.htm

### ☑ Safe FME

Learn FME Technology from the experts, and Get Results!
Learn from the experts how to use the essential components of the Feature Manipulation Engine (FME) through hands-on lab training. Join our two-day (1/3 lecture, 2/3 exercise and problem solving) course and learn to unlock the powerful features of FME to more effectively manage your data translation and data transformation challenges. FME Training can help open up a whole new world of possibilities for you. Questions are encouraged throughout the class and attendees are encouraged to bring their own sample data files.

Learn how to
- Take advantage of all the FME Suite applications
- Use a wide variety of data manipulation tools available in FME
- Easily build very complex translations using FME Workbench

- Debug and QA your translations and datasets
- Use FME with non-spatial data
- Use FME in a batch environment
-

Training workbooks are provided. Attendees can bring their own laptops, or may make use of the facility's hardware for the hands-on portion of the class

*FME Training Course Outline*
*Day 1*
*Overview*

- Course Introduction
- Introduction to FME Translation
- Schema Mapping in FME

*FME Suite*

- Using FME Universal Viewer Using FME Workbench Using FME Universal Translator
- Other FME Suite Components

*Exercises FME Basics*

- FME Datasets
- FME Features
- How FME processes data

*Exercises FME Workspace Introduction*

- What is a data schema?
- What is a workspace? Workspace sections
- Workspace parameters
- Debugging Tools

*Day 2*
*FME Workbench Interface*

- What is a workspace? Workbench sections (Menus, Toolbar,Navigation Window, Workspace)A look at Workbench's built-in shortcuts
- Debugging Tools

*Exercises*
*FME Transformers and Feature Type Definitions*

- Overview of the Most Commonly Used FME Functionality

*Exercises*
*Coordinate Systems*

- Introduction to FME Coordinate system support
- Creating Custom Coordinate Systems*

*Advanced Topics**

- Using Tool Command Language (TCL) in FMEBatch Processing Review of Specific Formats
- Introduction to Mapping File Syntax

*Examples of Exercises…*

- Restructuring land base data example
- Creating polygons and overlay analysis

- Cleaning data (gaps & overlaps) to form polygons
- Change Detection
- Reading flat-files (non-spatial) and creating point geometry
- Joining to database tables to retrieve attributes
- Merging points and attributes together based on IDs
- Reading two or more formats
- Creating street edges from centerlines
- Using surface modeling to create contours
- Draping 2D features onto a surface model to add elevation attributes

Price: $1,000 per person, plus travel expenses

A course description can be found online at:
http://www.safe.com/training/fme-training-course.htm

**Tier 3 applications**

The cost of all Tier 3 applications includes training for selected personnel. Enterprise-wide training of Tier 3 applications can be conducted by the GIS Specialist.

Tier 3 application training should cover the following topics/functionality:

- Brief overview of GIS
- Zoom and pan functionality
- Map extents
- Feature identification
- Map production/printing
- Reports (as needed)
- Spatial queries (as needed)
- Exporting maps
- Saving projects

In addition to the aforementioned topics/functionality, Tier 3 users should receive additional training specific to individual workflows or modules, such as work order request mapping and tracking or public notification via mapping module.

## GIS Applications Training Matrix

| Class | Site | Trainer | Days | Year of Training | Participants | Cost |
|---|---|---|---|---|---|---|
| Introduction to ArcGIS I | On | ESRI Authorized Trainer | 2 | 1,2 | Engineering (3), Information Technology (1), GIS Specialist, Planning (1), Police (1), Redevelopment (1) | $7,500 |
| Introduction to ArcGIS II | Off | ESRI | 3 | 1,2 | Engineering (1), GIS Specialist, Police (1) | $3,825* |
| Building Geodatabases I | Off | ESRI | 3 | 2 | GIS Specialist, Information Technology (1) | $2,550* |
| Building Geodatabases II | Off | ESRI | 2 | 2 | GIS Specialist, Information Technology (1) | $1,700* |
| ArcSDE Administration for SQL Server | Off | ESRI | 5 | 2 | GIS Specialist | $2,250** |
| Introduction to ArcIMS | Off | ESRI | 3 | 1 | GIS Specialist, Information Technology (1) | $1,200* |
| ArcIMS Administration | Off | ESRI | 2 | 1 | GIS Specialist | $900* |

| Class | Site | Trainer | Days | Year of Training | Participants | Cost |
|---|---|---|---|---|---|---|
| Safe FME | Off | Safe | 2 | 1 | GIS Specialist | $1,750** |
| AutoCAD Map | Off | CyberTek | 3 | 1 | GIS Specialist, Engineering (1) | $2,500*** |
| Tier 3 Applications | On | Internal | 1 | 1,2,3 | Various | N/A |

*Offsite training at ESRI Training Center in Sacramento, CA.
**Offsite training at FME Training Center in Vancouver, BC assumes $100 a day (hotel, food, rental car, gas) per day per student, plus $500 for airfare per student.
*** Offsite training at CyberTek Training Center in Riverside, CA assumes $100 a day (hotel, food, rental car, gas) per day per student, plus $200 for airfare per student.

## Recommended Number of Personnel for ArcGIS I and II Training

| Department/Division | ArcGIS I | ArcGIS II |
|---|---|---|
| Engineering (including Drafting Services Section) | 3 | 1 |
| Information Technology (including GIS Specialist) | 2 | 1 |
| Planning | 1 | 0 |
| Redevelopment | 1 | 0 |
| **Total** | **15** | **11** |

## Education & Participation

An important part of professional GIS education is not only formal training classes, but attending GIS conferences. GIS conferences allow attendees to attend workshops and seminars (some free, some at additional cost), and to interact with other GIS professionals from around the region, state, country, and world. The City of West Sacramento should budget approximately $5,000 every year for conference attendance. Important conferences that should be attended by City of West Sacramento staff (at the GIS Specialist's discretion, within budgetary limitations) include:

**ESRI International User Conference**

August 2005

San Diego, California

(http://www.esri.com)

Who Should Attend?

- The ESRI User Conference is open to all ESRI software users including:
  - New Users
  - Experienced Users
  - User Group Members
  - Coordinators
  - Programmers
  - Specialists
  - Analysts
  - Technicians
  - First Responders
  - Information Technology and Industry Solutions Managers
  - Project Managers
  - Department Heads
  - Division Chiefs

- Executive Directors
- Faculty
- Elected Officials
- Board Members
- Chairpersons
- NGO Representatives
- Local, Regional, National, and International Committee Members

Topics Covered

- Application Success Stories
- Lessons Learned
- Data Standards
- Data Migration
- Data Access
- Project Applications
- Software Development
- Complimentary Technology
- Mandates
- Grant Programs
- Collaborative Projects
- Initiatives

**Urban and Regional Information Systems Association (URISA)**

Annual Conference and Exposition

October 9-12, 2005

Kansas City, Missouri

(http://www.urisa.org)

The URISA Annual Conference offers a unique multidisciplinary approach, with sessions led by industry leaders, powerful keynote presentations, panels, roundtable discussions and networking meetings you won't find anywhere else.

This conference is vital to professionals concerned with the effective application of information technology in all state and local government agencies, including:

- Community & Economic Development
- Emergency Services/Public Safety
- Environmental Management
- Land Records
- Public Works
- Tax Assessment
- Transportation Planning
- Urban Planning & Design
- Utilities

**Geospatial Information and Technology Association (GITA)**

Annual Conference and Exhibition

March 6-9, 2005
Denver, Colorado

(http://www.gita.org)

GITA's Annual Conference and Exhibition is the premier educational event for professionals involved in geospatial information technologies, including automated mapping/facilities management (AM/FM), geographic information systems (GIS), supervisory control and data acquisition (SCADA), and related geospatial technologies. Conference 28 will provide attendees with better ways to plan, design, manage, and maintain their systems and operations.

# Chapter 9 – Three-Year Phased Implementation Plan

## In This Chapter


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This chapter defines the necessary tasks and procedures for the City of West Sacramento GIS Implementation Plan. It should be noted that much of the information included in this chapter is condensed and based on the previous chapters in this document. It is recommended that these chapters be read and understood in order to have the necessary context for the tasks and procedures outlined in this chapter. It is also expected that the recommended GIS Steering Committee serve as the primary mechanism for determining the priority and sequence for GIS-related tasks and procedures.

In addition, this chapter documents costs associated with a three-year phased implementation, based on a high-end budgetary projections. Given the timing of the release of this implementation plan, this chapter also provides costs associated with implementation of several recommendations during the current year.

This three-year phased implementation plan, if implemented, will provide the City of West Sacramento with a very thorough and sophisticated enterprise-wide GIS; on par with the best enterprise-wide GIS implementation in mid-sized cities in the United States. It should be noted that the budgetary projections included incorporate the assumption that data layer creation, conversion, and collection will be outsourced, and significant software purchases will be made. Therefore, data layer creation, conversion and collection of recommended layers will be completed more quickly, allowing the City to take full advantage of implemented GIS applications.

### Recommendations for Current Year

Initial Applications Development Phase

The current year will be focused on initial development of several enterprise-wide GIS applications as well as continuing data development efforts. The primary goal for the current year is to establish a foundation for the City's GIS implementation. Tasks and procedures for the current year are summarized below.

### *GIS Implementation: Current Year*

| ID | Task/Procedure Name | Duration | Start | Finish | Parties Responsible |
|---|---|---|---|---|---|
| 1 | **Current Year GIS Implementation** | | **Mon 2/28/05** | **Thu 6/30/05** | |
| 2 | Data Creation, Conversion, and Integration | Ongoing | Fri 5/20/05 | Thu 6/30/05 | GIS Specialist; GIS Intern; Drafting Services Section |
| 3 | **Metadata Documentation** | | **Tue 3/22/05** | **Thu 6/30/05** | |
| 4 | Generate FGDC metadata for base map layers | Ongoing | Tue 3/22/05 | Thu 6/30/05 | GIS Specialist |
| 5 | **Quality Assurance** | | **Mon 4/11/05** | **Tue 4/26/05** | |
| 6 | Develop preliminary QA workflows for base map layers | 3 days | Mon 4/11/05 | Thu 4/14/05 | GIS Specialist; Drafting Services Section |
| 7 | Develop QA workflow for vacant properties layer | 2-3 days | Mon 4/18/05 | Wed 4/20/05 | GIS Specialist; Redevelopment Agency |
| 8 | Develop QA workflow for Police and Community Development Layers | 1-2 days | Mon 4/25/05 | Tue 4/26/05 | GIS Specialist; Police Department |
| 9 | **Ongoing Data Maintenance** | | **Mon 2/28/05** | **Thu 6/30/05** | |
| 10 | Base Map Data | Ongoing | Mon 2/28/05 | Thu 6/30/05 | Drafting Services Section; GIS Specialist |
| 11 | Street Centerline Attribution | Ongoing | Mon 2/28/05 | Thu 6/30/05 | GIS Intern; GIS Specialist |
| 12 | Departmental Layers | Ongoing | Mon 2/28/05 | Thu 6/30/05 | GIS Specialist; GIS Intern; Drafting Services |
| 13 | **Application Development/Procurement** | | **Tue 3/1/05** | **Thu 5/5/05** | |
| 14 | **Internal** | | **Mon 3/14/05** | **Thu 5/5/05** | |
| 15 | Preliminary Intranet GIS Data Browser Development (Initial functionality and data access; See Enterprise-wide Applications in Chapter 1) | 25 days | Mon 4/4/05 | Thu 5/5/05 | GIS Specialist; Information Technology Division |
| 16 | GIS Intranet Web Page Development (Metadata and plan documentation) | 20 days | Mon 3/14/05 | Fri 4/8/05 | GIS Specialist |
| 17 | **Public** | | **Tue 3/1/05** | **Tue 3/1/05** | |
| 18 | N/A | N/A | Tue 3/1/05 | Tue 3/1/05 | |
| 19 | **Hardware Installations** | | **Mon 3/7/05** | **Mon 5/2/05** | |
| 20 | Acquisition of public kiosk | 1-2 days | Mon 5/2/05 | Mon 5/2/05 | Information Technology Division; Community Development |
| 21 | Color printer (11x17) | 1-2 days | Mon 3/7/05 | Mon 3/7/05 | Information Technology |
| 22 | **Software Purchase** | | **Tue 3/1/05** | **Tue 3/1/05** | |
| 23 | ArcIMS | Already Installed | Tue 3/1/05 | Tue 3/1/05 | Information Technology; GIS Specialist |
| 24 | PIN Mapping Application | 1 day | Tue 3/1/05 | Tue 3/1/05 | Information Technology; GIS Specialist |
| 25 | Touch Screen Mapping Application | 1 day | Tue 3/1/05 | Tue 3/1/05 | Information Technology; GIS Specialist |
| 26 | **Software Installation** | | **Tue 3/1/05** | **Tue 5/24/05** | |
| 27 | ArcIMS | Already Installed | Tue 3/1/05 | Tue 3/1/05 | Information Technology; GIS Specialist |
| 28 | PIN Mapping Application | 3 days | Mon 4/25/05 | Wed 4/27/05 | Information Technology; GIS Specialist |
| 29 | Touch Screen Mapping Application | 2 days | Mon 5/23/05 | Tue 5/24/05 | Information Technology; GIS Specialist |

| ID | Task/Procedure Name | Duration | Start | Finish | Parties Responsible |
|---|---|---|---|---|---|
| 30 | **Training** | | **Mon 4/18/05** | **Wed 6/8/05** | |
| 31 | AutoCAD Map | 3 days | Mon 6/6/05 | Wed 6/8/05 | GIS Specialist; Drafting Services Section |
| 32 | Introduction to ArcIMS | 2 days | Mon 4/18/05 | Tue 4/19/05 | GIS Specialist; Information Technology |
| 33 | ArcIMS Administration | 2 days | Wed 4/20/05 | Thu 4/21/05 | GIS Specialist; Information Technology |
| 34 | **GIS Steering Committee** | | **Fri 4/1/05** | **Wed 6/1/05** | |
| 35 | Monthly Meeting | 1 day (2-4 hours) | Fri 4/1/05 | Fri 4/1/05 | GIS Specialist; Department Heads |
| 36 | Monthly Meeting | 1 day (2-4 hours) | Sun 5/1/05 | Sun 5/1/05 | GIS Specialist; Department Heads |
| 37 | Monthly Meeting | 1 day (2-4 hours) | Wed 6/1/05 | Wed 6/1/05 | GIS Specialist; Department Heads |

Current Year costs are as follows:

| Item Description | Baseline GIS Project | GIS Project Specific Efforts | GIS Annual Maint. and Support | Department of Deployment | Purchased From | Notes |
|---|---|---|---|---|---|---|
| **Software** | | | | | | |
| ArcIMS | $0 | | | Information Technology | ESRI | Already Procured |
| PIN Mapping Application (5 licenses) | $9,500 | | | Police | GIS Application Developer | Includes training and setup; and maintenance and technical support |
| Public Access Desktop Application (1 license) | $2,000 | | | Community Development | GIS Application Developer | Includes training and setup; and maintenance and technical support |
| **Software Subtotal:** | **$ 11,500** | | | | | |
| **Hardware** | | | | | | |
| Public Access PC | $2,000 | | | Community Development | Preferred Vendor | Actual costs will vary depending on type of computers/kiosks purchased |
| **Hardware Subtotal:** | **$ 2,000** | | | | | |
| **Data** | | | | | | |
| Data Collection, Conversion, and Creation (does not include aerial photographs/planimetric) | $10,000 | | | Various | GIS Consultant with assistance from GIS Specialist | Cost is if all data creation is outsourced. In-house data creation can reduce costs considerably. |
| **Data Subtotal:** | **$10,000** | | | | | |
| **Training and Education** | | | | | | |
| Introduction to ArcIMS | $1,200 | | | GIS Specialist; Information Technology | ESRI or ESRI Authorized Trainer | |
| ArcIMS Administration | $900 | | | GIS Specialist | ESRI | |
| AutoCAD Map | $2,500 | | | GIS Specialist; Engineering | ESRI | |
| **Training and Education Subtotal:** | **$4,600** | | | | | |
| **Planning** | | | | | | |
| **Planning Subtotal:** | **$0** | | | | | |
| | | | | | | |

| Item Description | Baseline GIS Project | GIS Project Specific Efforts | GIS Annual Maint. and Support | Department of Deployment | Purchased From | Notes |
|---|---|---|---|---|---|---|
| **Current Year TOTAL:** | **$28,100** | | | | | |

### Recommendations for Year One

Applications Development and Initial Database Design Phase

Year One will be focused on continuing development and acquisition several enterprise-wide GIS applications as well as continuing data development efforts; the City will also begin to develop the foundation for a geodatabase by commencing on logical and physical database design, which will be used for an enterprise geodatabase. The primary goal for the Year One is to build on the current year's efforts and gain several "quick successes" in terms of application implementation, data development and integration, data maintenance procedures, and training. Year One will be pivotal in terms of providing GIS access across the enterprise through an Intranet GIS data browser. Tasks and procedures for Year One are summarized below.

### *GIS Implementation: Year One*

| ID | Task/Procedure Name | Duration | Start | Finish | Parties Responsible |
|---|---|---|---|---|---|
| 1 | **Year One GIS Implementation** | | **Fri 7/1/05** | **Fri 6/30/06** | |
| 2 | **Enterprise-Wide Data Creation, Conversion, and Integration (GIS data layers to be prioritized by GIS Steering Committee); See Appendix IV: Master Data List** | Ongoing | Fri 7/1/05 | Fri 6/30/06 | GIS Specialist; GIS Intern |
| 3 | **Department-Specific Layers (in addition to enterprise-wide layers)** | | **Fri 7/1/05** | **Fri 6/30/06** | |
| 4 | Redevelopment Agency Layers | Ongoing | Fri 7/1/05 | Fri 6/30/06 | Redevelopment Agency |
| 5 | Police Department Layers | Ongoing | Fri 7/1/05 | Fri 6/30/06 | Police Department; GIS Specialist |
| 6 | Community Development Layers | Ongoing | Fri 7/1/05 | Fri 6/30/06 | Drafting Services Section; GIS Specialist; |
| 7 | Public Works Layers | Ongoing | Fri 7/1/05 | Fri 6/30/06 | GIS Specialist; GIS Intern; Drafting Services |
| 8 | Existing Data Integration: Conversion to shapefile; FME Automation | Ongoing | Fri 7/1/05 | Fri 6/30/06 | GIS Specialist; Drafting Services Section |
| 9 | Digital Orthophotography Updates | 1 week | Mon 4/3/06 | Mon 4/10/06 | GIS Specialist; GIS Intern |
| 10 | **Database** | | **Mon 5/1/06** | **Fri 6/30/06** | |
| 11 | Logical Database Design | 1 month | Mon 5/1/06 | Mon 5/29/06 | GIS Specialist; Information Technology; |
| 12 | Physical Database Design | 1 month | Mon 6/5/06 | Fri 6/30/06 | GIS Specialist; Information Technology; |
| 13 | **Metadata Documentation** | | **Fri 7/1/05** | **Fri 6/30/06** | |
| 14 | Generate FGDC metadata for new layers | Ongoing | Fri 7/1/05 | Fri 6/30/06 | GIS Specialist |
| 15 | **Quality Assurance** | | **Mon 8/8/05** | **Thu 10/6/05** | |
| 16 | Refine and enhance QA workflows for base map layers | 3-4 days | Mon 8/8/05 | Thu 8/11/05 | GIS Specialist; Drafting Services Section |
| 17 | Develop Additional QA Workflows for Redevelopment Agency Layers | 2-3 days | Mon 8/22/05 | Wed 8/24/05 | GIS Specialist; Redevelopment Agency |
| 18 | Develop QA Workflow for Police and Community Development Layers | 4-5 days | Mon 9/5/05 | Fri 9/9/05 | GIS Specialist; Police Department |
| 19 | Develop QA Workflow for FME Automation; CAD to Shapefile Conversion | 3-4 days | Mon 10/3/05 | Thu 10/6/05 | GIS Specialist; Information Technology |
| 20 | **Ongoing Data Maintenance** | | **Fri 7/1/05** | **Fri 6/30/06** | |
| 21 | Base Map Data | Ongoing | Fri 7/1/05 | Fri 6/30/06 | Drafting Services Section; GIS Specialist |
| 22 | Street Centerline Attribution | Ongoing | Fri 7/1/05 | Fri 6/30/06 | GIS Intern; GIS Specialist |
| 23 | Departmental Layers | Ongoing | Fri 7/1/05 | Fri 6/30/06 | GIS Specialist; GIS Intern; Department Resources (as needed) |
| 24 | **Application Development/Procurement** | | **Fri 7/1/05** | **Fri 6/30/06** | |
| 25 | **Internal** | | **Fri 7/1/05** | **Fri 6/30/06** | |
| 26 | GIS Intranet Web Page Development | Ongoing | Fri 7/1/05 | Fri 6/30/06 | GIS Specialist |
| 27 | Intranet GIS Data Browser | Ongoing | Fri 7/1/05 | Fri 6/30/06 | GIS Specialist; Information Technology |
| 28 | GIS Data Extraction and Conversion Utility | 2 months | Mon 9/5/05 | Mon 11/7/05 | GIS Specialist; Information Technology |
| 29 | **Public** | | **Mon 10/3/05** | **Mon 4/3/06** | |
| 30 | Community Asset Tracking System (CATS) | Approximately 6 months | Mon 10/3/05 | Mon 4/3/06 | Redevelopment Agency; Information Technology |
| 31 | **Hardware Installations** | | **Mon 3/27/06** | **Tue 5/2/06** | |
| 32 | Acquisition of public kiosk | 1 day | Tue 5/2/06 | Tue 5/2/06 | Information Technology; Community |
| 33 | Mobile Computers (Fire) | 2-3 weeks | Mon 3/27/06 | Mon 4/10/06 | Information Technology |

| ID | Task/Procedure Name | Duration | Start | Finish | Parties Responsible |
|---|---|---|---|---|---|
| 34 | **Software Purchase** | | **Fri 7/1/05** | **Fri 7/1/05** | |
| 35 | ArcView 9 | 1 day | Fri 7/1/05 | Fri 7/1/05 | Information Technology; GIS Specialist |
| 36 | ArcGIS (Full Suite) | 1 day | Fri 7/1/05 | Fri 7/1/05 | Information Technology; GIS Specialist |
| 37 | ArcSDE | 1 day | Fri 7/1/05 | Fri 7/1/05 | Information Technology; GIS Specialist |
| 38 | Safe FME | 1 day | Fri 7/1/05 | Fri 7/1/05 | Information Technology; GIS Specialist |
| 39 | GISConnect | 1 day | Fri 7/1/05 | Fri 7/1/05 | Information Technology; GIS Specialist; Drafting Services |
| 40 | Touch Screen Mapping Application | 1 day | Fri 7/1/05 | Fri 7/1/05 | Information Technology; GIS Specialist |
| 41 | GIS Data Browser | 1 day | Fri 7/1/05 | Fri 7/1/05 | Information Technology; GIS Specialist |
| 42 | Cartegraph Suite (Engineering) | 1 day | Fri 7/1/05 | Fri 7/1/05 | Information Technology; Engineering |
| 43 | **Software Installations** | | **Mon 7/4/05** | **Thu 4/20/06** | |
| 44 | ArcView 9 | 1 week | Mon 1/9/06 | Fri 1/13/06 | Information Technology |
| 45 | ArcGIS (Full Suite) | 3 days | Mon 8/8/05 | Wed 8/10/05 | Information Technology |
| 46 | ArcSDE | 2 weeks | Mon 1/16/06 | Mon 1/30/06 | Information Technology; GIS Specialist |
| 47 | Safe FME | 2 days | Mon 7/4/05 | Wed 7/6/05 | GIS Specialist; Information Technology |
| 48 | GISConnect | 3 days | Tue 11/1/05 | Fri 11/4/05 | Information Technology; Drafting Services |
| 49 | Touch Screen Mapping Application | 2 days | Mon 3/13/06 | Wed 3/15/06 | Information Technology; GIS Specialist |
| 50 | GIS Data Browser | 3-4 days | Mon 4/17/06 | Thu 4/20/06 | Information Technology |
| 51 | Cartegraph Suite (Engineering) | 5 days | Wed 3/1/06 | Tue 3/7/06 | Information Technology; Engineering |
| 52 | **Software Maintenance** | | **Fri 7/1/05** | **Mon 7/4/05** | |
| 53 | Audit and Verify Existing Software Licenses | 1-2 days | Fri 7/1/05 | Fri 7/1/05 | Information Technology |
| 54 | Pay Software Maintenance | 1 day | Mon 7/4/05 | Mon 7/4/05 | Information Technology |
| 55 | **Training** | | **Fri 7/1/05** | **Fri 6/30/06** | |
| 56 | Introduction to ArcGIS I | 2 | Mon 8/1/05 | Wed 8/3/05 | All ArcGIS Users |
| 57 | Introduction to ArcGIS II | 3 | Mon 8/8/05 | Wed 8/10/05 | GIS Specialist; Drafting Services; Police |
| 58 | Safe FME | 2 | Mon 7/11/05 | Tue 7/12/05 | GIS Specialist |
| 59 | Tier 3 Applications (primarily Intranet GIS Data Browser) | Ongoing | Fri 7/1/05 | Fri 6/30/06 | GIS Specialist; Information Technology |
| 60 | Conferences | Ongoing | Fri 7/1/05 | Fri 6/30/06 | GIS Specialist; Information Technology |
| 61 | **GIS Steering Committee** | | **Fri 7/1/05** | **Mon 4/3/06** | |
| 62 | Quarterly Meeting | 1 day (2-4 hours) | Fri 7/1/05 | Fri 7/1/05 | GIS Specialist; Department Heads |
| 63 | Quarterly Meeting | 1 day (2-4 hours) | Mon 10/3/05 | Mon 10/3/05 | GIS Specialist; Department Heads |
| 64 | Quarterly Meeting | 1 day (2-4 hours) | Mon 1/2/06 | Mon 1/2/06 | GIS Specialist; Department Heads |
| 65 | Quarterly Meeting | 1 day (2-4 hours) | Mon 4/3/06 | Mon 4/3/06 | GIS Specialist; Department Heads |

Year One costs are as follows:

| Item Description | Baseline GIS Project | GIS Project Specific Efforts | GIS Annual Maint. and Support | Department of Deployment | Purchased From | Notes |
|---|---|---|---|---|---|---|
| **Software** | | | | | | |
| ArcGIS (Full Suite) 9 (1 single-use licenses) | | | $4,500 | GIS Specialist | ESRI | Pricing is estimated. |
| ArcView 9 (2 concurrent or single use licenses) | | | $3,000 | Redevelop-ment Agency | ESRI | Pricing is estimated. |
| ArcPad (15 licenses) | | $7,500 | | Engineering (5), Facilities Development and Maintenance (2), Information Technology (2), Public Works (6) | ESRI | Pricing is estimated. |
| ArcSDE | | $10,000 | | Information Technology | ESRI | Pricing is estimated. |
| Safe FME | $4,500 | | | Information Technology | Safe | Pricing is estimated. |
| Intranet GIS Data Browser (can be developed in-house) | | $15,000 | | All | GIS Application Developer | Pricing is estimated. Includes training and setup; and maintenance and technical support |
| GISConnect (2) | $3,250 | $3,000 | | Drafting Services Section | Haestad Methods | Pricing is estimated. |
| Cartegraph Suite | | $14,500 | | Engineering | Cartegraph | Pricing is estimated. |
| GIS Data Browser (10) | | $12,500 | | Fire | GIS Application Developer | Pricing is estimated. Includes training and setup; and maintenance and technical support |
| **Software Subtotal:** | **$7,750** | **62,500** | **$7,500** | | | |
| **Software Maintenance** | | | | | | |
| Maintenance on ESRI Products | | | $15,000 | Various | ESRI | |
| Maintenance on all other GIS applications | | $4,150 | | Various | Various | Estimated |
| **Software Maintenance Subtotal:** | | **$4,150** | **$15,000** | | | |
| **Hardware** | | | | | | |

| Item Description | Baseline GIS Project | GIS Project Specific Efforts | GIS Annual Maint. and Support | Department of Deployment | Purchased From | Notes |
|---|---|---|---|---|---|---|
| Hand-held Computers (15) | | $7,500 | | Engineering (5), Facilities Development and Maintenance (2), Information Technology (2), Public Works (6) | Preferred Vendor | Actual costs will vary depending on type of computers purchased |
| Mobile Computers (10) | | $25,000 | | Fire | Preferred Vendor | Pricing is estimated. |
| **Hardware Subtotal:** | | **$32,500** | | | | |
| **Data** | | | | | | |
| Data Collection, Conversion, and Creation (does not include aerial photographs/planimetrics) | $65,000 | $20,000 | | Various | GIS Consultant with assistance from GIS Specialist and other technical staff | Cost is if all data creation is outsourced. Please refer to the Master Data List for individual cost. In-house data creation can reduce costs considerably. |
| Aerial Photographs (6"/pixel) & Select Planimetrics | | $20,000 | $20,000 | GIS Specialist | Air Photo USA | Updates to existing orthophotography for areas where there is increasing development |
| Logical Database Design | | $15,000 | | GIS Specialist | GIS Consultant | |
| Physical Database Design | | $10,000 | | GIS Specialist | GIS Consultant | |
| **Data Subtotal:** | **$65,000** | **$65,000** | **$20,000** | | | |
| **Training and Education** | | | | | | |
| Introduction to ArcGIS I | $7,500 | | | All ArcGIS Users | ESRI or ESRI Authorized Trainer | |
| Introduction to ArcGIS II | $3,825 | | | All ArcGIS Users | ESRI | |
| Safe FME | $1,750 | | | GIS Specialist | Safe | |
| Tier 3 Applications | | $3,500 | | GIS Specialist | Application Developer | Training to be conducted on-site with relevant departmental staff |
| Conferences | $5,000 | | | Enterprise-Wide | Various | |
| **Training and Education Subtotal:** | **$18,075** | **$3,500** | | | | |
| **Planning** | | | | | | |

| Item Description | Baseline GIS Project | GIS Project Specific Efforts | GIS Annual Maint. and Support | Department of Deployment | Purchased From | Notes |
|---|---|---|---|---|---|---|
| Annual Update of Implementation Plan | $5,000 | | | GIS Specialist | GIS Planning Consultant | Reflect progress and changes in technology |
| **Planning Subtotal:** | **$5,000** | | | | | |
| | | | | | | |
| **Year 1 TOTAL:** | **$95,825** | **$167,650** | **$42,500** | | | |

**Recommendations for Year Two**

Continuing Application Development, Database Development, and Public Access Phase

Year Two will be focused on continuing development/acquisition of GIS applications, database development and integration of recently developed (and acquired) geo-spatial data; in addition, Year Two will include public access to geo-spatial data through the Redevelopment Agency's Community Asset Tracking System (CATS) as well as through a more general City Internet GIS data browser (that may work on the same platform as CATS). By Year Two, most, if not all, relevant City personnel will have access to base map data through a Tier 3 application. The City will have the opportunity to develop a geodatabase by leveraging the database design from Year One; however, it should be noted that the City's GIS data management and maintenance may also evolve to encompass other data management structures that are complementary to a geodatabase. Year Two will also include ongoing software and hardware installation and configuration, as well as training and education for both technical and non-technical staff.

### *GIS Implementation: Year Two*

| ID | Task/Procedure Name | Duration | Start | Finish | Parties Responsible |
|---|---|---|---|---|---|
| 1 | **Year Two GIS Implementation** | | **Mon 7/3/06** | **Tue 7/1/08** | |
| 2 | **Enterprise-Wide Data Creation, Conversion, and Integration (GIS data layers to be prioritized by GIS Steering Committee); See Appendix IV: Master Data List** | Ongoing | Mon 7/3/06 | Tue 7/1/08 | GIS Specialist; GIS Intern |
| 3 | **Department-Specific Layers (in addition to enterprise-wide layers)** | | **Mon 7/3/06** | **Mon 7/2/07** | |
| 4 | Redevelopment Agency Layers | Ongoing | Mon 7/3/06 | Mon 7/2/07 | Redevelopment Agency |
| 5 | Police Department Layers | Ongoing | Mon 7/3/06 | Mon 7/2/07 | Police Department; GIS Specialist |
| 6 | Community Development Layers | Ongoing | Mon 7/3/06 | Mon 7/2/07 | Drafting Services Section; GIS Specialist; |
| 7 | Public Works Layers | Ongoing | Mon 7/3/06 | Mon 7/2/07 | GIS Specialist; GIS Intern; Drafting Services |
| 8 | Existing Data Integration: Conversion to shapefile; FME Automation | Ongoing | Mon 7/3/06 | Mon 7/2/07 | GIS Specialist; Drafting Services Section |
| 9 | Digital Orthophotography Updates | 1 week | Mon 4/2/07 | Mon 4/9/07 | GIS Specialist; GIS Intern |
| 10 | Redevelopment Agency Layers | Ongoing | Mon 7/3/06 | Fri 6/29/07 | Redevelopment Agency |
| 11 | Police Department Layers | Ongoing | Mon 7/3/06 | Fri 6/29/07 | Police Department; GIS Specialist |
| 12 | Community Development Layers | Ongoing | Mon 7/3/06 | Fri 6/29/07 | Drafting Services Section; GIS Specialist; |
| 13 | Public Works Layers | Ongoing | Mon 7/3/06 | Fri 6/29/07 | GIS Specialist; GIS Intern; Drafting Services |
| 14 | Digital Orthophotography Updates | 1 week | Tue 4/3/07 | Tue 4/10/07 | GIS Specialist; GIS Intern |
| 15 | Fire Department Layers | 1 week | Mon 7/3/06 | Fri 6/29/07 | GIS Specialist; GIS Intern; Information |
| 16 | Enterprise-wide Data Migration to Geodatabase | 4-5 weeks | Tue 5/1/07 | Mon 6/4/07 | GIS Specialist; GIS Intern |
| 17 | **Database** | | **Tue 2/6/07** | **Tue 4/3/07** | |
| 18 | Geodatabase Development | 6-8 weeks | Tue 2/6/07 | Tue 4/3/07 | GIS Specialist; Information Technology; |
| 19 | **Metadata Documentation** | | **Mon 7/3/06** | **Fri 6/29/07** | |
| 20 | Generate FGDC metadata for new layers | Ongoing | Mon 7/3/06 | Fri 6/29/07 | GIS Specialist |
| 21 | **Quality Assurance** | | **Mon 8/7/06** | **Mon 6/4/07** | |
| 22 | Update QA workflows for base map layers | 3-4 days | Mon 8/7/06 | Thu 8/10/06 | GIS Specialist; Drafting Services Section |
| 23 | Update QA Workflows for Redevelopment Agency Layers | 2-3 days | Mon 8/14/06 | Wed 8/16/06 | GIS Specialist; Redevelopment Agency |
| 24 | Update QA Workflow for Police and Community Development Layers | 4-5 days | Mon 8/21/06 | Fri 8/25/06 | GIS Specialist; Police Department |
| 25 | Update QA Workflow for FME Automation | 3-4 days | Mon 8/28/06 | Thu 8/31/06 | GIS Specialist; Information Technology |
| 26 | Develop Geodatabase Documentation and Modification Procedures | 1 week | Mon 6/4/07 | Mon 6/4/07 | GIS Specialist; GIS Intern; Information Technology |
| 27 | **Ongoing Data Maintenance** | | **Mon 7/3/06** | **Fri 6/29/07** | |
| 28 | Base Map Data | Ongoing | Mon 7/3/06 | Fri 6/29/07 | Drafting Services Section; GIS Specialist |
| 29 | Street Centerline Attribution | Ongoing | Mon 7/3/06 | Fri 6/29/07 | GIS Intern; GIS Specialist |
| 30 | Departmental Layers | Ongoing | Mon 7/3/06 | Fri 6/29/07 | GIS Specialist; GIS Intern; Department Resources (as needed) |

| ID | Task/Procedure Name | Duration | Start | Finish | Parties Responsible |
|---|---|---|---|---|---|
| 31 | **Application Development/Procurement** | | **Mon 7/3/06** | **Fri 6/29/07** | |
| 32 | **Internal** | | **Mon 7/3/06** | **Fri 6/29/07** | |
| 33 | GIS Intranet Web Page Development | Ongoing | Mon 7/3/06 | Fri 6/29/07 | GIS Specialist |
| 34 | **Public** | | **Tue 8/1/06** | **Mon 12/4/06** | |
| 35 | Internet GIS Data Browser | 3 months | Mon 9/4/06 | Mon 12/4/06 | Information Technology; GIS Specialist |
| 36 | Continue Work on Community Asset Tracking System (CATS) | Approximately 2 months | Tue 8/1/06 | Mon 10/2/06 | Redevelopment Agency; Information Technology |
| 37 | **Hardware Installations** | | **Tue 2/6/07** | **Tue 4/10/07** | |
| 38 | Acquisition of public kiosk | 1 day | Tue 2/6/07 | Tue 2/6/07 | Information Technology; Police |
| 39 | Hand-held Computers | 1-2 weeks | Tue 3/27/07 | Tue 4/10/07 | Information Technology |
| 40 | **Software Purchase** | | **Mon 7/3/06** | **Mon 7/3/06** | |
| 41 | ArcView 9 | 1 day | Mon 7/3/06 | Mon 7/3/06 | Information Technology; GIS Specialist |
| 42 | ArcPad | 1 day | Mon 7/3/06 | Mon 7/3/06 | Information Technology; GIS Specialist |
| 43 | Haestad Methods Modeling Suite | 1 day | Mon 7/3/06 | Mon 7/3/06 | Information Technology; GIS Specialist; Engineering |
| 44 | Reverse 911 System | 1 day | Mon 7/3/06 | Mon 7/3/06 | Information Technology; GIS Specialist; Fire & Police |
| 45 | Touch Screen Mapping Application | 1 day | Mon 7/3/06 | Mon 7/3/06 | Information Technology; GIS Specialist |
| 46 | Planning Support System | 1 day | Mon 7/3/06 | Mon 7/3/06 | Information Technology; GIS Specialist; Planning |
| 47 | Mobile GIS Data Browser | 1 day | Mon 7/3/06 | Mon 7/3/06 | Information Technology; GIS Specialist |
| 48 | Internet GIS Data Browser | 1 day | Mon 7/3/06 | Mon 7/3/06 | Information Technology; GIS Specialist |
| 49 | **Software Installation** | | **Mon 7/10/06** | **Mon 4/16/07** | |
| 50 | ArcView 9 | 1 week | Mon 7/10/06 | Fri 7/14/06 | Information Technology; GIS Specialist |
| 51 | ArcPad | 1 week | Mon 7/17/06 | Mon 7/31/06 | Information Technology; GIS Specialist |
| 52 | Haestad Methods Modeling Suite | 1 week | Mon 8/7/06 | Fri 8/11/06 | Information Technology; GIS Specialist |
| 53 | Reverse 911 System | 3-4 days | Mon 9/11/06 | Thu 9/14/06 | Information Technology; GIS Specialist |
| 54 | Touch Screen Mapping Application | 2 days | Wed 2/7/07 | Fri 2/9/07 | Information Technology |
| 55 | Planning Support System | 5 days | Mon 3/19/07 | Fri 3/23/07 | Information Technology; Engineering |
| 56 | Mobile GIS Data Browser | 3 days | Wed 4/11/07 | Mon 4/16/07 | Information Technology; Drafting Services |
| 57 | Internet GIS Data Browser | 3-4 days | Mon 8/28/06 | Thu 8/31/06 | Information Technology; GIS Specialist |
| 58 | **Software Maintenance** | | **Mon 7/3/06** | **Tue 7/4/06** | |
| 59 | Audit and Verify Existing Software Licenses | 1-2 days | Mon 7/3/06 | Mon 7/3/06 | Information Technology |
| 60 | Pay Software Maintenance | 1 day | Tue 7/4/06 | Tue 7/4/06 | Information Technology |

| ID | Task/Procedure Name | Duration | Start | Finish | Parties Responsible |
|---|---|---|---|---|---|
| 61 | **Training** | | **Mon 7/3/06** | **Fri 6/29/07** | |
| 62 | Tier 3 Applications (primarily Intranet GIS Data Browser) | Ongoing | Mon 7/3/06 | Fri 6/29/07 | GIS Specialist; Information Technology |
| 63 | Conferences | Ongoing | Mon 7/3/06 | Fri 6/29/07 | GIS Specialist; Information Technology |
| 64 | **GIS Steering Committee** | | **Mon 7/3/06** | **Mon 4/2/07** | |
| 65 | Quarterly Meeting | 1 day (2-4 hours) | Mon 7/3/06 | Mon 7/3/06 | GIS Specialist; Department Heads |
| 66 | Quarterly Meeting | 1 day (2-4 hours) | Mon 10/2/06 | Mon 10/2/06 | GIS Specialist; Department Heads |
| 67 | Quarterly Meeting | 1 day (2-4 hours) | Tue 1/2/07 | Tue 1/2/07 | GIS Specialist; Department Heads |
| 68 | Quarterly Meeting | 1 day (2-4 hours) | Mon 4/2/07 | Mon 4/2/07 | GIS Specialist; Department Heads |

Year Two costs are as follows:

| Item Description | Baseline GIS Project | GIS Project Specific Efforts | GIS Annual Maint. and Support | Department of Deployment | Purchased From | Notes |
|---|---|---|---|---|---|---|
| **Software** | | | | | | |
| ArcGIS Extensions | | | $9,500 | GIS Specialist | ESRI | Pricing is estimated. |
| ArcPad (13 licenses) | | $6,500 | | Parks & Recreation (4), Police (3), Public Works (6) | ESRI | Pricing is estimated. |
| ArcView 9 (3) | | | $4,500 | Engineering (1), Redevelopmen t (1) | ESRI | Pricing is estimated. |
| Haestad Methods Modeling Suite | | $27,500 | | Public Works | Haestad | Pricing is estimated. Training and setup is included. |
| Mobile GIS Data Browser (15) | | $15,000 | | Police | GIS Application Developer | Pricing is estimated. Includes training and setup; and maintenance and technical support |
| Public Access PC | $2,000 | | | Police | GIS Application Developer | Includes training and setup; and maintenance and technical support |
| Planning Support System | | $4,500 | | Community Development | Preferred Vendor | Pricing is estimated. |
| Emergency Notification System | | $15,000 | | Fire (Other departments will utilize) | Preferred Vendor | Pricing is estimated |
| Internet GIS Data Browser | | $12,500 | | All | GIS Application Developer | Includes training and setup; and maintenance and technical support |
| **Software Subtotal:** | **$2,000** | **$81,000** | **14,000** | | | |
| **Software Maintenance** | | | | | | |
| Maintenance on ESRI Products | | $4,050 | $16,850 | Various | ESRI | |
| Maintenance on all other GIS applications | $1,525 | $5,900 | | Various | Various | Estimated |
| **Software Maintenance Subtotal:** | **$1,525** | **$9,950** | **$16,850** | | | |
| **Hardware** | | | | | | |

| Item Description | Baseline GIS Project | GIS Project Specific Efforts | GIS Annual Maint. and Support | Department of Deployment | Purchased From | Notes |
|---|---|---|---|---|---|---|
| Hand-held Computers (30) | | $15,000 | | Parks & Recreation (4), Police (18), Public Works (6) | Preferred Vendor | Actual costs will vary depending on type of computers purchased |
| Public Access PC | $2,000 | | | Police | Preferred Vendor | Actual costs will vary depending on type of computers/kiosks purchased |
| **Hardware Subtotal:** | **$2,000** | **15,000** | | | | |
| **Data** | | | | | | |
| Data Collection, Conversion, and Creation (does not include aerial photographs/planimetrics) | $35,000 | 20,000 | | Various | GIS Consultant with assistance from GIS Specialist and other technical staff | Cost is if all data creation is outsourced. Please refer to the Master Data List for individual cost. In-house data creation can reduce costs considerably. |
| Aerial Photographs (6"/pixel) & Select Planimetrics | | $20,000 | $20,000 | GIS Specialist | Air Photo USA | Updates to existing orthophotography for areas where there is increasing development |
| Geodatabase Development | | $20,000 | | GIS Specialist | GIS Consultant | |
| **Data Subtotal:** | **$35,000** | **$60,000** | **$20,000** | | | |
| **Training and Education** | | | | | | |
| Tier 3 Applications | | $5,500 | | GIS Specialist; Information Technology | Application Developer | Training to be conducted on-site with relevant departmental staff |
| Conferences | $5,000 | | | Enterprise-Wide | Various | |
| **Training and Education Subtotal:** | **$5,000** | **$5,500** | | | | |
| **Planning** | | | | | | |
| Annual Update of Implementation Plan | $5,000 | | | GIS Specialist | GIS Planning Consultant | Reflect progress and changes in technology |
| **Planning Subtotal:** | **$5,000** | | | | | |
| | | | | | | |

| Item Description | Baseline GIS Project | GIS Project Specific Efforts | GIS Annual Maint. and Support | Department of Deployment | Purchased From | Notes |
|---|---|---|---|---|---|---|
| **Year 2 TOTAL:** | **$50,525** | **$171,450** | **$50,850** | | | |

**Recommendations for Year Three**

Data Access and Sharing Phase

Year Three will revolve around continued data sharing throughout the organization and maintenance of the City's existing investment. At this point in the implementation, departments should be utilizing the GIS for sophisticated analysis. It should have become another resource that employees rely on, much like a word processor or spreadsheet program. During Year Three the public will have become familiar with many of the City's GIS offerings, including Internet GIS data browsing, public access kiosks, and publicly distributed maps and cartographic products. The City will have marked success in its GIS implementation and it will be primed to move forward with increasingly sophisticated technology, resources, and knowledge.

### *GIS Implementation: Year Three*

| ID | Task/Procedure Name | Duration | Start | Finish | Parties Responsible |
|---|---|---|---|---|---|
| 1 | **Year Three GIS Implementation** | | **Fri 7/1/05** | **Tue 6/29/10** | |
| 2 | **Enterprise-Wide Data Creation, Conversion, and Integration (GIS data layers to be prioritized by GIS Steering Committee); See Appendix IV: Master Data List** | Ongoing | Mon 7/2/07 | Tue 6/29/10 | GIS Specialist; GIS Intern |
| 3 | **Department-Specific Layers (in addition to enterprise-wide layers)** | | **Fri 7/1/05** | **Mon 6/30/08** | |
| 4 | Redevelopment Agency Layers | Ongoing | Mon 7/2/07 | Mon 6/30/08 | Redevelopment Agency |
| 5 | Police Department Layers | Ongoing | Fri 7/1/05 | Fri 6/30/06 | Police Department; GIS Specialist |
| 6 | Community Development Layers | Ongoing | Fri 7/1/05 | Fri 6/30/06 | Drafting Services Section; GIS Specialist; |
| 7 | Public Works Layers | Ongoing | Fri 7/1/05 | Fri 6/30/06 | GIS Specialist; GIS Intern; Drafting Services |
| 8 | Existing Data Integration: Conversion to shapefile; FME Automation | Ongoing | Fri 7/1/05 | Fri 6/30/06 | GIS Specialist; Drafting Services Section |
| 9 | Digital Orthophotography Updates | 1 week | Mon 4/3/06 | Mon 4/10/06 | GIS Specialist; GIS Intern |
| 10 | Redevelopment Agency Layers | Ongoing | Mon 7/2/07 | Mon 6/30/08 | Redevelopment Agency |
| 11 | Police Department Layers | Ongoing | Mon 7/2/07 | Mon 6/30/08 | Police Department; GIS Specialist |
| 12 | Community Development Layers | Ongoing | Mon 7/2/07 | Mon 6/30/08 | Drafting Services Section; GIS Specialist; |
| 13 | Public Works Layers | Ongoing | Mon 7/2/07 | Mon 6/30/08 | GIS Specialist; GIS Intern; Drafting Services |
| 14 | Digital Orthophotography Updates | 1 week | Mon 4/7/08 | Fri 4/11/08 | GIS Specialist; GIS Intern |
| 15 | Fire Department Layers | Ongoing | Mon 7/2/07 | Mon 6/30/08 | GIS Specialist; GIS Intern; Information |
| 16 | **Database** | | **Mon 2/4/08** | **Mon 2/18/08** | |
| 17 | Geodatabase Development | 1-2 weeks | Mon 2/4/08 | Mon 2/18/08 | GIS Specialist; Information Technology; |
| 18 | **Metadata Documentation** | | **Mon 7/2/07** | **Mon 6/30/08** | |
| 19 | Generate FGDC metadata for new layers | Ongoing | Mon 7/2/07 | Mon 6/30/08 | GIS Specialist |
| 20 | **Quality Assurance** | | **Mon 8/6/07** | **Fri 6/6/08** | |
| 21 | Update QA workflows for base map layers | 3-4 days | Mon 8/6/07 | Thu 8/9/07 | GIS Specialist; Drafting Services Section |
| 22 | Update QA Workflows for Redevelopment Agency Layers | 2-3 days | Mon 8/13/07 | Wed 8/15/07 | GIS Specialist; Redevelopment Agency |
| 23 | Update QA Workflow for Police and Community Development Layers | 4-5 days | Mon 8/20/07 | Fri 8/24/07 | GIS Specialist; Police Department |
| 24 | Update QA Workflow for FME Automation | 3-4 days | Mon 8/27/07 | Thu 8/30/07 | GIS Specialist; Information Technology |
| 25 | Develop Geodatabase Documentation and Modification Procedures | 1 week | Mon 6/2/08 | Fri 6/6/08 | GIS Specialist; GIS Intern; Information Technology |
| 26 | **Ongoing Data Maintenance** | | **Mon 7/2/07** | **Mon 6/30/08** | |
| 27 | Base Map Data | Ongoing | Mon 7/2/07 | Mon 6/30/08 | Drafting Services Section; GIS Specialist |
| 28 | Street Centerline Attribution | Ongoing | Mon 7/2/07 | Mon 6/30/08 | GIS Intern; GIS Specialist |
| 29 | Departmental Layers | Ongoing | Mon 7/2/07 | Mon 6/30/08 | GIS Specialist; GIS Intern; Department Resources (as needed) |

| ID | Task/Procedure Name | Duration | Start | Finish | Parties Responsible |
|---|---|---|---|---|---|
| 30 | **Application Development/Procurement** | | **Mon 7/2/07** | **Mon 6/30/08** | |
| 31 | **Internal** | | **Mon 7/2/07** | **Mon 6/30/08** | |
| 32 | GIS Intranet Web Page Development | Ongoing | Mon 7/2/07 | Mon 6/30/08 | GIS Specialist |
| 33 | **Public** | | **Mon 9/3/07** | **Mon 10/1/07** | |
| 34 | Internet GIS Data Browser (continued) | 1 month | Mon 9/3/07 | Mon 10/1/07 | Information Technology; GIS Specialist |
| 35 | **Software Purchase** | | **Mon 7/2/07** | **Mon 7/2/07** | |
| 36 | Haestad Methods Modeling Suite | 1 day | Mon 7/2/07 | Mon 7/2/07 | Information Technology; GIS Specialist |
| 37 | Continuing In-House GIS Application Development | 1 day | Mon 7/2/07 | Mon 7/2/07 | Information Technology; GIS Specialist |
| 38 | **Software Installations** | | **Mon 7/2/07** | **Mon 6/30/08** | |
| 39 | Haestad Methods Modeling Suite | 1 week | Mon 8/6/07 | Fri 8/10/07 | Information Technology; GIS Specialist |
| 40 | Continuing In-House GIS Application Development | Ongoing | Mon 7/2/07 | Mon 6/30/08 | Information Technology; GIS Specialist |
| 41 | **Software Maintenance** | | **Mon 7/2/07** | **Wed 7/4/07** | |
| 42 | Audit and Verify Existing Software Licenses | 1-2 days | Mon 7/2/07 | Mon 7/2/07 | Information Technology |
| 43 | Pay Software Maintenance | 1 day | Wed 7/4/07 | Wed 7/4/07 | Information Technology |
| 44 | **Training** | | **Mon 7/2/07** | **Mon 6/30/08** | |
| 45 | Tier 3 Applications (primarily Intranet GIS Data Browser) | Ongoing | Mon 7/2/07 | Mon 6/30/08 | GIS Specialist; Information Technology |
| 46 | Conferences | Ongoing | Mon 7/2/07 | Mon 6/30/08 | GIS Specialist; Information Technology |
| 47 | **GIS Steering Committee** | | **Mon 7/2/07** | **Tue 4/1/08** | |
| 48 | Quarterly Meeting | 1 day (2-4 hours) | Mon 7/2/07 | Mon 7/2/07 | GIS Specialist; Department Heads |
| 49 | Quarterly Meeting | 1 day (2-4 hours) | Mon 10/1/07 | Mon 10/1/07 | GIS Specialist; Department Heads |
| 50 | Quarterly Meeting | 1 day (2-4 hours) | Tue 1/1/08 | Tue 1/1/08 | GIS Specialist; Department Heads |
| 51 | Quarterly Meeting | 1 day (2-4 hours) | Tue 4/1/08 | Tue 4/1/08 | GIS Specialist; Department Heads |

Year Three costs are as follows:

| Item Description | Baseline GIS Project | GIS Project Specific Efforts | GIS Annual Maint. and Support | Department of Deployment | Purchased From | Notes |
|---|---|---|---|---|---|---|
| **Software** | | | | | | |
| Haestad Methods Modeling Suite | | $27,500 | | Engineering/Public Works | Haestad | Pricing is estimated. Includes training and initial setup. |
| Continuing Application Development | $15,000 | | | All | GIS Application Developer | Includes training and setup; and maintenance and technical support |
| **Software Subtotal:** | **$15,000** | **$27,500** | | | | |
| **Software Maintenance** | | | | | | |
| Maintenance on ESRI Products | | $5,550 | $20,100 | Various | ESRI | |
| Maintenance on all other GIS applications | $1,525 | $20,750 | | Various | Various | Estimated |
| **Software Maintenance Subtotal:** | **$1,525** | **$26,275** | **$20,100** | | | |
| **Hardware** | | | | | | |
| **Hardware Subtotal:** | **$0** | | | | | |
| **Data** | | | | | | |
| Data Collection, Conversion, Creation, and Migration (does not include aerial photographs/planimetrics) | $10,000 | $10,000 | | Various | GIS Consultant with assistance from GIS Specialist and other technical staff | Cost is if all data creation is outsourced. Please refer to the Master Data List for individual cost. In-house data creation can reduce costs considerably. |
| Aerial Photographs (6"/pixel) & Select Planimetrics | | $20,000 | $20,000 | GIS Specialist | Air Photo USA | Updates to existing orthophotography for areas where there is increasing development |
| Geodatabase Development | | $5,000 | | GIS Specialist | GIS Consultant | |
| **Data Subtotal:** | **$10,000** | **$35,000** | **$20,000** | | | |
| **Training and Education** | | | | | | |
| Conferences | $5,000 | | | Enterprise-Wide | Various | |

| Item Description | Baseline GIS Project | GIS Project Specific Efforts | GIS Annual Maint. and Support | Department of Deployment | Purchased From | Notes |
|---|---|---|---|---|---|---|
| **Training and Education Subtotal:** | **$5,000** | | | | | |
| **Planning** | | | | | | |
| Annual Update of Implemen-tation Plan | $5,000 | | | GIS Specialist | GIS Planning Consultant | Reflect progress and changes in technology |
| **Planning Subtotal:** | **$5,000** | | | | | |
| | | | | | | |
| **Year 3 TOTAL:** | **$36,525** | **$88,775** | **$40,100** | | | |

# Appendix I – Introduction to Geographic Technologies Group

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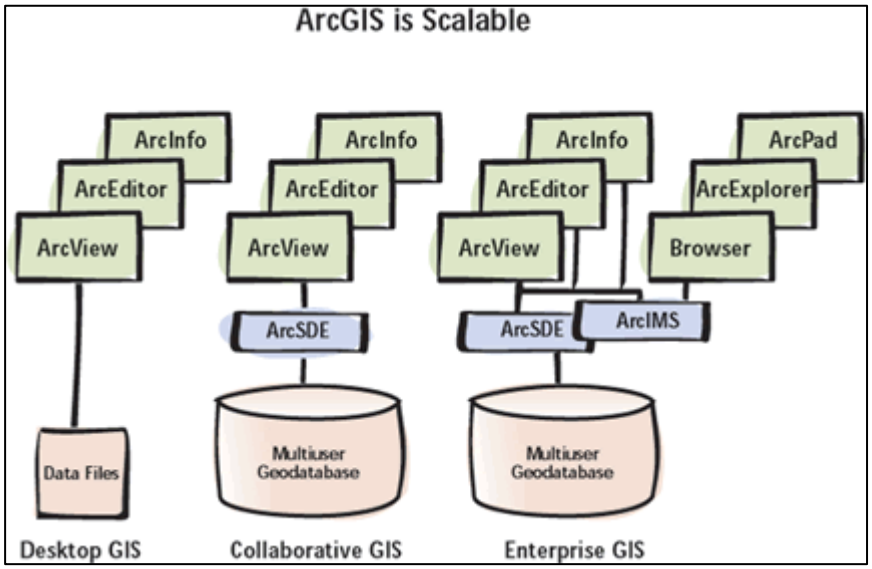
## Introduction

The task of managing a community's assets and resources is becoming more complex as a result of escalating growth. It is by no accident that the use of geographic technologies has grown commensurately. The complexity and cost of managing the vast amounts of data that Counties, Cities, and Towns require to operate, along with the reality of limited financial resources, have greatly increased the demand for automated information systems. Based on both tabular and graphic data, decisions must be made quickly and efficiently on a daily basis.

The use of geographic information tools has received overwhelming acceptance by local, state, and federal government organizations as well as the private sector. This technology is enabling organizations to consider more effective ways of doing business. Towns, Cities, and Counties are now embracing Geographic Information Systems (GIS) and the Global Positioning System (GPS) as mechanisms by which to improve efficiency, reduce costs, and increase productivity.

The organization, manipulation, and analysis of geographic information are extending the analytical reach of all departments of a local government. Many local governments have embraced GIS with high expectations. However, after absorbing the cost of building large databases, only a few organizations have made GIS available to all staff. The vast majority of local government officials are unable to take advantage of GIS for their daily duties. Many examples exist of the technology being too costly, accompanied by a lack of user-friendly software. GIS has therefore been arguably restricted to a few specialists within an organization.

Today, new technological developments and a new approach to GIS are allowing organizations to develop a more open, user-friendly GIS environment that allows all staff to take full advantage. A true "enterprise-wide" GIS is now possible. ESRI's new GIS solution is the ArcGIS suite of software. ArcGIS is available in three packages, ArcView 9, ArcEditor 9, and ArcInfo 9. The differentiation of the packages is different levels of functionality. ArcGIS is a family of software products that form a complete GIS built on industry standards that provide all available capabilities. ArcGIS is a complete, single, integrated system for geographic data creation, management, integration, and analysis. Much more than a specialized offering for a small niche of specialists, ArcGIS is designed as a scalable system that can be deployed in every organization, from an individual desktop to a globally distributed network of people.




***GIS Configurations***

Digital mapping has come of age with the union of the Global Positioning System (GPS), remote sensing technologies, and GIS. Creating accurate digital maps and associated databases from real world observations has long been the dream of utility companies, planners, and anyone who needs up-to-date mapping. GPS mapping/ inventory grade tools are offering new and exciting ways for collecting accurate, up-to-date data.

Advances in high-resolution remotely sensed imagery are also providing cost effective and timely updates to mapped information. The tools for capturing field data need to be fast, flexible, efficient, and easy to use. Fast processing times, as well as real-time processing, and flexible data collection techniques offer cost effective solutions for creating accurate and meaningful data. Accurate field observations are now seamlessly uploaded and used in a GIS environment.

# Geographic Information Systems (GIS)

## History

When GIS's were introduced in the 1950s, early use was limited to a small group of researchers. Botanists, meteorologists, and transportation planners began automating the process of thematic mapping. These researchers' efforts represent the early attempts at computerized cartography.

Today GIS is one of the fastest growing digital technologies, topping $7 billion in sales in 2000. GIS has emerged as a powerful and sophisticated means to manage vast amounts of geographic data. This growth of GIS over the last thirty years can clearly be linked to technological advancements in the computer, digitizers, and plotters, coupled with an increasing demand by interested parties for geographic information.

The spatial organization, manipulation, and analysis of geographic data are extending the analytical reach of organizations around the world. The use of geographic information tools has received overwhelming acceptance. This technology is enabling organizations to consider more effective ways of doing business.

## Definition

GIS has grown out of a number of technologies including cartography, photogrammetry, information management, computer science, and remote sensing. Advancements made in these fields correspond to advancements in GIS. This technology, therefore, consists of computer software and hardware designed to organize spatial data for analysis, assessment, and cartographic depiction. It provides a mechanism by which information on a feature's location, spatial interaction, and geographic relationship can be assessed and viewed in moments. It provides an opportunity to efficiently view and access geographic data to improve the decision-making process.

Because of the very nature of GIS, and the rapid growth of associated disciplines, many definitions of this technology exist. The following is a useful definition because it addresses functionality as well as components:

> "An organized collection of computer hardware, software, geographic data and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information." ESRI

Others have attempted to use the name itself to better understand the functions and components of GIS. GIS can be viewed in this way:

**Geographic**: The system is concerned with data relating to geography and geographic scales of measurement. This is referenced by some coordinate system to locations on the surface of the earth.

**Information**: The system allows for the storage and extraction of specific and meaningful attribute information. These data are connected to some geography, and are organized around a model of the real world. Spatial and aspatial queries are made possible.

**System**: An automated system should include an integrated set of procedures for the input, storage, manipulation, and output of geographic information.

GIS relies on the integration of three areas of computer technology: 1) relational database management systems to store graphic and non-graphic data; 2) cartographic capabilities to depict, graph, and plot geographic information; and 3) spatial analytical capabilities to facilitate manipulation and spatial analysis. Three distinct areas are:

1. ***Graphic capabilities***
2. ***Relational database***
3. ***Spatial analysis***

## Basic Map Concepts

Maps are simplifications of the real world and are, therefore, models of reality. Cartographers develop maps using a set of rigid rules and guidelines. Absolute geographic locations are specified using a coordinate system such as latitude/longitude or universal transverse Mercator (UTM) coordinates. The most familiar location reference system is that of the latitude and longitude. This system can be used to identify the locations of points anywhere on the earth's surface.

Latitude and longitude are angles measured from the earth's center to a point on the earth's surface. Latitude is measured North and South, while longitude is measured East and West. Latitudes and longitudes are traditionally measured in degrees, minutes, and seconds (DMS). Latitude/longitude, however, is a geographic reference system - not a two-dimensional Cartesian coordinate system or Planar system. Flat maps with a Cartesian coordinate system are essential to a GIS. Therefore, since the earth is a spheroid, a mathematical conversion is used to create a flat map. This mathematical conversion is commonly referred to as a map projection. Each coordinate system used is based on a particular map projection. These coordinate systems allow both the mapmaker and the map user to specify and define a position for every location on both the earth and maps of the earth.

**Coordinate Systems** are the x, y location in a Cartesian coordinate system. Coordinates are used to represent locations on the earth's surface relative to other locations.

**Projection:** A mathematical model that transforms the locations of features on the earth's surface to locations on a two dimensional surface. Some map projections preserve the integrity of shape; others preserve accuracy of area, distance, or direction.

**Scale:** This is the mathematical relationship of real earth distance to that same distance as it is shown on a map. The relationship is stated as the ratio of two distances. Maps are models of the real world and therefore the ratio of ground to map distance is normally much less than one. Maps stored in a GIS must be similar in scale if they are to be manipulated together. Maps with large differences in scale (e.g., 1:400 vs. 1:100,000) cannot be registered and overlaid without serious distortion.

## Data Models

GIS data models have always been different than data models for conventional business databases. While most databases only need to deal with alphanumeric content, GIS data models also include a spatial element. Spatial data can include location information, relationships between spatial features, and attribute data. This section compares the various data models: CAD, Coverage/Geo-relational, and the new Geodatabase model.

### CAD Data Model

The CAD data model is the earliest data model, and is not GIS, but a precursor to GIS data models. It uses a binary file format, with representations for points, lines, and areas. Data was not accessible through central databases, but only through the CAD software. Little attribute information could be stored about feature attributes. All attribute information was conveyed via graphical information, such as color, line style, and annotation. The biggest limitation the CAD data model had is no concept of topology.

### Coverage/Geo-relational Data Model

The cover model, also called the geo-relational data model, was developed by ESRI in the early 1980's. The basic unit of the coverage data model, a coverage, combined spatial data with attribute data. This data model supported topological relationships between features, that is, it deals with the underlying geography directly. However, because of the coverage data model's requirements for maintaining topology, behavior of real-world features was not yet supported. Instead, all features are represented as generic points, arcs, and polygons.

The geo-relational data model (or coverage data model) is still used, at least in part, by the most modern GIS software, so it is useful as well as instructive to examine the components of this geo-relational data model. The following is a list of the three features used in a geo-relational data model:

*1.* **Point Feature**: A single x, y coordinate that represents a geographic feature too small to be depicted as a line or an area.

<u>Points</u>
- Represented by a single coordinate, no extent or area
- Also referred to as nodes
- Attributes linked to a point ID
- Examples include: manholes, hydrants, utility poles, and meter locations

*2.* **Line Feature**: A set of ordered coordinates that represent the shape of a geographic feature too narrow to be displayed as an area.

<u>Lines / Arcs</u>
- *Also referred to as arcs or segments*
- Linear features. Length, no area
- Attribute linked to ARC ID
- Examples include: Roads, Streams, Power Lines

*3.* **Area Feature**: An area feature is a closed figure (series of arcs comprising its boundary) whose boundary encloses a homogenous area, such as a service area or city limits.

<u>*Polygons*</u>
- Also referred to as areas or complex shapes

- Features attached to polygons: Area and Perimeter
- Attributes linked to Polygon ID
- Examples include: Political boundaries, Zip Codes, Land Use

**Topology**

The coverage model relied on underlying connectivity referred to as topology. Spatial relationships between map features are represented on maps. The map user can interpret a map and estimate distances and perceive relationships. GIS builds spatial information, which facilitates an accurate data description of the relationship of features. In the geo-relational data model spatial relations are depicted using topology.

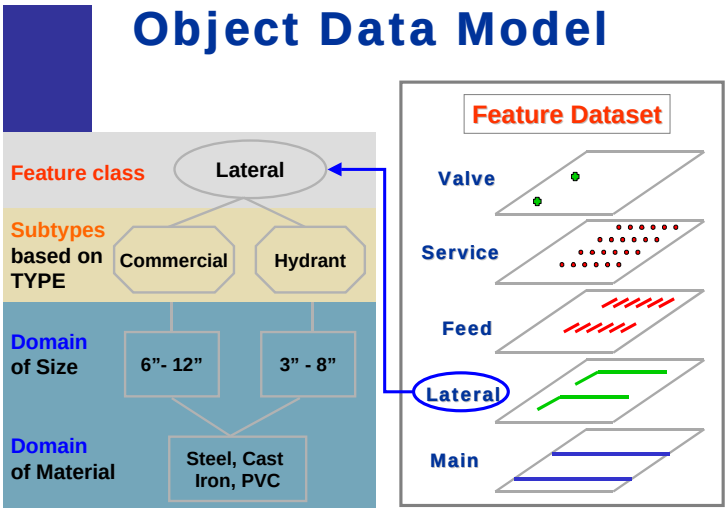
> "Topology is the spatial relationship between connecting or adjacent coverage features; e.g., arcs, nodes, polygons, and points. For example, the topology of an arc includes its from-and-to node and its left and right polygons. Topological relationships are built from simple elements into complex elements: points (simplest element), arcs (sets of connecting points), and areas of polygons (sets of connecting arcs)." ESRI

Three major topological concepts may include:

**Connectivity:** (arc-node topology) the topological identification of the set of arcs that connect at each node. Connectivity within a linear network is defined by recording the from-node number and the to-node number for each arc. Arcs that share a common node are connected.

**Area Definition:** (polygon-arc topology) a list of arcs that make up each polygon.

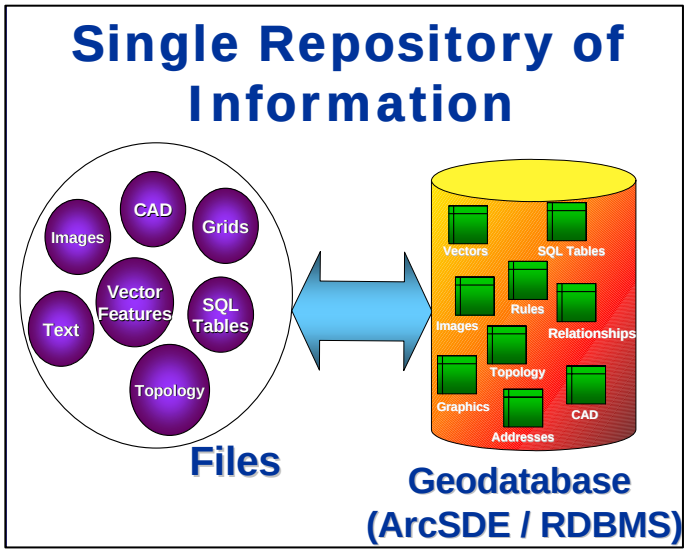
**Contiguity:** (left-right topology) the topological identification of adjacent polygons by recording the left and right polygons of each arc.




**Current Data Model – The Geodatabase**

With the introduction of ArcInfo 8.0 in 1999, came the introduction of the Geodatabase Data Model. The Geodatabase Data Model is object-oriented, which creates features that behave like the real-world objects that they represent. Features are stored in a relational database management system (RDBMS) such as Microsoft SQL Server and Oracle.

Geodatabases are organized hierarchically into four categories:




***Data Representation***

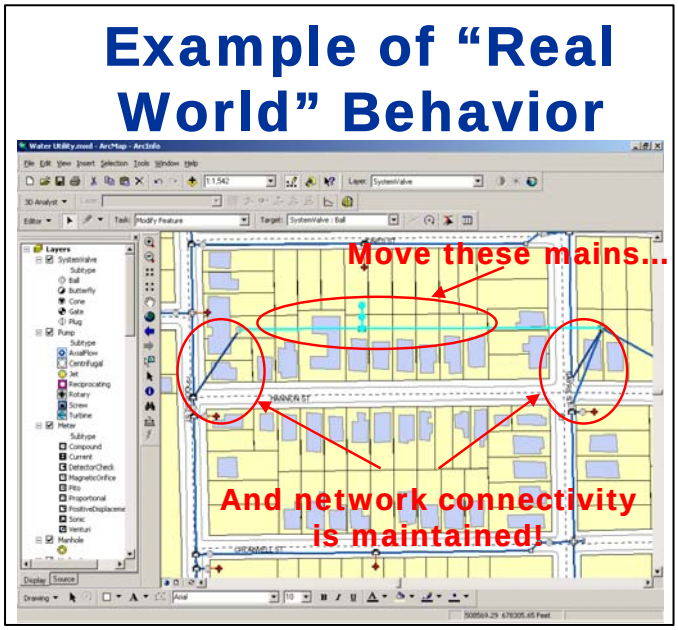
- Feature Datasets
- Feature Classes
- Subtypes
- Domains

The above figure is a schematic model of the Geodatabase Data Model.

**Technical Benefits of the Geodatabase Model**

**Single Repository of Information**: In the Geodatabase Data Model, all geographic data is stored and centrally managed from one database. This allows an organization to leverage the power, security, and reliability of relational database management systems (RDBMS).

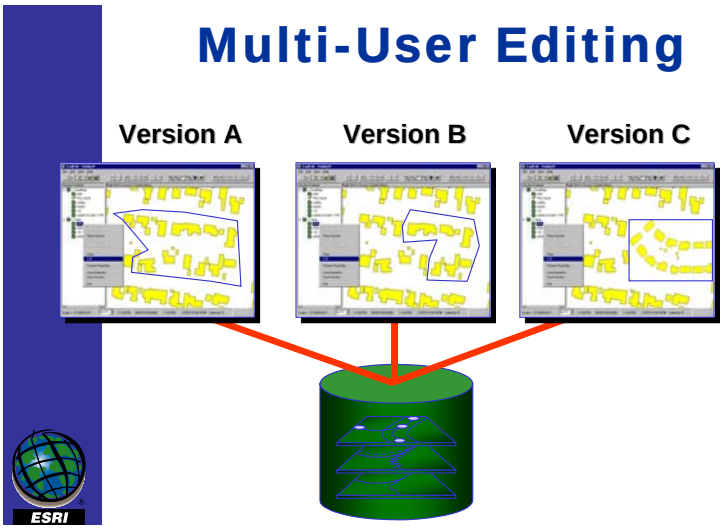
**Representation of Real World Features:** In addition to generic features, such as points lines, and areas, features in a Geodatabase can be created to behave like the real world objects they represent, such as parcels, transformers, and valves. Features will relate and respond to changes in neighboring features.




***Real World Example***

**Geodatabase Versioning, Multi-User Editing, and Accurate Data Entry and Editing:**
In a Geodatabase, edits take place on a record or transaction basis, instead of a file basis. This allows for multiple users to edit the same data set. Multi-user editing is supported through versioning. Each version is a persistent alternative representation of the Geodatabase. All versions will have the same schema, but may have different content. Instead of replicating the entire dataset for two versions, only the differences are stored.

Because features in Geodatabase behave like the real-world features they represent, intelligent validation is performed on all edits. Any edit that would violate the real-world logic of how real-world object interacts will not be allowed. For example, if you tried to use a 3" inch valve to connect two pieces of 2" piping, the Geodatabase would now allow it. Custom behaviors of features can be defined, however.




***Multi User Editing***

**Features in Geodatabase data model have a richer content:**
With topological associations, spatial representation, and general relationships, you define not only a feature's qualities, but also its content with other features. This lets

you specify what happens to features when a related feature is moved, changed, or deleted. This context also lets you locate and inspect a feature that is related to another.

**Shapes of features are continuous, and better defined:**
By their design, geodatabases can accommodate very large sets of features without tiles or other spatial partitions. The geodatabase data model also lets you define the shape of features using straight lines, circular curves, elliptical curves, and Bezier splines.

## Components of a GIS

There are four integrated components of a GIS: (1) data and databases, (2) hardware, (3) software including database management systems, and (4) users.

**(1) Data and databases:** The data in a GIS are by definition geographic. Specifically spatial data are locational information pertaining to where objects of interest are located, their distribution and extent, adjacency, proximity, and connectivity, verses, attribute data or observations about features.

**(2) Hardware:** A fully functional GIS must contain hardware to support data input, output, storage, retrieval, display and analysis. Hardware essentials focus on the platform and the peripheral devices. Rapid improvements in computer technologies have allowed the advent of true desktop GIS functionality.

**(3) Software:** Many GIS software packages are on the market, each offering different levels of functionality. Turnkey systems (ready for use directly out of the box) and customized installations are all possible. Because GIS software packages are so numerous the trend is to perform a needs assessment or requirements analysis prior to committing to a purchase from one vendor.

**(4) Users:** The true GIS professional needs to be well versed in many disciplines. Map reading, database management, spatial analysis, computer cartography, computer science, programming, and basic geography are disciplines in which a thorough grounding is required. A balanced education in GIS theory and practical experience (familiarity with GIS software) are essential. However five categories of GIS users are developing: (1) *Flagship or system user*, a technical person with a formal education and training in GIS who has hands-on use of GIS, (2) *Desktop-query & browser user*, a staff person with some software training, (3) *Application user*, a non-technical person using custom GIS software for specific tasks, (4) *End users,* people who make use of the end product, and (5) *Data gatherers / generators*, people who enter or capture data for analysis in the GIS.

## Functions of a GIS

The following is a list of GIS functionality:

**Manipulation**

1. *Coordinate Change*
   Coordinates are used to represent locations on the earth's surface relative to other locations. It is possible to transform or convert digital coverages between coordinate systems. For example, it is possible to transform coordinates from digitized units to UTM meters.

2. *Projection*
   A projection is a systematic representation of a round body such as the Earth on a flat (plane) surface. Each map projection has specific properties that make it useful

for specific purposes. Some projections preserve shape; others preserve accuracy of area, distance, or direction. GIS has the ability to transform geographic data on the fly to conform to a variety of projections.

3. *Edge Matching*
When a number of maps need to be merged together to create one single coverage, this properly ensures that all features that cross-adjacent maps are joined. In ArcInfo, up to 500 coverages can be joined.

4. *Windowing*
Windowing allows you to display a section within a map in larger and greater detail.

**Spatial Analysis**

1. *Aggregation*
Digital coverages can be aggregated by the deletion or dissolving of boundaries sharing the same values for a specified attribute.

2. *Classification*
Classification is the process of assigning individual observations of features into groups, categories, or classes.

3. *Measurement*
GIS can perform complex measurements including length, location, area, and perimeter.

4. *Overlay*
This is the process of combining spatial information from two or more maps with the same geographic area, deriving a map consisting of new spatial boundaries and entities or themes.

5. *Buffering*
This process will introduce a zone of specified distance around the selected feature(s). Constant and variable width buffers can be generated for a set of features based on the feature's attribute values. These buffers can be used for proximity analysis (e.g. find sewer pipes within 100 feet of a road).

6. *Networks*
A network is a number of intersecting arcs that show possible paths from one location to another. Network analysis involves techniques used to conduct analyses on a set of points (nodes) and lines that are connected to each other.

7. *Map Algebra*
Map algebra is the process of adding, subtracting, multiplying, and dividing maps by applying mathematical operations to map themes. Map algebra utilities allow the user to specify mathematical relationships between map layers. For example, a new map can be generated by determining the difference in elevation between a topographic map and the corresponding map of the water table.

8. *Query*

Both spatial and aspatial queries can be performed on geographic information systems.

An aspatial query might ask, "What is the population of Manhattan, NY?" This does not involve any attributes dealing with latitude and longitude.

A spatial query might ask "How many people live within two miles of Manhattan, NY?" or "What is the shortest route between Public Works depot and 101 Smith Street?" Spatial queries can deal with location, condition, trends, patterns, modeling, proximity, boundary operations, and logical operations.

## GIS Software

GIS developers have provided effective software that has made the technology accessible to local governments throughout the world.

### ESRI Software

Environmental Systems Research Institute (ESRI) is the world's leading GIS software company. Governments, business, utilities, and educators throughout the world rely on ESRI software to improve operational efficiency, increase profitability, and tap the true potential of their databases. They have a suite of products that cover all imaginable uses of GIS. ArcGIS 9 marks ESRI's transition into object-oriented GIS software. ArcGIS 9 marks the unification of the ArcInfo and ArcView environments. All ArcGIS 9 extensions are compatible with ArcInfo, ArcView, and their new intermediate software, ArcEditor.

**ArcInfo 9**: ArcInfo integrates graphic or "spatial" data in the form of maps with descriptive or attribute information from an organization's internal databases. ArcInfo does a variety of tasks including, but not limited to: Data automation and integration, open data management, spatial analysis, advance cartographic productions, open development environment/object oriented programming, and scalability. ArcInfo is infinitely more powerful than desktop mapping with its ability to enable organizations to distribute access across the enterprise, incorporate relational database technologies, implement multi-user systems, perform transaction management, and use higher-level modeling tools that help people transform data into meaningful information.

**ArcEditor 9:** ArcEditor is the new software that includes all the functionality of ArcView and adds the power to edit topologically integrated features in a geodatabase or coverage. Additional functionality includes support for multi-user editing, versioning, custom feature classes, feature-linked annotation, and dimensioning. ArcEditor allows you to create and edit all ESRI-supported vector data formats.

**ArcView 9:** ArcView is the world's most popular desktop GIS and mapping software, with more than 500,000 copies in use worldwide. ArcView provides data visualization, query, analysis, and integration capabilities along with the ability to create and edit geographic data. ArcView 9 maintains the base functionality of ArcView 3 and adds a host of improvements driven by user requests. New features include a catalog for browsing and managing data, on-the-fly coordinate and datum projection, metadata creation, customization with built-in VBA, new editor tools, support for static annotation, enhanced cartographic tools, direct access to Internet data, and much more. ArcView 9 is an exceptional stand-alone GIS as well as the entry point to ArcGIS, an integrated and scalable family of GIS software products. ArcGIS extends ArcView by providing multi-user editing, advanced analysis, Internet services, and high performance spatial database services.

**ArcGIS 9 Extensions**: ArcGIS 9 introduces a new set of functional extensions that operate with ArcView 9, ArcEditor 9, and ArcInfo 9. ESRI reengineered the extensions to incorporate the best features of the existing ArcView and ArcInfo extensions. The list of extensions available for 9 include ArcGIS Spatial Analyst, ArcGIS 3D Analyst, ArcGIS Geostatistical Analyst, ArcGIS Schematics, ArcPress for ArcGIS, ArcGIS StreetMap USA, ArcGIS Publisher, and MrSID Encoder for ArcGIS.

One of the key features of these extensions is that they operate with the entire line of ArcGIS Desktop software. Prior to ArcGIS 9, if ESRI users needed to perform raster analysis they licensed different software depending on their core GIS software. They used ArcView Spatial Analyst with ArcView or ARC GRID with ArcInfo. In contrast, ArcGIS Spatial Analyst 9 can operate with ArcView 9, ArcEditor 9, or ArcInfo 9.

**ArcSDE 9:** ArcSDE is the gateway for storing and managing a multi-user geodatabase stored in a database management system (DBMS). By allowing joint multi-user editing and providing transacted views of a geodatabase, ArcSDE plays a fundamental role in collaborative GIS systems. ArcSDE 9 is tightly integrated with ArcEditor 9 and ArcInfo 9 for designing, creating, implementing, and sharing multi-user geodatabases. In a collaborative GIS environment, ArcView 9 acts as a client for viewing and analyzing geographic data. ArcSDE 9 supports Oracle, Microsoft SQL Server, IBM DB2, and Informix.

## Relational Database Management Systems (RDBMS)

The power of ArcGIS 9 can only be fully exploited when used in conjunctions with a RDBMS. ArcGIS 8 utilizes the new geodatabase data model. The RDBMS is the foundation of the geodatabase. A primary purpose of the geodatabase is to handle complex spatial data with a uniform data model independent of the RDBMS. Geodatabases are implemented directly in a commercial relational database management system, such as Oracle or MS SQL Server. The reason for this is to leverage the capabilities of commercial database software, which include data backup, table definition, transaction management, and system administration tools. A GIS extends a RDBMS so that it can efficiently store spatial data, produce maps, and perform spatial analytic tasks.

Some of the abilities that GIS software adds to a relational database management system are:

- The ability to store the geometric shapes of features directly in a database column.
- A framework to define map layers on data and specify drawing methods; these can be drawn based on attribute values.
- An infrastructure to support the creation of simple and sophisticated maps. Many common map-making tasks (such as field books for service and repair personnel) are simplified.
- The creation and storage of topological relationships that exist among features, such as network connectivity and integrated polygon topology.
- A spatial index spanning two dimensions for rapid retrieval of geographic features.
- A set of operators for determining geographic relationships such as proximity, adjacency, overlay, and spatial comparison.
- Many tools to support spatial queries such as network tracing and polygon overlay analysis.
- A workflow system that allows the editing of geographic data by many users and manages versions.

There are several popular RDBMS platforms on the market, including Oracle, Microsoft SQL Server, Informix, and Microsoft Access. Regardless of which RDBMS is selected for

implementation, it should be the same for both GIS and other countywide data servers, to simplify training and support.

# Remote Sensing

## History

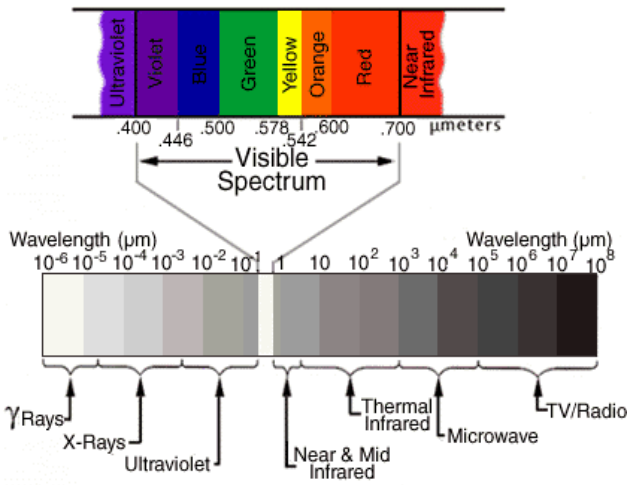
In 1858 Gaspard Felix Tournachon, known as "Nadar", took the first known aerial photograph by ascending to 80 meters above Bievre, France in a balloon. In doing so, this Parisian photographer birthed the movement of remote sensing. The first American, James Wallace Black, to use remote sensing, flew a balloon 365 meters above Boston on October 13, 1860 to record his images. Photographs made at this time were more valued for their artistic and purely visual worth, rather than for their scientific and serious data gathering potential.
It wasn't until around 1882 that scientific data was gathered through remote sensing when very large kites were flown in order to acquire meteorological information. Adding to the growth of remote sensing as a serious discipline, A. Batut published the first "state of the art" textbook in Paris, France in 1890. However, it was the work of an American, G. R. Lawrence, who would bring worldwide attention to remote sensing; and provide the fledgling discipline with a new application in disaster mapping. Following the Great San Francisco earthquake and fire of 1906, Lawrence sailed out into San Francisco Bay and flew a battery of 17 kites to a height of 610 meters over the city. The arrival of the airplane, in 1903, provided remote sensing with what would become its most popular platform for acquiring imagery. World War I and II saw the rapid development of remote sensing as an important data collection method. Imagery acquired by cameras in planes proved invaluable as a source of military intelligence.

The next major advancement for remote sensing was ushered in with the age of satellites. In the late 1960's and early 1970's a continual series of orbital platforms were launched which provided data from the "ultimate" vantage point. Data collected addressed subjects as diverse as vegetation type and surface geology to military intelligence and urban change. Today, the combined value of satellite and airborne remote sensing devices provide a perfect balance for acquiring data at a scale and resolution needed by researchers and governments.

## Definition

There are two primary methods for gathering geographic data: the first is through direct physical contact, or in-situ, with that which is of interest. Thermometers and wind gauges are examples of this method. With these types of instruments, contact must be made with the feature being observed in order for a measurement to occur. The second primary method places the measuring instrument in a location some distance from the feature of interest. These instruments are said to be "remote", as they make no physical contact when recording. Examples include cameras and x-ray machines. Both of these devices contain sensors, which permit "images" to be recorded without the device being near the feature that the image represents. An advantage of this is that very large or inaccessible areas can be observed without incurring the high cost and added time required to physically place an instrument on site.

The second aspect of the definition addresses the word "sensing". It is not enough for an instrument to be remotely located, if that device is not observing and recording data. Most instruments used for geographical purposes record data in what is termed the Electromagnetic spectrum. This is a very broad range of wavelengths, of which visible light (that which our eyes see) is only a small part.




***Electromagnetic spectrum showing region visible to our eyes.***

The fundamental process of remote sensing, for geographic purposes, places an instrument at a distant location, in order to record an image in a section of the Electromagnetic spectrum; which when analyzed will provide valuable information. Lillesand and Kiefer (1987 p.1) have defined remote sensing more formally as:

> "…the science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area, or phenomenon under investigation."

## Basic Advantages of Using Remote Sensing

As stated previously, the fundamental characteristic that separates in-situ and remote sensing data collection is the placement of the instrument in a remote location to the feature of interest. The following are five basic advantages, given by Lillesand and Kiefer (1987 pp37-38), of using remote sensing over traditional "on-the-ground" data collection.

The first advantage is the improved vantage point the imagery provides. Interpreting features within their spatial context allows for "deeper" information to be extracted concerning relationships and interactions. An image taken from a plane can provide clues as to how a change in watershed drainage, from suburban development, affects wetland vegetation health down stream. In this example one image allowed three different components; watershed hydrology, suburban growth, and wetland vegetation health to be interpreted together. Relationships between the three became obvious when their spatial connection was preserved in the remotely sensed image. Gaining the same level of relationship information, using on-the-ground data collection, would have required extensive man-hours, by various agencies, followed by tedious data compellations before the "big picture" was understood.

The second advantage is the ability to record a moment in time. An image such as this provides a non-biased view of events at a precise instance. This can prove valuable in settling legal disputes (i.e. water contamination sources) and verifying the progress of events (i.e. extent of reforestation efforts). Recording a moment in time also allows for change detection. Change detection is one of the most common operations performed in remote sensing. It uses two different images that were taken on two different dates of the same feature; when compared with each other any areas of change are highlighted. This would not be possible if each image did not represent a single instance in time. A contemporary example would be the comparison of imagery before hurricane Hugo and shortly after the

storm. The differences in the images quickly and accurately identified crop loss, structural damage, erosion, and vegetation loss.

The third advantage is the ability to permanently record events. After images have been acquired an archive can be constructed, which will allow them to function as permanent documents for future reference. These "image-documents" when placed in a database with additional GIS layers can prove invaluable in uncovering long-term trends (i.e. floods, wildlife migration habits, forest fires) and the effects incurred. As well, when future methods of analysis are refined, these images can be re-evaluated and more detailed information extracted.

The fourth advantage is broadened spectral sensitivity. The human eye is sensitive to only those wavelengths of light in the visible spectrum. However, the entire Electromagnetic spectrum is considerably larger, and contains valuable information in the areas outside of human sight. Instruments used in remote sensing are designed to detect in these regions. One of the more important is the Near Infrared (NIR). Wavelengths in the NIR are completely absorbed by water and appear black on imagery, while vegetation strongly reflects these wavelengths and appears bright. This simple but valuable difference allows for accurate delineation of lakes, streams, drainage areas, and coastal inlets from the vegetation that usually grows right up to their edge.

The fifth advantage is the improved spatial resolution and geometric fidelity. Remotely sensed imagery has the ability to detect finer details in features, from similar distances, than the unaided human eye. Remote sensing applications benefit as well from the inherent geometric fidelity found within imagery. Being able to obtain accurate and precise measurements of heights, volumes, slopes, distances, and positions of real world features allows for construction of planimetric and topographic maps directly from imagery in a fraction of the time required using on-the-ground methods.

## Four Types of Imagery Resolution

Resolution is understood as the ability to distinguish between two different features that are spatially near or spectrally similar. The ability of an instrument to resolve individual features is vitally important in remote sensing. If image features cannot be located, then no information concerning them will be extracted. It is therefore, important to correctly match the type of instrument to the ultimate goals for the imagery. When this does not happen, the imagery collected is either too coarse a resolution to be useful, or it is overly detailed for the eventual project goals. To avoid such problems, four types of resolutions, and how they impact the final imagery, need to be understood.

The first is spatial resolution. This is a measure of how close two objects can be before the remote sensing instrument fails to distinguish them as unique features. The fundamental rule of thumb is that the size of the instrument's spatial resolution should be half the size of the largest feature that needs to be resolved. If the imagery is to be used to locate trees that are greater than or equal to six feet in diameter then the instrument's spatial resolution does not need to be better than three feet.

The second is spectral resolution. Each remote sensing instrument is designed differently in order to best suit specific tasks. To this end, some instruments utilize multiple sensors with each one recording over a very narrow and unique section of the spectrum. These individual sections are known as bands, and instruments of this type are termed multi-spectral (for their multiple spectral bands). Other remote sensing devices have only one very

broad band that simultaneously covers many different wavelengths. These are termed panchromatic, as they are equally sensitive to many (pan) colors (chromatic) at one time.

When determining the spectral resolution of an instrument, one must consider both the number of individual bands and the size, or width, of each band. If the multi-spectral bands are too narrow they may not "see" enough of a specific wavelength to resolve a feature. Likewise, if the bands are overly broad, then they "see" too much and different features may become similar. In general, panchromatic sensors provide better spatial resolutions and are utilized where just locating features is important. Multi-spectral sensors, while having poorer spatial resolutions, are extremely valuable when there exists a large diversity of features (rivers, forests, barren ground, suburbs, and wetland) in one image that must be accurately separated from each other. This feature identification procedure is known as 'classification'.

The third is temporal resolution. This is a measure of how much time must elapse before the flight path of the remote sensing device is brought back over the exact same location. Airborne remote sensing devices can be contracted to cover custom flight paths when the need arises. Their temporal resolution is not fixed. This is not the case for satellites. They are in fixed orbits with prescribed flight paths. This means that it could take anywhere from 14 to 30 days before they revisit the exact same location. This return time is their temporal resolution. A long time between revisits would not be suitable for rapidly occurring events (i.e. floods, fires), as the satellite would not be in position to record it.

The fourth is radiometric resolution. As wavelengths enter the remote sensing instrument they are converted into a format that can be recorded. In this process of recording some generalizations occur due to the sensor's inability to discriminate all incoming signal strengths. Satellite Landsat 1, using a MSS (multi-spectral scanner) sensor, recorded only 64 different gray-scale levels per image band. This means that all signals entering each band had to be generalized down into 64 different "bins" for recording. Later improvements with Landsat 5, and its TM (thematic mapper) sensor, produced images with 256 different signal levels per image band. The higher the number of individual "bins" used for recording, the fewer image features are lost to generalizations. Radiometric resolution then, is the number of individual signal strengths ("bins") a sensor uses to record images.

## The Two Primary Types of Sensors: Passive and Active

Passive sensors use only the naturally available illumination that enters the instrument to record images. Active sensors, conversely, emit their own energy that travels from the instrument to the target, returns to the sensor, and is used to produce an image of the target. A passive sensor is what is commonly thought of in connection to remote sensing applications: a camera suspended beneath a plane. Examples of active sensors would be radar, sonar, LIDAR, and FLIR (Forward Looking Infrared Radar), which are all devices that "probe" the target for information. Passive sensors are generally less expensive to construct and maintain, than active ones, due to the greater simplicity of using natural illumination. Active sensors have the advantage of being able to operate day or night, and in any kind of weather. However, there is greater cost in acquiring such imagery.

**Passive Sensors:** There are two varieties of passive sensors: reflective and emitted. Reflective sensors are designed to detect the natural illumination that is being reflected off a target. A common situation would have sunlight striking the earth's surface, being reflected off that surface, collected by a passive remote sensing instrument (i.e. camera), and finally converted into an image of the surface. Emitted sensors are designed to detect the natural illumination that is being produced by the target itself. Thermal (heat) and radioactivity are examples of emitted energy. The heat generated by hot water released from a nuclear

reactor would be easily discriminated from cold river water by its emitted heat signature. A remote sensing instrument would collect this emitted energy, originating from the hotter than normal river water, and convert it into an image. Likewise, photons (packets of energy) emitted from radioactive sources, such as contaminated plants or soil, can be recorded and represented as an image.

The primary varieties of passive satellite sensor platforms used for geographic purposes include the United States' Landsat MSS (Multispectral Scanner), Landsat TM (Thematic Mapper), and the French SPOT (Systeme Pour l'Observation de la Terre) program. For airborne multispectral sensors the Daedalus platform has found the most favor. The MSS, and TM sensors use a mirror that scans and rotates perpendicular to the flight line of the satellite to direct light into the instrument. The SPOT sensor system uses a long strip of detectors (much like in a flatbed scanner), aligned perpendicular to the satellite's flight path, to record its images. This non-moving, fixed row of sensors progressively scans a new strip of the earth's surface as the satellite moves forward in its flight path.

The MSS has been flown since 1972 on Landsat 1 through 5. It has four spectral bands which records reflected light in the green, red, NIR, and MIR (Middle Infrared), with a spatial resolution of 79 x 79 meters (each image pixel is nearly 80 meters square). Temporal resolution for the MSS is 18 days. The radiometric resolution is 6 bits, meaning there were only 64 different image brightness levels, "bins", per image band. With these resolutions the MSS was best suited for broad analysis of general vegetation inventories, and geologic studies.

The TM sensor was an improvement on the MSS and was added to the Landsat's 4 and 5 platforms. It has six spectral bands for reflected light (blue, green, red, NIR, and two MIR bands). The spatial resolution is 30 x 30 meters, while the temporal resolution is every 16 days. Radiometric resolution was increased to 8 bits, or 256 different brightness levels per band. Improved spatial resolutions allowed the TM sensor to benefit applications on more local levels as the smaller pixel size resolved smaller features. Spectral and radiometric resolutions enhanced the ability of the sensor to detect soil moisture, discriminate vegetation types, better identify rock types, and differentiate clouds, snow, and ice from one another.

The SPOT sensor system was first launched in 1986 by the French Centre National d'Etudes Spatiales (CNES). It carried both panchromatic (10 x 10 meter) and multispectral (20 x 20 meter) sensors. Due to the lower orbit required to decrease the size of each pixel the temporal resolution rose to every 26 days. Radiometric resolution matched the TM sensor with 8 bits. SPOT only carried three multispectral bands (green, red and NIR). Therefore, it did not have all the discriminatory ability of the TM's six bands; but the increased spatial resolution (namely in the panchromatic band) allowed SPOT to benefit smaller area studies. The panchromatic ban has often been used to conduct urban and suburban road network updates, while the three multispectral bands found value in the majority of vegetation, terrain, and crop discrimination.

The Daedalus sensor system has two platforms, the DS-1260 and the DS-1268. Over the past 25 years it has been adopted as a standard in airborne remote sensing by approximately 80 laboratories and government agencies in 24 countries. Daedalus is known for its ability to produce very high spatial and spectral resolution images. Both the DS-1260 and 1268 platforms have spectral resolutions that exceed the MSS, TM and SPOT; with 10 unique bands recording reflected energy. They also exceed the spatial resolutions of these satellite platforms, with pixel sizes down to a few feet square at 1000 meters flying altitude. Radiometric resolution for this device is between 8 and 12 bits, which is from 256 to 4096 different gray scale levels per image band. The Daedalus also provides a flexible temporal

resolution, due to its ability to fly custom flight paths, which the satellite platforms cannot match. These advantages allow for extremely detailed studies of crop/vegetation type and health, urban street network change, and locating building footprints.

**Active sensor:** These devices transmit their own energy in short bursts towards a target and then record the strength of the signal that "bounces" back to the sensor. The variation in the strength of the returned signal can be processed into an image that describes the target's structure and/or surface. One of the most common examples active sensors is Radar (Radio Detection and Ranging). Radar has an advantage over all passive detectors in that it can function both day and night, in all weather conditions, and can penetrate surfaces (whether solid or liquid).

This last attribute has allowed Radar to be used for a number of unique remote sensing applications. In 1971 Radar was used to penetrate the nearly year round cloud cover of Venezuela in order to map 500,000 $km^2$. This provided a systematic inventory of the countries water resources, geologic terrain, transportation routes, water supplies, forestry resources, and sites suitable for agriculture. Seasat 1 launched in 1978 provided detailed information concerning oceanic and atmospheric phenomena such as current boundaries, eddies, fronts, bathymetric features, rainfalls, and ocean bottom configurations. Radar has also been used regularly to penetrate the soil surface to locate buried Roman ruins and ancient riverbeds beneath the Sahara desert. Interferometric Synthetic Aperture Radar (IFSAR) is a new airborne radar mapping system designed to map large areas at high resolutions and, for the first time, to create terrain models of the true ground surface beneath the vegetation canopy. These models will be created by interferometrically correlating radar data collected in two frequency bands —X-band and the longer, foliage-penetrating P-band. A related radar technology was recently used to map the earth during NASA's Shuttle Radar Topography Mission (SRTM). The shuttle mapping mission utilized Spaceborne Imaging Radar-C/X-Band Synthetic Aperture Radar (SIR-C/X-SAR) technology to produce global elevation maps using interferometry techniques.

Airborne LIDAR is an aircraft-mounted laser system designed to measure the three-dimensional coordinates of a passive target. As the aircraft flies over a target, the LIDAR system measures the time it takes for a single laser pulse to travel round trip from the source, to the target, and back to the receiver. Combined with aircraft positioning (AGPS – Airborne GPS) and orientation information (IMU – Inertial Measuring Unit), this measurement yields the target's precise three-dimensional position. The spatial resolution of the resulting terrain model is a function of the scanning angle, the laser pulse rate, the aircraft's flying height and the speed of the aircraft. LIDAR technology is ideal for aerial mapping applications such as generation of digital elevation models, topographic contouring, and automated feature extraction. Using LIDAR for DEM and contour generation is faster than using conventional photogrammetric techniques and less susceptible to data collection problems resulting from sun angle and shadows. One of the most exciting applications of LIDAR data is in automated feature extraction. LIDAR's ability to discriminate the heights of discrete features, such as buildings, roads and water bodies, yields valuable data for automated interpretation and extraction of these features

## Products from Remote Sensing

Valuable products generated through remote sensing include orthophotos, DTM's (Digital Terrain Models), landcover classifications, and planimetric features. Orthophotos provide the user with qualities of both maps and photographs. Like maps, they have only one scale, which allows for accurate measurements of distances, angles, and areas to be made directly from their surface. Another common product from remote sensing is the DTM (Digital

Terrain Model). These models use a wide sampling of elevation points to mathematically represent the real world terrain. Landcover classifications identify aerial features within photos and imagery that are uniquely discernable. These features include different types of vegetation, bare earth, water, and various man-made structures. Orthophotography is an excellent source of infrastructure data. Planimetric features such as buildings, streams, roads, and railroads can be extracted from aerial photography and incorporated into a GIS framework.

All of these products are used to create the foundation layers of a community GIS. They maintain value independently. However, they are of greatest value when combined in analyses to support decision making and planning.

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## Global Positioning System (GPS)

### History

People have always wanted to know where they are, where they have been, and where they are going. At first, mankind guided himself by leaving piles of rocks or by traveling by landmarks. As people started traveling further more sophisticated methods of navigation were required. Celestial navigation was used for guidance, but very careful measurements had to be made, and these could only be done on clear nights.

With the advent of technology, boats were soon able to use navigation systems besides the stars. Radio-based coastal systems, such as LORAN and DECCA proved successful. However, these systems are limited and only cover small areas. Also, their accuracy is liable to variations depending on electrical interference and geographic variations.

Another navigational system is the Transit System or "Sat-Nav". This uses a satellite system like GPS, but it is of much poorer quality, and is difficult to get a true reading. This system is based on Doppler so very small movements on the receiving end can cause a great deal of error.

The Department of Defense (DOD) required an accurate navigational system that covered the entire world. The DOD invested $12 billion into research and development of the Global Positioning System (GPS). Today we have a fully operational GPS used extensively by the military and increasingly being used by civilians.

### Definition

GPS consists of a base station, which is in constant contact with a group of 24 satellites in orbit of earth, and hand units tracking satellites in the field.

> *"Global positioning systems are space-based triangulation systems using satellites and computers to measure positions anywhere on earth. GPS was originally a defense system created by the United States Department of Defense. The advantage of this system and what sets it apart from others is its extensive geographic coverage, 24-hour coverage, and exceptional accuracy."*

Although 12 billion dollars is a vast amount of tax money, the technology has proved useful in a variety of circumstances. The satellites are very high in orbit so they avoid a large amount

of interference from the earth, and the technology is accurate enough to determine a position anywhere in the world, 24 hours a day. As GPS was originally developed as a defense system, it was designed to be resistant to jamming and interference.

GPS provides the capability of mapping every square inch on the earth's surface. To determine a location, the hand held units are taken into the field and are positioned beside or on top of an object of interest, such as a manhole, a water meter or a fire hydrant, etc. This processing of coordinates yields cartographic data with a high degree of accuracy. This method is the best available for building GIS layers. Although GPS is accurate within 100 meters in detecting location, there is a method that even surpasses normal GPS function. This is known as Differential GPS and it can be accurate within less than a meter.

## The GPS System

GPS is an effective mapping tool because line of sight between the unknown and a known location is NOT necessary. Only a line of site to the sky is needed. When operated properly, GPS satellites provide accurate positioning, user mobility, and rapid data capture. While satellite based positioning has revolutionized the GIS/mapping data capture industry, it is important to note that GPS is only a useful mapping tool. The GPS has three distinct phases:

***The Space Segment***

The space segment, when fully operational, consists of 24 operational satellites in six circular orbits, 20,200 kilometers above the earth at an inclined angle of 55 degrees with a 12 hour revisit period. The satellites are spaced in orbit so that at any time a minimum of 6 satellites are in view to users anywhere in the world. The satellites continuously broadcast position and time data to users throughout the world.

***The Control Segment***

The control segment consists of a master control station in Colorado Springs, with five monitor stations and three ground antennas located throughout the world. The monitor stations track all GPS satellites in view and collect information from the satellite broadcasts. The monitor stations send the information they collect from each of the satellites to the master control station, which computes extremely precise satellite orbits. The information is then formatted into updated navigation messages for each satellite. The updated information is transmitted to each satellite via the ground antennas, which also transmit and receive satellite control and monitoring signals.

***The User Segment***

The user segment consists of receivers, processors and antennas that allow land, sea and airborne operators to receive the GPS broadcasts and compute their precise position and velocity.

The GPS concept of operation is based upon satellite ranging. Users figure their position on the earth by measuring their distance from the group of satellites in space. The satellites act as precise reference points. Each GPS satellite transmits an accurate position and time signal. The user's receiver measures the time delay for the signal to reach the receiver, which is the direct measure of the apparent range to the satellite.

## User Applications

- GIS Data Capture
- Vehicle Tracking
- Marine/Vehicle Navigation
- Surveying

- Emergency Services
- Aviation
- Precise Positioning
- Agriculture
- Photogrammetry
- Recreation (hiking, etc.)

## GPS in Five Steps

There are five main steps that need to be conceptualized to understand how the GPS works.

1. Based on trilateration.
2. To trilaterate, GPS measures distance from the satellites.
3. To measure distance, you need good clocks and four satellites.
4. Once the distance is known, the satellite's position is needed.
5. Differential correction

Trilateration from satellites forms the base of the system. To trilaterate, GPS measures distance from the satellites. The GPS system measures distance by timing how long it takes a radio signal to reach us from a satellite, and then calculating the distance from that time. To measure travel time, GPS has very precise, accurate clocks. They can detect time with nanosecond timing. That's 0.000000001 of a second. Once the distance to the satellite is known, GPS receivers determine where the satellite is located. GPS satellites are very high above the earth and travel in a very precise orbit. These orbits are known in advance, and some GPS receivers on the ground have this information programmed into their computer's memory. This lets the receiver know exactly where a satellite is at a precise moment. The Department of Defense also monitors the satellites, and in the rare case of a minor variation, they have the satellite relay that information back to the receivers. GPS is subject to a number of errors that are compensated for through mathematics and modeling.

In practice, normal GPS operation can tell you where you are within a hundred meters. This figure decreases proportionally with the good quality of a receiver. GPS working in differential mode can pinpoint your location to within less than a meter using mapping-grade GPS receivers, and within one centimeter using survey-grade GPS receivers.

## Differential GPS

GPS can achieve even greater levels of accuracy using a technique known as 'differential GPS'. GPS can achieve measurements within one centimeter using this technique. The secret to this ideal accuracy is based on knowing the exact location on a ground point. When a GPS receiver is placed over this point, it can then figure out what errors the satellite data contain. It acts as a static reference point. Once the GPS receiver corrects the error, the receiver can transmit the correction factor to other receivers in the same locale. This will virtually eliminate all error in the measurements.

## The Potential of GPS

Now that GPS is in place, the applications afforded by it are infinite. GPS receivers have become inexpensive, and small enough to be owned by anyone. Today, local governments are using GPS to build GIS databases. The following is a list of realistic potential local government uses of GPS:

## List of Local Government Uses for GPS Inventory:

1. Water Infrastructure
   Valves
   Fire Hydrants
   Pipes
   Meters
2. Sanitary Sewer Infrastructure
   Manholes
   Lift Stations
   Pipes
3. Storm Water Infrastructure
4. Street Lights
5. Streets
   New Roads
   Pavement Management
   Sidewalks
   Railroad Crossings
   Bridges
   Markings
6. Regulatory Signs
7. Street Signs
8. Trees
9. Park Infrastructure
10. Inspections

# Appendix II – Seven Keys to a Successful GIS Implementation

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Growth in the use of Geographic Information Systems (GIS) technology over the past few years has been phenomenal. Organizations in the public and private sectors have been adopting the technology in droves. More often than not, however, these implementations have been less than successful. Too many organizations are spending millions of dollars on data, hardware, and software but getting very little return on investment. Is the technology to blame? Are traditional organizations standing in the way of progress? What can be done to reverse the trend toward failure? These are questions being asked frequently throughout the GIS community.

Meanwhile, in some organizations, this powerful new technology has revolutionized daily operations. Is there a common thread that successful organizations share? Fortunately, there is. In visiting and reviewing hundreds of GIS implementations nationwide, Geographic Technologies Group, Inc. has seen a few common elements surface in all successful GIS operations. These elements can be defined as seven keys to success. The absence of one or more of these keys will greatly reduce the effectiveness of an enterprise-wide GIS.

## Adhering to the "Seven Keys to a Successful GIS" is critical and will make or break a project.

GIS implementation has the capability of completely changing the way a local government does business. Properly implemented, GIS will have a positive effect on how all services are delivered and how all employees perform their jobs. The twenty-first century will see GIS and information processing serving as the backbone for all local government activities. Implementation of a technology of this magnitude must not be taken lightly or implemented cavalierly.

### What Is a Successful Enterprise-Wide GIS?

If reports from local governments are taken at face value, it would seem that no GIS implementation has failed. A local government that has invested in a GIS will almost always characterize it as successful. However, when pressed to qualify or quantify the success of the system, many can identify little benefit. Too often a GIS becomes an expensive mapping system fully implemented in only one department. Although mapping is an important part of a GIS, it is only one capability of GIS technology.

A truly successful GIS implementation harnesses the analytical power of the technology. An organization may have a wealth of compiled data but may not have an effective way of distributing or using it. The successful GIS breaks down barriers between departments and uses a combination of off-the-shelf and customized GIS applications to enable staff with varying levels of skills to use the technology to manipulate data.

### The successful GIS breaks down barriers between departments and organizations.

For example, the City of Wilson, North Carolina, has more than 250 layers of GIS data. Trained personnel in each department maintain their own GIS layers. The data are available throughout all departments in the city. Products such as ArcView from ESRI are used in conjunction with customized applications written to perform a specific set of tasks - crime analysis in the police department, floodway management in planning, and pavement management in Public Works.

Thus, the defining characteristic of a successful GIS implementation is participation and use by all departments of the GIS technology. For instance, before a building permit can be issued, an inspector needs to know the location of gas, sewer, water, and electric lines; and information about historic properties, floodways, watersheds, zoning districts, etc. A GIS can pull this information into one easy-to-use interface for the inspector, but each department must maintain pertinent data in the GIS. Each missing layer of information makes the GIS less effective.

GIS is a unifying technology. Implemented properly, it will break down traditional barriers between departments. For example, the Louisville (Kentucky) Development Authority has a GIS that uses data from a variety of municipal departments (zoning, historic properties, sewer, water, tax parcels) for neighborhood development.

To summarize, a GIS needs to be viewed as another tool available to each employee. It should not be hoarded by one division or department but should be fully integrated, as are word processors, into all departments.

## Key Number 1:

### Have a Well Thought Out Master Plan

Many GIS projects have failed due to a lack of planning and foresight. Many municipalities and counties have looked at GIS as just another computer program and have given as much thought to its implementation as they would a new word processor. These organizations' lack of insight has yielded them an unfruitful GIS and has cost their taxpayers dearly.

Successful cities and counties have recognized the potential of GIS and have harnessed its power by laying out a well thought out implementation plan. Any organization embarking on GIS should consider some of the key ingredients:

- A Steering Committee – *political strength*
- Top-Down Leadership – *secure funding*
- A GIS Champion – *at the policy level*
- A Technical Committee – *interdepartmental success*
- GIS Users Group – *open forum*
- An Independent GIS Specialist and Staff – *serving all departments*
- Departmental GIS – *everybody responsible for own databases*
- Technical Standards – *accuracy and compatibility*
- GIS Staff development – *expanding staff roles*

- Systems Integration – *linkage and accessibility*
- Common Spatial Data – *interagency cooperation*
- Unified Approach – *a comprehensive departmental understanding*

We have all heard, "A failure to plan is a plan to fail." This is never truer than with the implementation of GIS. Many organizations have been implementing GIS with little forethought. A typical scenario goes as follows. A department head attends a conference and sees an impressive GIS demonstration. This department head returns home and begins to stimulate interest in a local GIS. Funds are allocated, hardware and software are ordered, and a GIS is born—but without a detailed master plan. This is a recipe for failure.

**The master plan:** The City of West Sacramento contracted with the Geographic Technologies Group, Inc. to study and identify GIS needs and uses. This study will serve as a master plan to guide the GIS implementation.

A good GIS implementation study and master plan should address:

- Staffing
- Data needs
- Data acquisition and creation options
- Training and education
- Relationships with other organizations
- Hardware and software
- Infrastructure needs
- The role of the GIS within the organization
- Costs and benefits
- A three-year implementation schedule

A detailed, step-by-step process should be outlined for each of these issues. For instance, the plan for training and education should detail which classes each person needs to attend and when, what should be taught in-house, what training should be out-sourced, the benefit of each course, costs, and a list of trainers available to teach the classes. This plan should be specific.

**Updating the plan.** Keep the master plan updated. Successful, mature GIS implementations continue to be guided by a master plan. It is wise to update the GIS plan every year.

Conduct Surveys of GIS users anonymously to determine staff perceptions of its usefulness. No GIS is successful unless staff, throughout the organization, recognizes the usefulness of the technology and consider it an indispensable tool in their own arsenal.

**Sharing the plan.** The master plan is of limited usefulness unless it is shared with all involved parties. Organization leaders, elected officials, and other pertinent staff should have a copy of the master plan. It will serve as a guide for everyone using the technology and will invigorate the project. If the staff of one department sees how other departments are using the GIS, they will be more apt to make sure that their own department is not left behind.

Within the City of West Sacramento, this document should be relied on to direct the day-to-day implementation of the technology, especially for the first year. However, this study should be looked upon as a living document that will evolve to incorporate the invariable changes that occur in local government. Also, new and emerging technologies will need to be considered as the phases of implementation unfold. It is therefore important to regularly

update your master implementation plan. The City of West Sacramento should update the plan on an annual basis.

A copy of the implementation plan should be given to all parties. These parties should be consulted for input into the plan. It is a good idea to get each department and participating organization to sign off on the plan, especially those parts that relate to them. This will serve a two-fold purpose. First, each department/organization will see that they are an integral part of the GIS implementation team and have a vested interest in its success. Secondly, each department/organization will have a good idea about the direction of the implementation.

## Key Number 2:

### Have an Independent GIS Specialist

In the last section we looked at the importance of having a master plan for the GIS program. This master plan should clearly define the goals of the GIS project over a three-year period. Without this type of guidance, a GIS program can become like a rudderless ship, adrift and going nowhere. The master plan serves as the rudder of the ship. However, the ship also needs a knowledgeable captain on board. All of the most successful GIS programs have a full-time project leader. Having this person or persons is the *most* important of the seven keys to GIS success because leadership can make or break the project.

The project leader is often referred to as the GIS Manager, GIS Specialist, or GIS Director. Alternatively, project leadership can come from the combination of existing staff and an outside consultant. However this leadership is structured, you must have access to people with the technical savvy to run diverse operating systems, networks, and GIS software and the people skills to coordinate, sell, champion, teach, and referee the implementation of this revolutionizing technology.

### Why a Full-Time Coordinator?

Do we really need a new position to run our GIS? Can't we just use our existing staff? In which department should we put our GIS Specialist? How much should we pay? These questions are not to be answered lightly. Organizations have spent millions of dollars on GIS just to see the project fail because these questions were not addressed properly.

GIS projects are inherently complex. Decisions have to be made about hardware, software, networking, data standards, data sharing, data security, database design, data maintenance, data creation, priorities of data layers, training, programming, etc. Managing these tasks is the role of the GIS Specialist and it is a time consuming task.

### Where to Locate the GIS Specialist?

It seems natural to put the GIS Specialist in the department that seems to need GIS the most. In many city governments, this is the Planning Department; in counties, it might be the Property Appraiser's office.

When the GIS Specialist is in a user department, that department invariably gets much better treatment than other departments. The GIS Specialist is faced with a dilemma: "Do I work on the project that will please my boss, or do I spend my time helping other departments?"

More often than not, the Coordinator will satisfy the boss. For example, a GIS Specialist in the Planning Department will develop a comfort level with planning issues and will tend to gravitate to GIS activities that further planning goals. Other departments will soon feel isolated, grow resentful, and begin to lose interest in the GIS project. Support for the project as a whole will begins to erode. Instead of breaking down traditional barriers, this model tends to erect new ones.

For these reasons, the GIS Specialist should be independent. Typically, the GIS Specialist should be placed in one of three places.

- A division of Information Technology
- An independent department
- A position directly under the supervision of the City Manager

The City of West Sacramento GIS Specialist should be located in the Information Technology Division, in order to operate independently within a department that interacts equally with all other departments and offices. The GIS Specialist will be instrumental in spearheading the GIS effort. It is necessary for the GIS Specialist to serve as the management GIS liaison/project champion.

## Characteristics of an Effective GIS Specialist

The ultimate success of an organization's GIS will rest squarely on the shoulders of the GIS Specialist. The successful GIS Specialist must be several things:

**Technically proficient but not intimidating.** Today's GIS Specialist must understand a diverse range of technological issues—computer networking; operating systems, such as: Windows 95/98, XP, WindowsNT/2000, Unix, and Linux; data exchange with midrange and mainframe computers; various GIS software; GIS programming in different GIS languages; data conversion, etc. If the Coordinator does not have a tight grasp on the technology, the GIS will languish.

It is important that the GIS Specialist not only know the technology but also to be able to share this knowledge with staff. The GIS Specialist must determine each user's level of expertise and relate the technology in terms that each user can understand. The GIS Specialist must also avoid confusing and frustrating users, or antagonizing them by engaging in technical one-upmanship.

**A geographer.** It is said that 95 percent of everything done in local government has a geographic component. The GIS Specialist must understand geography and be familiar with proper mapping techniques and geographic constructs. A formal background in geography is desirable. An extremely competent computer person may fail as a GIS Specialist because he or she does not understand geography.

**A salesman.** "Be everywhere, do everything, and never fail to astonish the users." This spin-off of the Macy's department store motto makes a good motto for the GIS Specialist. The GIS Specialist has to become the champion of GIS in the organization. Whenever new technology is adopted, there will be skeptics. It is up to the Coordinator to quiet the skeptics and tout the benefits of GIS to the organization. The Coordinator should make sure that every department knows what GIS can do for it. Newsletters, presentations, informal conversations, and magazine articles should be used to educate users about the technology. It is important that the Coordinator has good people skills and be able to articulate the benefits of GIS. A good GIS salesman can quiet even the harshest of critics.

**A diplomat.** Diplomacy has been defined as the art of letting someone else have your own way. GIS will change the way your organization works. Whenever a revolutionary technology such as GIS is adopted, change will occur. Old, inefficient ways of doing business have to be evaluated and sometimes jettisoned. Often, this will not go over well with some staff. It is critical to be diplomatic in these situations. The Coordinator needs to make sure that no one feels alienated. If possible, it is best to prompt users into coming up with ideas on how to change their operation using a GIS instead of coming in and trying to force change.

To build a fully functional GIS, the Specialist will have to ensure that all departments get involved and that data are shared between departments. Inevitably, departments will disagree on how GIS should be implemented. Such issues can drive a wedge between departments, and many organizations never get through this stage. It is up to the diplomatic GIS Specialist to see that these issues are resolved in a manner acceptable to all parties. In Wilson, North Carolina, potentially divisive issues relating to accuracy and cost of data to the public arose between departments. These important issues were met head on and resolved by gathering all involved parties before problems could occur. With the help of the Specialist, the users came up with a mutually acceptable agreement.

## What Should be Included in a Job Description?

A good job description for a GIS Specialist should cover at least four areas:

*General definition of the job.* This section gives a brief overview of the position, where it will be located, who will be supervised, etc.

*Typical tasks:* This section will discuss specific tasks that are required, such as:

- Responsibility for the installation, maintenance, and upgrade of hardware and its operating systems (be specific about the hardware and software decided upon in your implementation plan).
- Provision of training for users in the organization.
- Establishment of database standards.
- Develop of plans and procedures for effective integration or transfer of GIS data from various sources into usable databases.
- Establishment of mapping standards.
- Maintenance of data security and integrity.
- Primary contact for user problems and vendor support.

*Knowledge, skills, abilities.* This section discusses the technical knowledge that the Coordinator needs to bring to the position. Specific software, programming, hardware, and database capabilities need to be covered.

*Education and experience:* This section talks about formal education and experience and could read as follows: "Any combination of education and experience, equivalent to graduation from an accredited college or university in computer science, geography, or related field and considerable experience in the use of geographic information systems."

## Key Number 3:

### Show Success Quickly and Frequently

In the two previous sections, we analyzed the importance of having a master plan and the critical need for an independent GIS Specialist. The master plan clearly defines the goals of the GIS project, while the GIS Specialist is instrumental in seeing that the goals are met. The master plan serves as the rudder of the GIS ship and the GIS Specialist is its captain.

A successful voyage requires that the ship leave port. Dry dock for a GIS is the data creation phase. Data creation is necessary but should be viewed as a means of enabling GIS applications and products. Some projects have placed too much emphasis on the completion of GIS data at the expense of GIS products and, as a result, have never gotten under way.

Ironically, the initial phases of a GIS implementation are the most expensive and least glamorous. The most expensive component of a GIS is the creation of data. Some GIS project leaders have insisted that a host of GIS databases be fully completed before products are generated. Others have demanded that the GIS databases be excessively accurate before deployment —sometimes to within a millimeter when a few feet would suffice. Both of these scenarios kill the momentum of a GIS project. Months can turn into years as these databases are created. But if no products are being produced, leaders in an organization begin to question their investment in a GIS.

The ultimate success of a GIS is often decided in the first year of the project. There is a honeymoon period of a few months, but after that, decision-makers, under pressure to run government more like a business, need to see results. Products must be generated. Benefits must be quantifiable. Even successful GIS implementations can lose their momentum if staff rests on past successes.

### Use Existing Data

Using existing digital data is a good way to get quick results from a GIS investment. A first step for any GIS should be to determine what useful data already exist. A local government may be able to create as many as 30 GIS layers from existing digital data. Exploit resources that meet some of the needs in your organization.

Almost all engineering firms and surveyors compile data in a digital format that can be used in a GIS. Digital data for all areas of the United States and the world are becoming more plentiful every day. Almost all federal agencies and many state agencies are creating GIS data and offering this information to local governments for a relatively low cost, or free through the Internet. Private companies create digital GIS data to sell or for their own uses. The Federal Geographic Data Committee maintains a clearinghouse of spatial data on the Web at http://www.fgdc.gov/clearinghouse/clearinghouse.html

A few issues need to be considered when a local government acquires data. Scale and age of the data, format of the data, and transfer media can all affect usefulness.

**Scale.** Federal and state data are often created for national and/or regional studies. Therefore, the positional accuracy of the data may not have been a high priority. There has been a national push for metadata (i.e., information documenting the source, scale,

accuracy, etc., of digital data), and many federal and state agencies have been meticulous in their efforts to document the scale of their digital data. However, it is the responsibility of a local government to determine whether the scale and accuracy of available data are suitable for local needs.

Once data are in a GIS, they can be displayed at any scale, so it is important to make sure that the scale and accuracy of acquired data are not abused. If data collected at a 1:100,000 scale are displayed at a scale of 1:1,000, unsuspecting users will assume, incorrectly, that the displayed data are accurate. This can be a dangerous and costly assumption when the data are used in life-and-death situations or to support financial decisions. The local government can be held liable for any incorrect data that it makes available. The solution is to carefully document the scale, accuracy, and source of all data entered into the GIS. This information should be included on printed maps and distributed with all data transactions.

**Age.** You need to find out when data were compiled and whether they are obsolete. Most city and county governments deal with rapidly changing populations and infrastructure. Data that are a few years old are usually of little value for local government operations.

**Format.** If you find that useful digital data exist, the next question should be: In what format are the data available? Few standards exist in the GIS industry: different GIS software packages use different data formats. Therefore, you must determine what data formats your GIS software can interpret and which are preferable. Although some leading GIS software packages can interpret a plethora of data formats, many of these formats require additional manipulation of data to make them usable. **It is recommended that the City of West Sacramento continue to utilize Environmental Systems Research Institute (ESRI) and AutoDesk AutoCAD products for their GIS. Optimal data formats include: ArcGIS Geodatabases, ArcView Shapefiles, and Drawing (DWG) files.**

Sometimes you don't have a choice. Many federal agencies distribute data in formats created specifically for their own projects. Also, federal agencies feel compelled to provide data in a generic format so as not to favor one software company over another. This is often to the detriment of the user community. For instance, the U.S. Bureau of the Census creates extremely valuable GIS-ready databases from the census, but in an effort to distribute their data in a vendor-neutral format, they have created data files that are cumbersome and difficult for the average user to interpret. Modern GIS software, such as ArcGIS 9, is fully capable of converting most spatial data formats into optimal data formats.

**Transfer media.** Once you have found useful data in a usable format, the next question is: How am I going to get this data into my computer? No standards exist for data transfer. Until recently, most geographic information systems resided on UNIX-based computers. A variety of transfer media were available for most UNIX-based systems: diskette drives, CD-ROM drives, 8-mm tape drives, or 4-mm (DAT) tape drives. Now GIS technology is moving rapidly to the personal computer. No standards exist here, either. Many people use CD-ROM and ZIP drives to transfer their data from PC to PC. Increasingly, GIS data are being transferred via the Internet. This eliminates any concern about compatibility of tape drives, but many organizations are not yet Internet-savvy, and much information is not available over the Internet. **The City of West Sacramento should adopt the City's internal network as the transfer media of choice, where possible. Large datasets may be burned to CD-RWs or DVDs (if available) and distributed between departments.**

### Showcase Your Progress

Many GIS Specialists make the mistake of assuming that building the GIS database is too mundane an accomplishment to share with others. They forget that in an organization that is just beginning to use computers extensively and has been using only paper maps, digital plotting of maps is a noteworthy event. People are amazed as they watch a map of their city or county being electronically created. Digital mapping is commonplace to a GIS Specialist, but to staff new to the technology, it is an impressive capability.

Share your new maps with others. Print maps that show the creation of new GIS layers. Take these maps to staff meetings and to the different departments, and let them see the results of the data entry process. They will be more patient if they see steady progress.

### Show Success Continually

An organization that has a mature, successful GIS has to guard against staff complacency and myopia. Traditional GIS staffing structures do not allow much room for growth and advancement. Routines are established, and the desire to find innovative uses of the technology can wane. GIS staff may find themselves doing the same kind of tasks over and over.

It is important to allow GIS staff to work on a variety of projects. This keeps the job interesting, broadens staff perspective and experience, and fosters innovative uses of the technology. Staff becomes more creative and more effective. New uses of the technology should be showcased and shared with the rest of the organization. If the GIS is to continue to be useful to the organization, all staff must continually be reminded about the powerful tool they have available to them. If months go by and no new GIS products and uses are shared, staff begin to lose interest in the system.

The success of a GIS project is often determined within the first year. Many people within the organization will get their first look at the GIS in year one and will be looking for some tangible results. Presentation should be made to staff. It is crucial that the GIS team show even modest results. It is a good idea to produce maps showing the progress of the project. As base maps are created for the GIS, maps of the area should be printed and shared.

The GIS team should always strive to deliver what the users ask for. However, if they absolutely cannot deliver they should explain why it isn't possible. The success of an organization-wide GIS depends on participation and adoption by all departments. Therefore, the early perception of GIS as a useful tool is imperative.

## Key Number 4

### Explain the Uses of the Technology Frequently

In the last section we looked at the importance of producing products early in the life of a GIS. Support for a GIS is product-driven. Early results show an organization that the investment in the technology is worthwhile. Also, we examined the need to continually develop new and innovative uses of the technology. Early success will soon be forgotten if not followed by a continual stream of new products.

This section focuses on the connection between the delivery of successful GIS products and the recognition within the organization of specific needs and uses for the GIS. GIS projects are not successful unless they meet a specific need or solve a specific problem. The fully integrated GIS is considered a tool by all departments in an organization. For a department to consider GIS as a problem-solving tool, an education process has to occur. Lack of knowledge about the capabilities of GIS is one of the major reasons that the technology is underutilized in some organizations. It is critical to the project's success that the GIS Specialist and other GIS staff explain the capabilities of GIS frequently in a variety of venues.

## Users need information about how the technology is being used specifically in their field.

Although formal GIS hardware and software training is important, it is often less than effective for educating an organization about the usefulness of GIS. Users need information about how the technology is being used specifically in their field. Software training focuses on software functionality, usually in generic terms. Trainees who attend software classes can get a good understanding of how to make the software operate but still not understand how they can apply it to their own tasks.

There are many teaching methods, in addition to formal training, that need to be used throughout the life of a GIS project to educate an organization about the potential uses of GIS technology. The education process is continual. Like all other technologies in the computer age, GIS is changing rapidly. New functionality is being released every few months. GIS technology has moved to the desktop. A few years ago a high dollar workstation was required to run a GIS. Today anyone with a relatively new personal computer (900 MHz Pentium or higher, preferably 256 MB RAM or higher) can harness the power of a GIS.

The old paradigm of training an elite few GIS gurus is giving way to the need to train a majority of the organization. The user friendliness of GIS technology has increased dramatically. Easy-to-use, point-and-click, menu-driven interfaces are being implemented on PCs throughout organizations. Now most if not all employees must be aware of an installed GIS and what it can do. In this section, we will take a look at the various methods of educating your organization about GIS.

## GIS Steering Committee

A GIS Steering Committee should be formed to guide the overall use of GIS throughout the organization. Optimally, this Committee is formed before the first piece of hardware or software is ordered. The Steering Committee should consist of upper management and high-level GIS staff. A person from each major department or division within the organization should be on the committee. This Committee ensures that the GIS is being implemented throughout the organization and that the departments in greatest need are phased in first.

A GIS Steering Committee provides the critical high-level commitment to the investment in GIS. Each member will gain an understanding of the technology and feel some ownership in the project. These high-level allies will be indispensable during budgeting, and each will serve as a champion of the technology within his or her own department. They will see the benefits of the technology and push for its implementation. At the onset of the GIS implementation, this committee should meet at least every two months. As the project matures, twice a year should suffice.

## Formal Training

Technical training on GIS hardware and software is critical, but hardware training is becoming less of an issue as the UNIX workstations that were the main platform of the GIS industry throughout most of the 1990s give way to the personal computer. Hardware maintenance and upkeep is falling to the traditional personal computer support services group, usually in the data processing department. The GIS user will only require training on the GIS software he or she will be using.

**Tier 1—Flagship GIS.** GIS software has evolved into three tiers. Tier 1 is the full flagship GIS product for the GIS power user. When a special project requires the use of a tier 1 GIS product, ArcEditor 9 should be used. This software has all of the functionality afforded by GIS. The cost of the software is $4,000. Training at this level is usually acquired from the GIS software company, ESRI, or from authorized vendors. A two-day overview of ArcEditor 8 will cost approximately $850 per student (discounts are available for group training).

**Tier 2—Desktop GIS.** The second tier is the desktop GIS product. This product delivers many of the often-used functions of the flagship product. The desktop GIS product recommended for the City of West Sacramento is ArcView 9. This software will run on a standard personal computer (650 MHz Pentium or higher, 256 MB RAM). This level of software is robust, provides much GIS functionality, requires at least a moderate level of computer expertise, and requires the user to make many decisions about how to derive a product. ArcView 9 has the same user-interface as ArcEditor 9, but with less functionality. Because they share a common interface, training for both ArcEditor 9 and ArcView 9 can be conducted concurrently, under the umbrella of ArcGIS. A two-day overview of ArcView will cost approximately $850 per student (discounts are available for group training).

**Tier 3 - Customized GIS.** The third tier of GIS has just recently arrived on the market. GIS technology has steadily moved to a more open environment. This means that standard programming languages, like Microsoft Visual Basic (VB), can be used to create customized GIS interfaces that are project specific. This tier is the easiest to use. The interface is designed to perform a specific task. Intuitive push buttons and menus are used to make the application foolproof. An hour-long training session for one of these interfaces should suffice. A good user's manual could substitute for formal training.

A programmer has to write the customized interface for a particular task. Many products are being developed to meet the needs of local government. Organizations have the option of hiring a programmer to create these interfaces, purchasing off-the-shelf products, or contracting with a GIS consulting firm to create custom interfaces.
An organization-wide GIS will require that all three tiers of GIS software be deployed, depending on the user and purpose.

## Newsletters

An invaluable tool for educating an organization about GIS is a newsletter. The newsletter should have articles describing how the GIS *is* being used within the organization, how it *can* be used within an organization, and how other organizations are using the technology. This will give users ideas about how they can use the technology. Highlighting successful uses of GIS within the organization will make non-users ask how they can benefit. Also, a newsletter gives users recognition for their hard work and ingenuity. Others want to create a noteworthy project of their own so that they, too, can receive some notoriety.

In addition, the lead GIS person should share with staff throughout the organization pertinent articles from magazines, trade journals, and newspapers detailing the uses of GIS technology for all aspects of local government.

## Users Group

**A GIS Users Group should be formed in the City of West Sacramento.** The group should meet at least once a quarter. A users group is an excellent way for users to share their expertise and experiences. All users of GIS should attend these meetings. Each meeting should address the following topics:

- Current projects - Each department/ division should share the details of any GIS projects that are being worked on. Maps and data should be brought to show others.
- Upcoming projects - Upcoming projects should be discussed. Ideas on how best to accomplish the projects should be shared.
- Industry trends - New software releases, new hardware, and networking issues should all be discussed. This forum allows all users to stay abreast of the latest technology.
- New databases or changes to existing databases
- Upcoming GIS conferences and/or training
- A brief technical session - A user might conduct a brief how-to seminar on an aspect of GIS.
- Organizational and staffing issues
- Joint project initiatives
- New funding sources
- Other issues.

A users group will provide an excellent opportunity for communication among all GIS users in the area. It is a good venue for users to share their successes and failures. Duplication of effort will be minimized, and sharing of ideas and data will be optimized.

## National Conferences

National GIS conferences are an excellent venue for staff to expand their base of knowledge. Major vendors conduct conferences, with sessions ranging from very technical to general. Software-specific training sessions, access to technical staff, and hands-on demonstrations make these conferences invaluable.

Others are not specific to any one software company: all software companies are invited to show their products. GIS experiences from all over the world are shared in various presentation formats, and technical workshops are usually offered. These conferences give an excellent overview of the GIS industry as a whole. A variety of GIS conferences are held nationally. Some conferences are software specific or industry specific. There is one major national GIS conference that covers the industry as a whole while trying to focus on issues pertinent to local government. The conference is:

## One-on-One Meetings

The lead GIS staff person should meet periodically with department and division heads to discuss current uses and potential uses of the technology. Candid evaluations of progress will serve to keep GIS on track for each department.

### Revisit the Master Plan

It is critical to keep the GIS master plan updated. Successful, mature GIS implementations still need the guidance of an overall master plan. It is wise for GIS staff to conduct or contract a new GIS study every three years to evaluate the current status of the GIS and make recommendations for the next three- to five-year time frame. The updated document should be distributed throughout the organization. By highlighting successes and failures, an updated plan can spur on a department that is lagging behind. **The City of West Sacramento should update their document annually.**

## Key Number 5:

### Make it Useful and Easy to Use

The easier a GIS is to use, the more it will be used. There are many options available to make a GIS user friendly. In fact, GIS information can be delivered throughout the organization and to the entire community via the Internet.

The first GIS programs had to have a few gurus on staff just to get off the ground and couldn't be accessed at all by most employees. However, GIS software developers were constrained by the hardware from making GIS applications more accessible. Until just recently personal computers did not have the processor speed to run a robust GIS package. GIS applications could only be run on expensive Unix-based workstations. With much more powerful and affordable hardware now available, the user interface can be customized to meet any need. Applications can be written to address specific tasks.

Given the current state of technology, a GIS should be deployed in three tiers throughout an organization (see previous section).

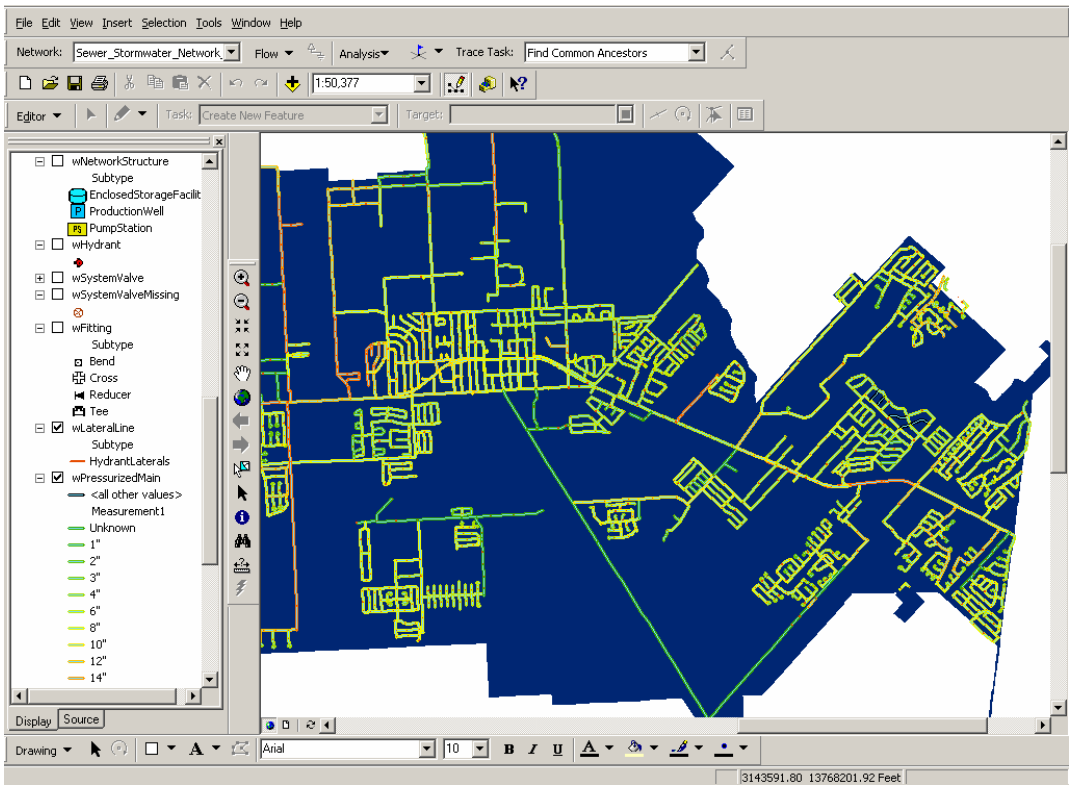
ArcGIS is a scalable system of software designed to meet all Tier 1 and Tier 2 needs. Three different levels of ArcGIS are available: 1) ArcInfo, 2) ArcEditor, and 3) ArcView. Although licensed separately, ArcGIS is a scalable set of software with the same underlying executables and user interface. ArcInfo, ArcEditor, and ArcView can all be customized using VB, C, and many other popular programming languages within the ArcObjects object model.

### Tier 1—Flagship GIS

ArcEditor 9 for ArcGIS is the recommended Tier 1 application for the City of West Sacramento. ArcEditor 9 (Figure ii.2) includes all the functionality of ArcView 9 and allows users to access the power of ESRI's Spatial Data Engine (ArcSDE). As described in Appendix I, the geodatabase is the primary data format used in ArcGIS. Two types of geodatabases are offered: 1) personal geodatabases, which store data within MS Access MDB files (regardless of whether the user has MS Access on their computer), and 2) enterprise geodatabases, which store data in a wide variety of commercial relational database management systems (RDBMS), including Oracle, SQL Server, Informix, and DB2. ArcSDE is required as a gateway between ArcGIS and the enterprise geodatabase stored in an RDBMS. ArcEditor can store and edit data in enterprise-wide geodatabases and personal geodatabases. ArcView can only store data in personal geodatabases. The primary advantage of using ArcSDE and enterprise-wide geodatabases is simultaneous, multi-user editing of geodatabases.

ArcEditor 9 costs approximately $4,000 per license. Most users will not need access to the full functionality of ArcEditor 9.

***Figure ii.2:*** *Tier 1 - ArcInfo 9*




## Tier 2—Desktop GIS

Over the past few years the use of desktop GIS has increased dramatically, facilitated by advancements in computing power and improvements in operating systems. Desktop GIS includes many of the more popular functions of the flagship GIS products but omits some of the lesser-used functions. Desktop GIS is much less expensive than the flagship product. Desktop GIS can be purchased for an average price of $1,000 per license. Products such as ArcView have proliferated throughout local government and have allowed a new, larger group of employees to use the GIS. If 5 people are using the flagship package, perhaps 30 will be using the desktop version.

ESRI's Tier 2 software application has recently migrated from ArcView 3 (Figure ii.3) to ArcView 9 (Figure ii.4), although ArcView 3 is still supported. ArcView 3 was much more user-friendly than ArcInfo Workstation, as it was all menu-driven, as opposed to ArcInfo Workstation's command line interface. ArcView 9 is the least robust and least expensive of the ArcGIS suite. As an ArcGIS product, it uses the same interface as the Tier 1 one products, ArcInfo and ArcEditor. The primary differences (beside cost) between ArcView 9 and the Tier 1 products is that ArcView: 1) cannot edit coverages, 2) can only use personal geodatabases, 3) has less geoprocessing tools, 4) and lacks many database schema customization tools.

Tier 2 desktop applications still offer more functionality than many users need, and their robust functionality often cause them to run slowly on machines not intended to operate memory intensive applications.

**Fig. ii.3**: Tier 2 – ArcView 3x

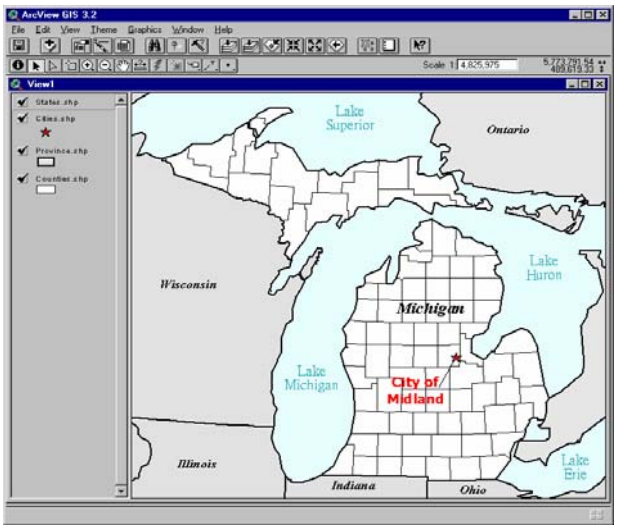
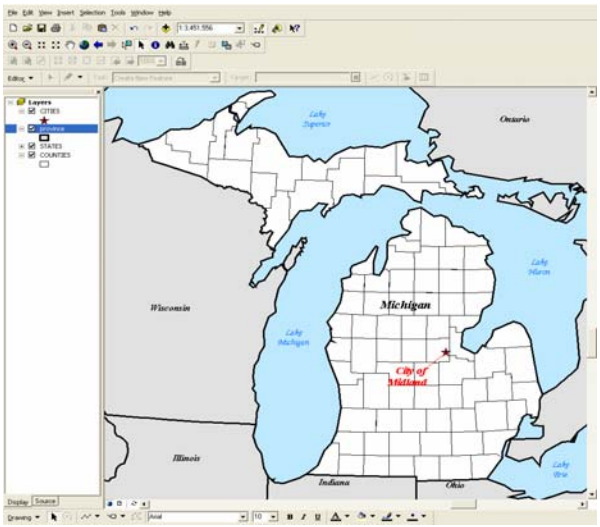



***Fig. ii.4**: Tier 2 – ArcView 8x*




## Tier 3—Customized/Open GIS

The majority of potential GIS users need easy-to-use, intuitive interfaces that perform well-defined tasks. Thus, the third tier of GIS software was born: customizable/open GIS. GIS software companies have moved GIS functionality to common, widely used programming languages such as C++ and Microsoft Visual Basic. The result is that application developers can create very user-friendly interfaces that have the look and feel of other personal computer applications. Only the GIS functionality needed for a specific program is used. Thus the overhead of non-used functionality is not slowing down the applications. Custom applications can be created and distributed throughout the organization. The Tier 3 product has a price tag of $3,000 to $4,000, which includes all the necessary programming software and 10 deployment licenses. For each additional deployment, a $100 fee is paid to the software company.

Counties like Columbia County, Georgia, are deploying a GIS using all three tiers and concentrating on custom applications. Columbia County will be deploying a "generic data browser" that will allow citizens, elected officials, and anyone with a personal computer to access a wealth of information (Figure ii.5).

***Figure ii.5:** A generic data browser.*

The interface for open GIS applications is very specific. The user has very few decisions to make and can get to data contained in the GIS quickly and efficiently. Narrow applications can be written for each department. For instance, in Boyton Beach, Florida, one application is being written to allow employees to track and query citizen calls and complaints through an easy-to-use interface (Figure ii.6).

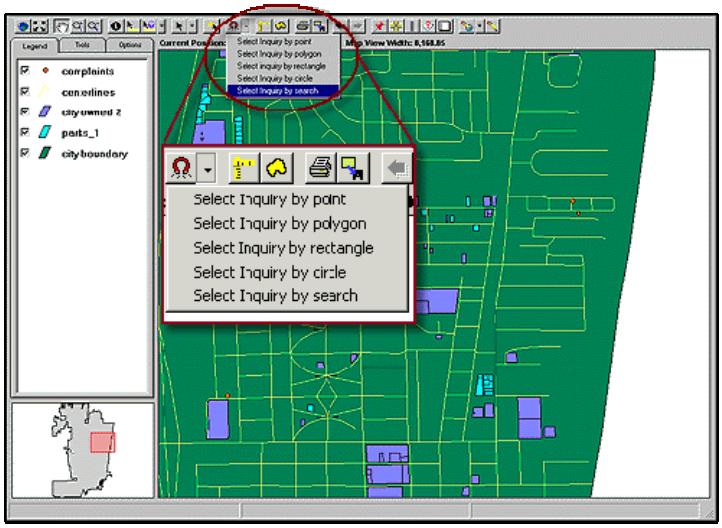



***Figure ii.6:*** *Department-specific application: tracking citizen complaints.*

The open programming interface opens the GIS door for any application developer in any industry. No longer is GIS development the domain of an elite few GIS gurus. Now any programmer adept at a standard programming language can embed GIS functionality in applications to be used by anyone throughout the organization.

## The Internet and Intranets

As part of this push to open GIS, GIS software companies have developed tools that allow organizations to put their GIS data on the Internet. Cities and counties throughout the U.S. and the world are deploying GIS applications on the web, giving citizens access to the investment made in data. All local governments will soon feel the pressure to put GIS data on the web if they have not felt it already. Boyton Beach, Florida, has deployed a web interface that gives citizens access to a variety of data layers (Figure ii.7).

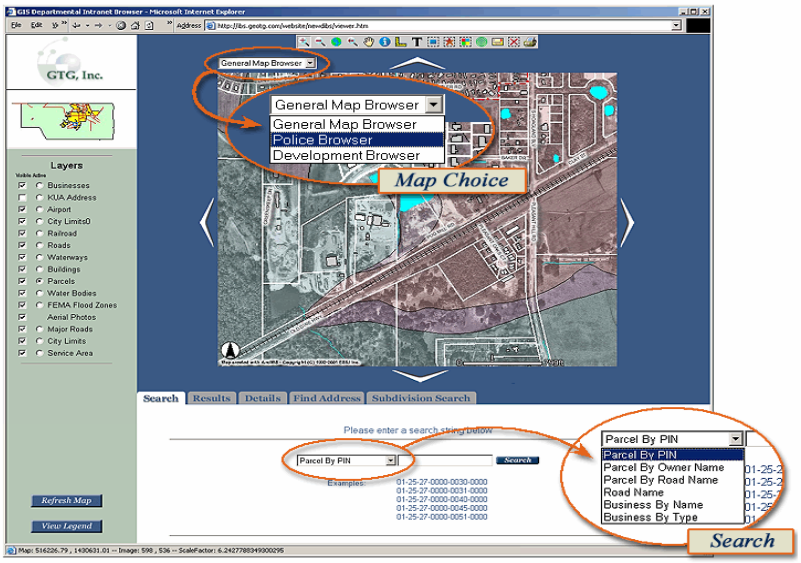



***Figure ii.7: GIS on the Web***

A local government that has an intranet can deploy applications to be used by everyone on the network. GIS staff should be using these new tools for GIS deployment and should be moving geographic-based data to employees and citizens alike.

## Key Number 6:

### Delegate - Don't Do All the Work

Thus far we have examined the necessity of creating a master plan, appointing an independent GIS Specialist, showing results early and often, explaining the capabilities of the technology, and making GIS useful and easy to use. All of these are important for the success of an enterprise-wide system. Many organizations address these issues but ignore the critical issues of staffing and work loads associated with the implementation of GIS. Too many organizations have made the mistake of thinking that existing staff can integrate GIS into their daily routine without the leadership of a GIS Specialist or a consultant. As we noted in Key #2, the absence of GIS leadership makes the creation of an enterprise-wide GIS a veritable impossibility. However, the presence of a GIS leader, no matter how talented, does not ensure the viability of GIS throughout the organization. All too often the GIS leader is seen as the only person that needs to be doing GIS for the organization. In order for the enterprise-wide GIS to flourish the organization must realize that some GIS responsibilities must be delegated to existing staff.

### You Cannot Do It Alone

It's a typical day in the GIS center: Planning needs the zoning map updated as soon as possible. Engineering wants a program written for stormwater modeling. The new personal computers have arrived and must be networked and given GIS capabilities. The attributes for the tax parcel database need updating. The police department has asked for help to create maps and do some analysis on a rash of breaking and entering. Four new subdivisions have been approved, which means a host of GIS layers must be updated. The fire department wants to know where to locate their new fire station. Elected officials are demanding updated district maps for the upcoming elections. A local surveying firm needs a few GIS layers converted to a CAD format. Citizens are lined up at the door wanting maps from the new mapping system. Clearly, the workload has become unmanageable for one person. The answer is to distribute responsibilities throughout the organization.

One person cannot create and maintain an organizational wide GIS alone. One person may be able to create a rudimentary GIS that functions reasonably well for one department with other departments deriving minor benefits. However, a fully functional GIS pervades the entire organization. Every staff person should utilize GIS data and products. Some staff will need GIS more than others.

Many organizations have erroneously looked upon the GIS Specialist or a consultant as the sole GIS provider. Local government has traditionally been very regimented. Utilities took care of water and sewer, Finance took care of billing, Planning took care of zoning, etc. Everyone had their own tasks and there was very little overlap. Even IT was given the specific task of keeping the computers and computer programs running. IT often became one of the most isolated groups. GIS cannot function properly if forced to fit into this traditional structure. GIS is a unifying technology that has at its core, cooperation by departments throughout the organization. GIS can serve to bring down traditional barriers as departments rely on each other for up-to-date information and the sharing of expertise.

Make Sure That Each Department Has GIS Expertise

Each department that will be utilizing GIS frequently (more than once a month) will need to train staff. This training can be conducted in-house and/or it may be done in formal training sessions. It is imperative that each department develops their own expertise. GIS should be seen as another tool for existing staff to utilize to assist in their daily tasks. It should be looked upon as an indispensable tool, like a word processor or a spreadsheet. It will be the responsibility of the GIS Specialist to get the proper level of GIS tools to each staff person. There are a variety of GIS software products available that range in user sophistication from the GIS novice to the GIS expert (see Key 4 and Key 5 for discussion on the three tiers of GIS). Appropriately deployed, these products will allow GIS work to be conducted and GIS products to be produced by each department. Some departments will embrace the technology immediately and train staff accordingly. Other departments will hold out and try to push their own GIS work and needs onto other departments or the GIS Specialist. There comes a time when these resisting departments must operate on their own. It may require the GIS Specialist to draw a line in the sand and let the offending department director know that any further GIS work for the department will require its staff's participation. The Coordinator must make it clear that he or she serves all departments equally. Doing all project work for one department severely limits service to other departments.

### Utilize Existing Staff

It is not reasonable to think that each department could or should hire their own GIS staff person. Therefore, it is imperative to utilize existing staff to do the GIS work. The initial outcry from many departments is that their staff is already overworked and cannot possibly do any more. There may or may not be any truth in this assertion. Regardless, it is important to point out that after the initial time investment in learning the software that productivity should increase and decision-making should improve. GIS technology should be sold to these departments in terms of how it can save time, lives, and money. GIS should be presented as an indispensable tool that staff must utilize to do their job properly.

## Key Number 7

### Be Able to Explain and Quantify Costs vs. Benefits

No matter how well the first six keys have been adhered to, the GIS ship will be called back to port if those funding the project don't think it's worth the time and effort. Every GIS project must be viewed in light of how it will save the organization time, lives, or money. Christopher Columbus's voyage almost never was. They had to convince the decision makers that his undertaking would pay off with tangible rewards. The job facing a GIS project manager is no different. Organization leaders, department heads, and elected officials demand that the value of each project be analyzed and quantified. Elected officials don't want to hear the nebulous assertion that a GIS will save the organization money. They want to see specific examples of how it will save money and they want to know how much. If a GIS is presented as a time saver, its proponents must be able to give specific examples and say how much time the technology will save on specific tasks. They must be able to explain how the GIS can save lives.

The GIS project leader is responsible for differentiating between what is "neat" and what is necessary. Hard questions need to be addressed. Why are we doing this? What current processes will a GIS application enhance or replace? What are the costs (database

creation, programming, etc.) associated with the project? Who will actually use the output? What staff will be needed? These questions must be addressed again for each new project. It is good to evaluate all projects under the microscope of usefulness. Always be prepared to answer questions about why the GIS is a good investment.

This section provides a few examples of how GIS technology is saving time, lives, and money for local government.

## Saving Time

**Public access tax application—Wayne County, North Carolina:** Tax offices across the country are bombarded daily with questions from the public. Wayne County, North Carolina, is no exception. Citizens, realtors, lawyers, and county staff need pertinent information and maps of selected tax parcels (properties). Providing this information is a time consuming task for county employees. However, Wayne County has recently implemented a GIS application that allows a visitor at the public tax counter to look up a property by a variety of attributes, such as owner, address, or PIN (parcel identification number). Pertinent tax information and an area map are presented on the screen and easily printed (Figure ii.8). David Ward, Wayne County assessor, says that this application saves county staff many hours a week.

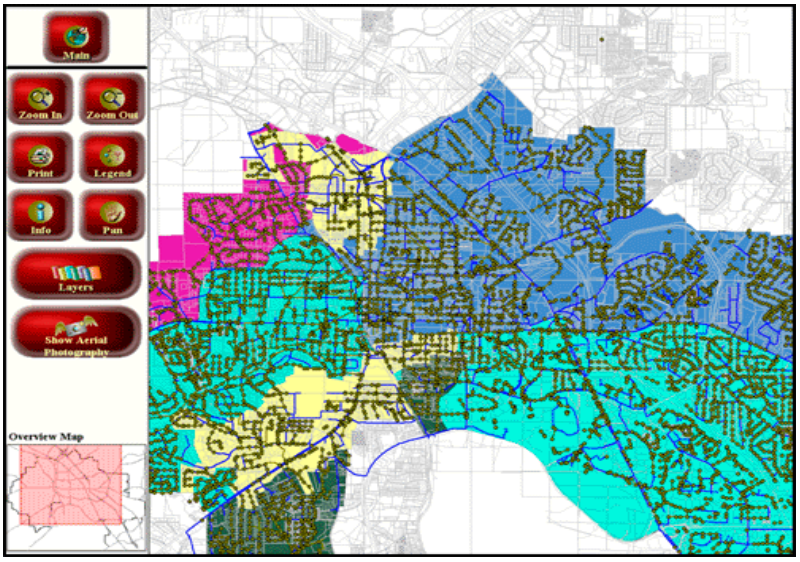



***Figure ii.8:*** *Saving time with GIS at the tax counter*

**Configuring voting precincts—Wayne County, North Carolina.** Wayne County's voters have been voting in 20 precincts for many years. Because of growth and shifts in population, the number of registered voters per precinct is highly unbalanced: in a recent election, a few precincts had more than 6,000 voters at the polls while others had only a few hundred. Many voters had to wait in line for up to three hours to vote. Wayne County has rectified this problem by using its GIS to create ten new precincts and reconfigure existing precincts. Now a maximum of 2,000 voters are assigned to a given precinct. This GIS application saves citizens time and frustration and encourages them to vote.

**Welfare reform—Forsyth County, North Carolina.** Forsyth County, North Carolina, Department of Social Services (DSS) is implementing GIS tools to track the location of day care centers and potential employers. DSS staff can enter the address of a welfare recipient seeking employment and within seconds identify bus routes, potential employers, and day care

centers that are suitable for the applicant. This GIS tool saves vast amounts of time for DSS staff and allows them to serve clients in a way previously impossible.
Other timesaving examples:

- Oakland, California, provides tax data and maps on the Internet.
- Bellevue, Washington, uses a GIS to automate the process of notifying property owners before beginning street improvement projects.
- Goldsboro, North Carolina, uses a GIS to create letters of notification to property owners within 300 feet of a rezoning. Creating the letters, which used to take approximately three hours, now takes five minutes.

## Saving Lives

**Hazard mitigation—Morehead City, North Carolina.** Morehead City, North Carolina, has frequently felt the wrath of hurricanes, but planning for such natural disasters is an inexact science. Where should development be allowed? How much time do we need for an evacuation? What areas will be flooded by a hurricane? How do we best locate infrastructure after a storm? These are all questions that staff at Morehead City have to grapple with. Linda Staab, planning director for Morehead City, recognized the usefulness of GIS technology for answering these questions. With funding from CAMA (Coastal Area Management Act), Linda spearheaded the development of over 75 GIS data layers for all the communities in Carteret County. Twelve agencies have access to this GIS data, GIS software, and customized applications for emergency preparedness and hazard mitigation.

**Crime analysis—North Carolina Governor's Crime Commission**. There has been much speculation about the correlation between night crime and the location of streetlights. Many believe that areas that are well lit experience less crime. Using GIS technology, the North Carolina Governor's Crime Commission worked with local communities to study the issue. One study showed that 82 percent of night crime occurred in non-lit areas (Figure ii.9). Armed with this information, a community can begin to justify the need for more streetlights in crime-ridden areas.

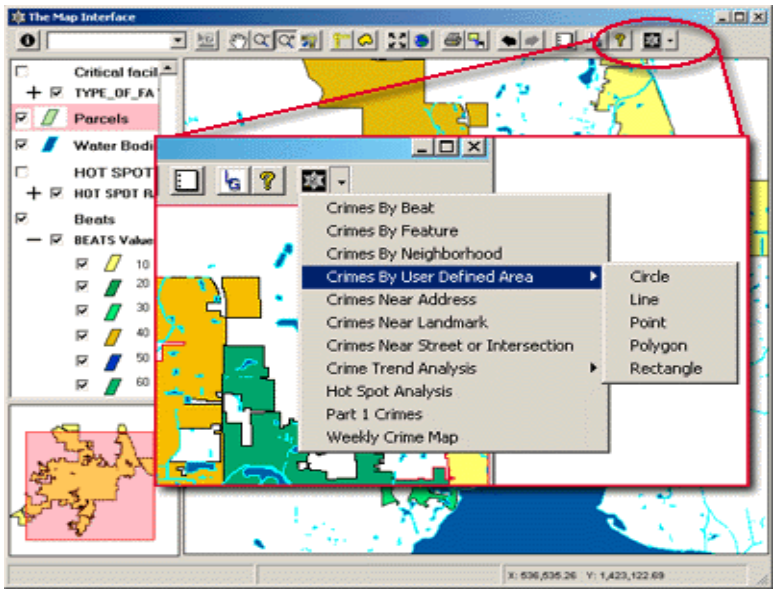



***Figure ii.9:*** *Analyzing crime patterns saves lives*

**Fighting Crime – Pittsburgh, Pennsylvania.** Fighting crime has traditionally been a reactive effort. Officers are seldom equipped with the information needed to head off crime as it surfaces. However, GIS technology is allowing the Pittsburgh police department (and many other departments around the world) to be much more proactive. Digital mapping is available to all officers in the department. Hot spots can be identified and mapped. For example, a GIS can analyze all types of crime for a specific geographic area (beat, response zone, etc.). If a significant increase in crime has occurred, an automated program can print maps and data or fax the data to the appropriate people.

**Emergency dispatch—Kennebunk, Maine.** Kennebunk, Maine, has a permanent population of 10,000 but the number of residents increases significantly during the summer months. Emergency calls are frequent and a GIS is used to handle them in a fluid and expeditious manner. The GIS is used to display a caller's location and view the surrounding area. Also, the optimal path from the police or fire station is displayed to speed the arrival of help. Other life-saving examples:

- Montreal, Quebec, uses its GIS to dispatch the closest ambulance.
- Greenville, South Carolina, uses its GIS for emergency evacuation.
- Los Angeles, California, uses a GIS for optimal response to earthquake damage.
- Salinas, California, uses a GIS to track gangs and gang-related crime.

## Saving Money

**Mapping flood zones and reducing insurance costs - Carteret County, North Carolina.** Mike Addertion, Emergency Services Director for the coastal Carteret County, is a strong proponent of using GIS to save citizens money. He uses a GIS to map flood zones in conjunction with properties. As a result, the emergency services staff and local planning departments can notify property owners of their proximity to flood zones (Figure ii.10) and their need for flood insurance. By mapping and managing flood hazards, the county expects to reduce flood insurance rates for the county, thus saving citizens money.

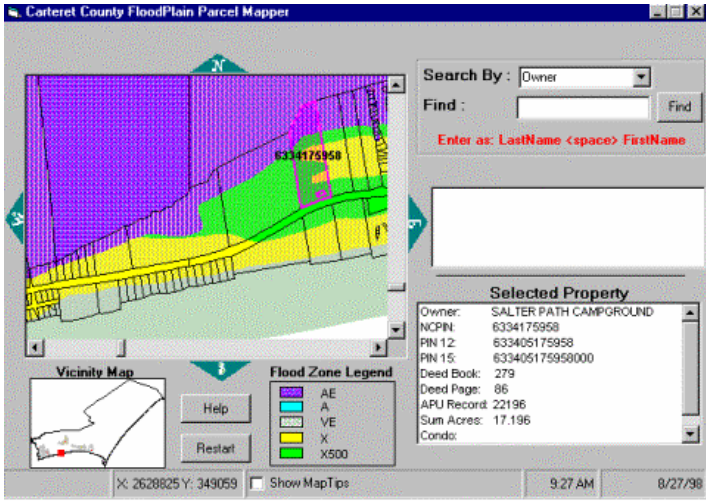



***Figure ii.10:*** *Mapping Flood Hazards Saves Citizens Money*

**Relocating fire stations—Wilson, North Carolina.** Wilson, North Carolina's fire department has a mandate to arrive at a fire within four minutes. In the early 1990s, city leaders recognized that the existing configuration of five fire stations could no longer provide this level of service to growing areas of the city. They assumed that a sixth fire station would have to be built. However, Randy Godwin, assistant fire chief, used the city's GIS to study the problem.

Godwin and the GIS staff ran 40 scenarios in which some of the five existing fire stations were relocated and/or a sixth fire station was added. In each scenario, the GIS generated a four-minute driving distance from each fire station (Figure ii.11). It was found that the existing fire station configuration could provide four-minute service to only 85 percent of the city. However, relocating two fire stations brought 99 percent of the city's residents within the four-minute service areas and obviated the need for a sixth fire station. The city did not need to buy new pumper trucks and fire equipment, or staff a new fire station. City Manager Ed Wyatt noted that this one project saved the city more than two million dollars over a five-year period.

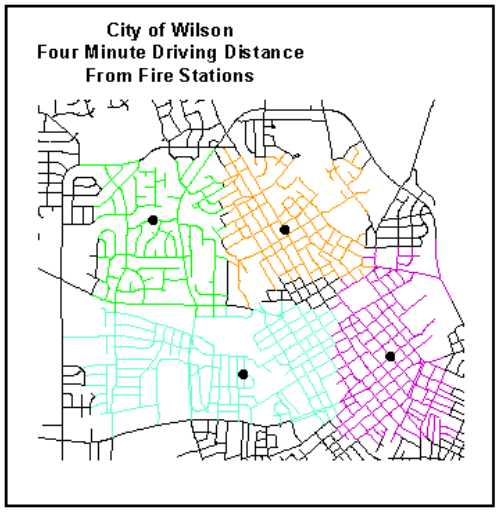



***Figure ii.11:*** *Finding the optimal location for fire stations saves lives and money.*

**Economic development - Carson, California.** Carson, California, is not only saving money with its GIS but it is using the GIS to attract money by locating optimal sites for interested businesses or industries. Staff input parameters for desired size, zoning, cost, and other characteristics. Used in conjunction with census data, business license records, assessor records, and other GIS layers, the system's ability to make matches between business needs and available properties puts Carson on the cutting edge for business recruitment.

Other money-saving examples:

- San Diego, California, uses a GIS to plan new routes for public transportation.
- Albuquerque, New Mexico, uses it's GIS to coordinate improvements to storm drains, streets, and parks.
- Birmingham, Alabama, uses a GIS to identify sites for potential industrial redevelopment.

## Conclusion

Examples of how GIS technology is saving time, lives, and money are as numerous as GIS sites themselves. Case studies abound in GIS magazines and trade journals. GIS project managers should study these examples to find pertinent uses for their organizations. Be ready to quantify benefits when called upon. Guard against using a broad brush or speaking in generalities. Elected officials and organization leaders will demand to know what the quantifiable benefits of the technology are for your organization and if those benefits outweigh the costs.

# Appendix III – GIS Functionality Matrix

This appendix identifies mapping process functionality requirements by department, needed to accomplish the City of West Sacramento's overall mission. The *Priority* rank of a particular functionality parameter (High, Moderate, or Low) reflects its relative importance to each department for accomplishing the GIS function. The *Complexity* ranking (High, Moderate, or Low) of the functionality parameter reflects the relative difficulty and/or effort and cost required to provide this feature. This information is summarized in the tables on the following page.

| City of West Sacramento, CA | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Building Division | | City Manager | | Drafting Services | | Engineering | | Facilities Development and Maintenance | | Finance | |
| ***Mapping Functionality Parameter*** | P | C | P | C | P | C | P | C | P | C | P | C |
| *Pan and Zoom* | ● | ◆ | ● | ◆ | ● | ◆ | ● | ◆ | ● | ◆ | ● | ◆ |
| *Map Layer Display* | ● | ◆ | ● | ◆ | ● | ◆ | ● | ◆ | ● | ◆ | ● | ◆ |
| *Hard-copy Map Generation* | ● | ■ | ● | ■ | ● | ■ | ● | ■ | ● | ■ | ■ | ■ |
| *Report Generation* | ● | ■ | ● | ■ | ● | ■ | ● | ■ | ● | ■ | ● | ■ |
| *Graphic and Attribute Query & Browser* | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| *Buffer Generation - Overlay techniques* | ● | ■ | ■ | ■ | ● | ■ | ● | ■ | ● | ■ | ◆ | ■ |
| *Latitude/Longitude/Geo-reference Generator* | ■ | ■ | ◆ | ■ | ● | ■ | ● | ■ | ● | ■ | ◆ | ■ |
| *Coordinate/Area/Volume/Length Calculations* | ● | ● | ◆ | ● | ● | ● | ● | ● | ● | ● | ◆ | ● |
| *Feature Overlay* | ● | ■ | ■ | ■ | ● | ■ | ● | ■ | ● | ■ | ◆ | ■ |
| *Hyper-linking Objects* | ■ | ◆ | ● | ◆ | ● | ◆ | ● | ◆ | ■ | ◆ | ◆ | ◆ |
| *Text and Graphics Placement* | ■ | ● | ● | ● | ● | ● | ● | ● | ● | ● | ◆ | ● |
| *Address/Street/Intersection Search* | ● | ■ | ● | ■ | ● | ■ | ● | ■ | ● | ■ | ● | ■ |
| *Tabular and Graphic Data Import/Export* | ● | ■ | ● | ■ | ● | ■ | ● | ■ | ● | ■ | ◆ | ■ |

| | | | |
|---|---|---|---|
| ● | High | | P = Priority |
| ■ | Medium/Moderate | | C = Complexity |
| ◆ | Low | | |

| City of West Sacramento, CA | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fire | | Grants & Community Investment | | Information Technology | | Parks & Recreation | | Planning | |
| ***Mapping Functionality Parameter*** | P | C | P | C | P | C | P | C | P | C |
| Pan and Zoom | ● | ◆ | ● | ◆ | ● | ◆ | ● | ◆ | ● | ◆ |
| Map Layer Display | ● | ◆ | ● | ◆ | ● | ◆ | ● | ◆ | ● | ◆ |
| Hard-copy Map Generation | ● | ■ | ● | ■ | ● | ■ | ● | ■ | ● | ■ |
| Report Generation | ● | ■ | ● | ■ | ● | ■ | ● | ■ | ● | ■ |
| Graphic and Attribute Query & Browser | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Buffer Generation - Overlay techniques | ● | ■ | ● | ■ | ● | ■ | ● | ■ | ● | ■ |
| Latitude/Longitude/Geo-reference Generator | ● | ■ | ■ | ■ | ● | ■ | ● | ■ | ● | ■ |
| Coordinate/Area/Volume/Length Calculations | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Feature Overlay | ● | ■ | ● | ■ | ● | ■ | ● | ■ | ● | ■ |
| Hyper-linking Objects | ● | ◆ | ■ | ◆ | ● | ◆ | ■ | ◆ | ■ | ◆ |
| Text and Graphics Placement | ◆ | ● | ■ | ● | ● | ● | ● | ● | ● | ● |
| Address/Street/Intersection Search | ● | ■ | ● | ■ | ● | ■ | ● | ■ | ● | ■ |
| Tabular and Graphic Data Import/Export | ● | ■ | ● | ■ | ● | ■ | ● | ■ | ● | ■ |

| | | | |
|---|---|---|---|
| ● | High | | P = Priority |
| ■ | Medium/Moderate | | C = Complexity |
| ◆ | Low | | |

| | Police | | Public Works | | Redevelopment Agency | |
|---|---|---|---|---|---|---|
| ***Mapping Functionality Parameter*** | P | C | P | C | P | C |
| Pan and Zoom | ● | ◆ | ● | ◆ | ● | ◆ |
| Map Layer Display | ● | ◆ | ● | ◆ | ● | ◆ |
| Hard-copy Map Generation | ● | ■ | ● | ■ | ● | ■ |
| Report Generation | ● | ■ | ● | ■ | ● | ■ |
| Graphic and Attribute Query & Browser | ● | ● | ● | ● | ● | ● |
| Buffer Generation - Overlay techniques | ● | ■ | ● | ■ | ● | ■ |
| Latitude/Longitude/Geo-reference Generator | ● | ■ | ● | ■ | ● | ■ |
| Coordinate/Area/Volume/Length Calculations | ● | ● | ● | ● | ● | ● |
| Feature Overlay | ● | ■ | ● | ■ | ● | ■ |
| Hyper-linking Objects | ● | ◆ | ● | ◆ | ■ | ◆ |
| Text and Graphics Placement | ■ | ● | ● | ● | ● | ● |
| Address/Street/Intersection Search | ● | ■ | ● | ■ | ● | ■ |
| Tabular and Graphic Data Import/Export | ● | ■ | ● | ■ | ● | ■ |

| | | | |
|---|---|---|---|
| ● | High | | P = Priority |
| ■ | Medium/Moderate | | C = Complexity |
| ◆ | Low | | |

# Appendix IV – Master Data List

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Address Points** | Extract, cleanse, geocode, and map from Springbrook; georeference based on aerial photography and GPS field work | Automated; GIS Specialist; Drafting Services Section | Recommended |
| **Aerial Photography** | Fly-over with control points | GIS Data Services Vendor | Recommended |
| **Backflow Devices** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Bad Bridges** | GPS data collection and integration with existing information | Fire Department; GIS Specialist | Recommended |
| **Bare Spots - Grass (Parks)** | GPS field work | GIS Specialist | Recommended |
| **Bicycle/Pedestrian Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Building Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Buildings with Site Plans** | Manually digitize polygons from plans and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Business Data** | Purchase commercially available business data from Claritas, Info USA, and other business data providers. Arranged by NAICS/SIC Code | Data Vendor | Recommended |
| **Business Loans** | Acquire data from lending institutions (if available); other financial data sources. Geocode and map. | Lending Institutions; Financial Data Vendors | Recommended |
| **Census Data** | Download from Census Bureau →http://www.census.gov/geo/www/census2k.html | GIS Specialist | Recommended |
| **Certificates of Compliance** | Extract, cleanse, geocode and map from Permits Plus database | Automated | Recommended |
| **City-owned Property** | Extract, cleanse, geocode, and map from Yolo County tax roll; other map sources as required | Automated | Recommended |
| **Commercial Addresses** | Extract, cleanse, geocode, and map from Springbrook | Automated | Recommended |
| **Community Facilities District** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Crime Data** | Extract, cleanse, and automatically map from Police VisionAIR database | Automated | Recommended |
| **Critical Facilities** | Manually digitize points from aerial photography and address sources | Drafting Services Section; GIS Specialist | Recommended |
| **Day Care Facilities** | GPS field work. | GIS Specialist; Redevelopment Agency | Recommended |
| **Drafting Water Sources** | GPS data collection; digitizing from existing maps | Fire Department; GIS Specialist | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Easements** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Encroachment Permits** | Extract, cleanse, geocode, and map from Permits Plus (Accela) database | Automated | Recommended |
| **Enterprise Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Entrapment Areas** | Manually digitize polygons from aerial photography and other imagery | GIS Specialist | Recommended |
| **Facilities** | Digitize on screen; aggregate layers as needed | Drafting Services Section | Existing |
| **Fire Hydrant Permits** | Extract, cleanse, geocode and map from Permits Plus database (TBD) | Automated | Recommended |
| **Fire Hydrants** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Fire Incidents** | Extract, cleanse, geocode, and map from FirePoint or in-house database | Automated | Recommended |
| **Fire Inspections** | Extract, cleanse, geocode, and map from FirePoint or in-house database | Automated | Recommended |
| **Fire Investigations** | Extract, cleanse, geocode, and map from FirePoint or in-house database | Automated | Recommended |
| **Flood Zones** | Acquire from FEMA (free to government entities) http://www.fema.gov/fhm/ | Drafting Services Section; GIS Specialist | Recommended |
| **GCI Special Plan and Special Study Areas** | Digitize from base map data; aggregate layers as needed | GIS Specialist | Recommended |
| **General Plan** | Digitize features from aerial photographs and existing data layer | Drafting Services Section | Recommended |
| **GPS Monument Map** | GPS field work | Drafting Services Section | Existing |
| **Hazardous Materials** | GPS data collection for location; extract from FirePoint or other database once data is entered | GIS Specialist; Fire HAZMAT Manager | Recommended |
| **Housing Condition Data** | Extract, geocode, and map from database | Automated | Recommended |
| **HUB Zone Boundary** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Impervious Surfaces** | Digitize polygons from aerial photographs; derive polygons by raster analysis of remotely-sensed data | Drafting Services Section; GIS Specialist | Recommended |
| **Industrial Pretreatment** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Irrigation lines** | Digitize from as-builts; GPS field work (may be available from GreenTech system) | Drafting Services Section; GIS Specialist | Recommended |
| **Irrigation sprinkler heads** | GPS field work (may be available from GreenTech system) | Drafting Services Section; GIS Specialist | Recommended |
| **Jurisdictions (Adjacent)** | Digitize polygons existing maps; existing CADD data; acquire data from other organizations | GIS Specialist; Drafting Services Section | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Labor Force** | TBD | GIS Specialist | Recommended |
| **Land Use** | Digitize polygons from aerial photographs and general plan maps; existing CADD data | Drafting Services Section | Existing |
| **Levees** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Licensed and Unlicensed Businesses** | Extract, cleanse, geocode, and map from in-house database | Automated | Recommended |
| **Liens** | Extract, cleanse, geocode and map from Springbrook | Automated | Recommended |
| **Lighting and Landscape Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Liquor Licenses** | Acquire from state ABC database; geocode and georeference using base layers | GIS Specialist; Drafting Services Section | Recommended |
| **Major Intersections** | Use street centerline layer as source | Drafting Services Section | Recommended |
| **Measure "K" Street Rehabilitation** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Mello-Roos Districts** | Digitize from base map data; aggregate layers as needed | GIS Specialist; Redevelopment Agency | Recommended |
| **Neighborhood Watch Areas** | Digitize from base map data; GPS field work (if needed) | GIS Specialist; Drafting Services Section | Recommended |
| **Oak Trees (Heritage)** | GPS field work; validation may be possible using aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Parcels** | Acquire from Yolo County | Yolo County ( and GIS Data Services Vendor) | Recommended |
| **Park benches** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park Facilities** | Query from address point layer; attribute as needed; digitize from base map data; GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park lights** | Extract, cleanse, and map based on Excel spreadsheet maintained by Parks & Recreation Department | Drafting Services Section; GIS Specialist | Recommended |
| **Park signs** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park tables** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park trash receptacles** | GPS field work | Drafting Services Section; GIS Specialist | Recommended |
| **Park tree canopies** | Digitize from aerial photography | Drafting Services Section; GIS Specialist | Recommended |
| **Parks** | Digitize from base map data; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Parolees** | Extract, geocode, and map from Parole download (available from California Department of Corrections) http://www.corr.ca.gov/ | Automated | Recommended |
| **Planning Department Special Projects** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Police Beats** | Digitize from base map data; other map sources as needed | GIS Specialist; Crime Analyst | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Police Department Special Projects** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Police Station Location** | Manually digitize points from aerial photography and address sources | GIS Specialist; Drafting Services Section | Recommended |
| **Port** | Digitize features from aerial photographs and other maps | Drafting Services Section; GIS Specialist | Recommended |
| **Real Estate Sales** | Geocode and map from MLS database and utilize automated entry system created for Community Asset Tracking System (CATS) allowing brokers to enter their own listings | Automated; Administrative Analyst | Recommended |
| **Reclamation District Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Record of Survey Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Redevelopment Project Areas** | Digitize from base map data; aggregate layers as needed | GIS Specialist | Recommended |
| **Redevelopment Projects** | Extract, cleanse, geocode and map from Access database | Redevelopment Agency | Recommended |
| **Rehabilitation Projects** | Extract, cleanse, geocode and map from Access database | Automated | Recommended |
| **Riverfront Infrastructure** | Digitize existing Riverwalk from base map data; GPS field work; require new design firm to submit digital data | Drafting Services Section | Recommended |
| **Schools** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Sewer Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Sewer Fees Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Sexual Offender Locations** | Extract, cleans, and automatically map from VisionAIR; Megan's Law Database | Crime Analyst & GIS Specialist | Recommended |
| **Sidewalk Trip Hazards** | Based on citizen complaints; potentially GPS field work | Drafting Services Section | Recommended |
| **Signs** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Site Location Base Map** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Existing |
| **Social Service Facilities** | Digitize from base map data; GPS field work | Drafting Services Section | Recommended |
| **Speed Zones** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Recommended |
| **Sphere of Influence** | Acquire, geocode, and map locations; rectify utilizing base map data; derive spheres of influence through buffers | Drafting Services Section | Recommended |
| **Storm Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Storm Drain Fee Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Street Trees** | GPS field work; validation may be possible using aerial photography | Drafting Services Section; GIS Specialist | Recommended |

| Data Layer | Creation Methodology | Recommended Update Division or Individual | Existing or Recommended? |
|---|---|---|---|
| **Streets** | Derived from aerial photography; GIS Consortium | Drafting Services Section | Existing |
| **Street-Sweeping Routes** | Query route segments from existing street centerline layer | Drafting Services Section | Recommended |
| **Striping & Pavement Markings** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section | Recommended |
| **Tax Assessment Districts** | Aggregate parcels and assessor data; other sources, such aerial photography, as needed | GIS Specialist | Recommended |
| **Telecommunication Facilities** | Obtain data from telecommunications comparies and/or purchase data from commercial sources | GIS Specialist; Automated | Recommended |
| **Traffic Accidents** | Extract, cleanse, geocode, and map from Crossroads database | GIS Specialist; Engineer; (Crime Analyst) | Recommended |
| **Traffic Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Traffic Calming Devices** | GPS field work; derive from aerial photography; aggregate layers as needed | Drafting Services Section; GIS Specialist | Recommended |
| **Traffic Counts** | Extract, cleanse, geocode and map from Crossroads database | GIS Specialist | Recommended |
| **Traffic Signals** | GPS field work; aggregate layers as needed | Drafting Services Section | Recommended |
| **Transit Routes** | Derive from street centerline layer; acquire from SACOG? | Drafting Services Section | Recommended |
| **Trees (Parks)** | Digitize from aerial photographs and existing maps | GIS Specialist | Recommended |
| **Truck Routes** | Derive from street centerline layer | Drafting Services Section | Recommended |
| **Under-utilized Buildings** | Query from parcel layer; other sources as needed | GIS Specialist; Redevelopment Agency | Recommended |
| **Vacant Properties** | Query from parcel layer; other sources as needed | GIS Specialist; Redevelopment Agency | Recommended |
| **Water Base Map** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Existing |
| **Water Meters** | Digitize on screen; existing CADD data; GPS field work | Drafting Services Section | Recommended |
| **Water Quality Complaints** | Extract, cleanse, geocode, and map from complaints database (TBD) | Automated | Recommended |
| **Waterways** | Digitize polygons from aerial photographs and existing maps | Drafting Services Section; GIS Specialist | Recommended |
| **Work Orders** | Extract, cleanse, geocode, and map from work order database (TBD) | Automated | Recommended |
| **Zoning** | Based on existing maps; General Plan | Drafting Services Section | Existing |

# Appendix V – Existing Software Resources

The tables below provide a summary of the existing GIS software resources that the City of West Sacramento currently maintains. At present, GIS software is maintained by the Engineering Division, Information Technology Division, and Police Department.

**Engineering Division**

| Quantity | Description | Version | MTCE Type | Product Name |
|---|---|---|---|---|
| 6 | LIC,AV,SU,UNKY | 9 | Secondary | ArcView |
| 1 | LIC,AV,SU,UNKY | 9 | Primary | ArcView |
| 1 | LIC,AIMS,4X,STD INTNT DPLMT,1SVR,1STCPU | 9 | General | ArcIMS |
| | LIC,AIMS,4X,STD INTNT DPLMT,ADL CPU | 9 | General | ArcIMS |
| 4 | ACAD,2005,UPD,US | 2005 | Inapplicable | AutoCAD |
| 2 | ACADMP,2005,UPD,US | 2005 | Inapplicable | AutoCAD Map 3D |
| 1 | ACADLD,2005, UPD,US | 2005 | Inapplicable | AutoCAD Land Desktop |
| **Total Licenses:** | **15** | | | |

**Information Technology Division**

| Quantity | Description | Version | MTCE Type | Product Name |
|---|---|---|---|---|
| 1 | ACAD,14,UPD,US | 14 | Inapplicable | AutoCAD |
| 1 | LIC,AV,3X,WIN,US | 3.1 | Optional | ArcView |
| 1 | LIC,AV,3X,WIN,US | 3.2 | Optional | ArcView |
| 1 | LIC,AV,3X,WIN,US | 3.0A | Optional | ArcView |
| 2 | LIC,AV,SU,UNKY | 9 | Secondary | ArcView |
| 1 | LIC,AV,SU,UNKY | 9 | Primary | ArcView |
| 1 | ACADMP,2005,UPD,US | 2005 | Inapplicable | AutoCAD Map 3D |
| 1 | ACADRD,2005,UPD,US | 2005 | Inapplicable | AutoCAD Raster Design |
| **Total Licenses:** | **9** | | | |

**Police Department**

| Quantity | Description | Version | MTCE Type | Product Name |
|---|---|---|---|---|
| 1 | LIC,AV,SU,UNKY | 9 | Primary | ArcView |
| 1 | LIC,AG SA,SU,UNKY | 9 | Ext | Spatial Analyst |
| **Total Licenses:** | **2** | | | |

# Appendix VI – Cost and Benefit Analysis

In This Appendix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## Introduction

One of the primary benefits of GIS implementation for the City of West Sacramento is increased efficiency and productivity in existing operations. GIS technology can transform existing business practices and reduce resources required to perform daily tasks.

## Cost and Benefit Analysis

An investment in Geographic Information Systems (GIS) based technology is often accompanied by questions about the benefits of the investment. Do the proposed benefits outweigh the costs? Any technology investment requires support from organizational leaders who often believe that the benefits will exceed the cost of implementation. One of the most commonly raised questions is "Can we afford not to do this?" This is often driven by the intangible as well as the tangible benefits of the technology. It is therefore important to illustrate that there are multiple types of benefits of implementing GIS technology.

A cost-benefit evaluation is often necessary to demonstrate a systems net benefit to elected officials. However, the nature and magnitude of benefits and costs will vary among organizations.

## Benefits

The potential benefits of geographic information systems technology can be categorized. Quantifiable or tangible benefits include improved efficiency in existing practices. Cost savings may be achieved through the reduction or elimination of redundant activities. A geo-spatial GIS based application for zoning variance notification will eliminate all manual operations for the identification of residents living within 200' of a zoning variance applicant. This is an example of how GIS technology will reduce a thirty-minute manual procedure to an approximate 15-second activity. Automation of geographic data capture, handling, archiving, and manipulation also represents examples of improvement in existing practices.

Another quantifiable benefit is improved productivity in existing practices. The implementation of GIS-based software will facilitate the improved production of accurate maps and map products. GIS is currently used in a few West Sacramento departments, but should be moved to the entire enterprise. Thematic mapping as well as three-dimensional mapping can be produced quickly and efficiently. Expanding and adding capabilities in the form of spatial analysis and analytical computation also offers improvement in existing procedures.

The following table details some of the savings and benefits that will be realized by the City of West Sacramento.

**Figure 1: Benefits/Savings**

| | Departments | General Issue | Benefits | Savings |
|---|---|---|---|---|
| **1.** | All | Address Point Layer | Will provide an accurate set of points for every known address within the City. This will provide improved decision-making and more accurate analyses. Especially helpful for emergency response and public safety. | Currently personnel do not have access to this information. Improved emergency response, address-based tracking and analysis of departmental information (e.g., building permits). All departments will have access to the same layer. |
| **2.** | Building, Engineering, Finance, Fire, Parks & Recreation, Planning, Police, Public Works, Redevelopment | Public Access to Information | Will provide access to multiple data layers such as tax parcels, crime incidents, fire response areas, and zoning. | Providing public access to data will save the City significant staff hours per week in responding to public requests for information. The time savings generated by these applications will grow as citizens become aware of and familiar with the technology. |
| **3.** | Public Works | Utility Network Modeling and Analysis | Will allow accurate modeling of network tracing tasks. | Network analysis will allow City staff to identify customers affected if a given valve is turned off, or where a pollutant might flow if hazardous material is released into the city's storm water system. Will save time in notifying customers of possible service interruptions, and will allow better overall utility management. |
| **5.** | Building, Fire, Police, Public Works | Mobile Infrastructure Data Access | This application will allow field crews to access digital maps showing infrastructure location. | Will reduce time required to locate assets in the field. Particularly important in instances where potential safety hazards may not be readily visible or instances in which infrastructure repairs are critical. |
| **8.** | Fire | Spatial Analysis of Fire Incidents | Will map location of fire calls for service to allow department to take prescriptive measures. | This type of application can allow the department to place resources in areas where there is a high probability of incident occurrence. This reduces response times, and reduced response times lead to saved lives. In addition, knowing the spatial distribution of incidents can allow proposed stations to be |

| | Departments | General Issue | Benefits | Savings |
|---|---|---|---|---|
| | | | | optimally located. In some cases, station location analysis in light of incident locations has led to the realization that a new station was not needed. This can result in hundreds of thousands if not millions of dollars in savings. |
| **9.** | Fire | GIS for ISO Rating Improvement | GIS can provide required map products to improve ISO rating. | This application will result in lower insurance premiums for citizens of West Sacramento. |
| **10.** | Fire | Field Access to GIS Data | Will provide access to data such as streets and addresses via a mobile interface. | Will allow firefighters to search for addresses in the field, and assist in efficient routing of apparatus. Results in reduced response times and saved lives. |
| **11.** | Redevelopment | Site Selection Presentation Development | Will allow redevelopment staff to quickly determine if a site meets a clients needs | Most site location consultants are making the first cut of communities based largely on information available via the web. Providing easy access to information required in general site location studies will increase the city's chance of making it past the first cut. Additionally, economic development staff can use GIS to generate professional responses to requests for information. |
| **12.** | Various, depending on deployment of Springbrook and Permits Plus | Mapping Records Management System (RMS) Data | Will provide access to special permits, variances, building permits, utility billing, and other data stored in RMS via GIS | Will reduce time required to access data in these RMS. Will allow department to generate mailing labels and other types of addresses-based information in a matter of seconds. |
| **13.** | Planning, Public Works | Flood Zone Management – NFIP/CRS | Will allow City to participate in more Community Rating System activities | Will result in lower flood insurance premiums for citizens. |
| **14.** | Police | Crime Incident Analysis | Will allow department to analyze crimes to identify patterns | Analysis results in prescriptive measures such as reallocation of resources in city or alteration of patrols. Goal is reduction in crime. |
| **15.** | Police | Sex Offender Tracking | Track locations of registered sex offenders in city. | Allow citizens to know where offenders live, allow police to quickly identify registered offenders in area if a crime occurs. |

Some of the benefits of GIS cannot be anticipated. However, they can be measured after the fact. Hazard mitigation is an example of how GIS can be used to save lives. Utilizing GIS for

emergency preparedness, response, and recovery is a good example of how GIS can be utilized in response to events that could not have been predicted. A gas line explosion or a contamination event will prompt organizations to recognize the unforeseen benefits of geographic information systems.

The direct benefits therefore include:

- Productivity gains
- Efficiency gains
- A possible reduction in workload
- A possible reduction in labor costs
- Improved accuracy which means better and more well informed decisions

Some benefits defy quantification in the traditional monetary sense. Not quantifiable or intangible benefits are diverse and vary in type and significance. Intangible benefits may include:

- Improved data access
- Public access to information that would otherwise be impossible
- A possible perception of reduced liability - having a good management system in place for the tracking and monitoring of assets will go a long way in off-setting liability issues
- A sense of achievement and increased staff morale

## Costs

There are many components associated with the implementation of GIS technology. The following is a list of major cost accounting issues to address during the implementation phase.

It is important during the initial implementation of GIS technology that all Capital and Operating Costs are identified and anticipated. These costs may include:

- Personnel costs
- Overhead costs
- Maintenance fees
- Supplies

Data Base Costs will be incurred during the initial database construction phase. This can be substantial and often jeopardize the project. Costs can include aerial photography, GPS survey, data conversion and data adjustment. Database development can often involve labor efforts both internal and external to the organization.

Hardware & Software Costs are addressed in the three-year phased implementation plan. Components that should be addressed include:

- Computers
- Servers
- Data storage devices
- Terminals
- Printers
- Plotters
- Scanners

Software costs should be divided into four types: Operating Systems, GIS software, application software, and device software.

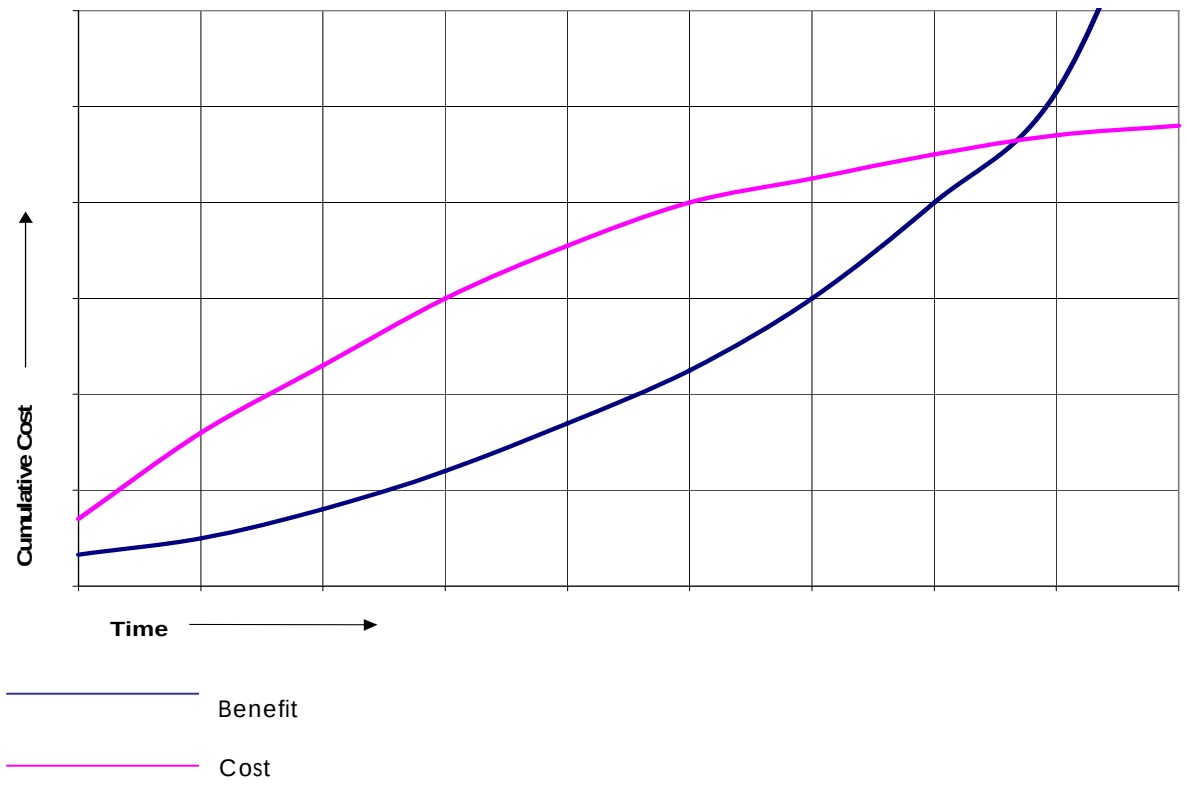
Personnel Costs are incurred when an organization utilizes an independent coordinator and staff to design, develop, implement, and operate the GIS. This cost accompanied by consulting costs should be considered during the implementation-planning phase. Consultant costs for the development of the implementation plan, pilot studies, training, and software prototyping should be considered. Training and user support is often overlooked during this phase.

If hardware, software, and/or database software is purchased with borrowed funds (e.g. bonds) or through lease or purchase agreement financing costs will need to be addressed.

## Cumulative Benefits

Implementing a GIS requires a substantial initial investment for staff, hardware, software, data, applications, interfaces, and communications. Typically, the benefits of a GIS start to outweigh the costs within a three to five year period (ESP-1, 1996). The total benefits of a GIS are only fully realized over time. Over a ten-year period the cost-benefit ratio is 1: 2.5. Thus, for every dollar spent on GIS implementation, the benefit to the organization over time is two and a half dollars (Tomlinson, 2000).

Figure 2:Cost/Benefit Graph




## Application Prioritization – Cost/Benefit Analysis

A successful GIS is measured not by the amount of money spent, the volume of data, or the GIS software utilized but by the applications made available to staff and the public. The following is

a compilation of the applications recommended in the implementation plan and how they were prioritized.

The categories analyzed and weighted were:
*Cost Savings* – Potential of monetary savings to the organization or to the public
*Improved Efficiency* – Does the application improve staff ability to do their job?

*Potential Life Savings* – The potential of the application to assist in preventing loss of life

*Improved Decision Making* – Does the application enable staff to more quickly and accurately make decisions

*Enterprise Usage* – How widely will the application be utilized in the organization?

*Federal/State Mandate* – Does the application assist in satisfying any mandates?

*Pressing Need, Timing, Available Data* – Is data available for this application, is there a compelling need to purchase immediately

*Societal/Community Usage* – Will the application be utilized by and provide direct benefit to the public

*Cost of the Application* – The cost to deploy the application was given a weight as follows:

| | |
|---|---|
| 0$ - $10,000 | = 5 |
| $10,001 - $20,000 | = 4 |
| $20,001 - $30,000 | = 3 |
| $30,001 - $40,000 | = 2 |
| > $40,000 | = 1 |

The maximum amount of points for any category is 5. The higher the total score, the higher the application priority.

***Figure 3: Application Specific Cost Benefit Ratio***

| *Application* | *Cost Savings* | *Improved Efficiency* | *Potential Life Savings* | *Improved Decision Making* | *Enter-prise Usage* | *Fed/ State Mand-ate* | *Societal Community Usage* | *Pressing Need, Timing, Available Data* | *Weighted Costs* | *Total Score* | *Year of Imple-mentation* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Intranet Data Browser | 1 | 5 | 0 | 5 | 5 | 0 | 5 | 5 | 1 | 27 | Under impleme-ntation |
| Desktop GIS Data Browser | 3 | 5 | 0 | 5 | 4 | 0 | 2 | 5 | 4 | 28 | 1,2 |
| Mobile GIS Data Browser | 4 | 5 | 2 | 5 | 5* | 0 | 2 | 5 | 4 | 27 | 1,2 |
| Touch Screen Public Access | 1 | 4 | 0 | 3 | 2 | 0 | 5 | 4 | 4 | 23 | 2 |

| *Application* | *Cost Savings* | *Improved Efficiency* | *Potential Life Savings* | *Improved Decision Making* | *Enter-prise Usage* | *Fed/ State Mand-ate* | *Societal Community Usage* | *Pressing Need, Timing, Available Data* | *Weighted Costs* | *Total Score* | *Year of Imple-mentation* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Utility Modeling Software | 2 | 4 | 0 | 3 | 1 | 4 | 0 | 3 | 1 | 18 | 2 |
| Routing and Scheduling Software | 3 | 5 | 0 | 5 | 1 | 0 | 0 | 2 | 2 | 18 | 3 |
| Internet GIS | 1 | 5 | 0 | 5 | 5 | 0 | 5 | 2 | 3 | 26 | 2,3 |

## Cost and Benefit Examples

The following are examples of how other organizations are utilizing GIS to save time, lives, and money.

### City of Wilson, NC

Using GIS technology the City was able to:

- Determine that a planned Fire Station was not needed, thereby saving the City the cost of building a new station
- Identify property in the city that was not identified as being in the city's jurisdiction in the county tax database, resulting in increased tax revenue
- Implement a storm water management fee based on impervious surface on commercial property in the city, fee calculation would not have been possible without GIS
- Identify transformers that were over or under loaded on the city electric distribution system, allowing the city to more efficiently manage their electric infrastructure
- Identify an evacuation area and notify residents in the area when a bomb was found in a residential area. Analysis was conducted in the field by fire fighters

Contact: Donna Hendrix 252.399.2434

### Forsyth County, GA

Using GIS technology the county was able to:

- Provide county wide access to GIS data, reducing staff time required to answer typical questions
- Provide public access to information via public access terminals, reducing the amount of time staff spends dealing with customer questions
- Allow planners to model various "what if" scenarios for proposed development, allowing decision makers to visualize proposed development prior to approval
- Centralize data management, reducing data redundancy and insuring all personnel are accessing current information

Contact: John Kilgore 252.399.2434

### Town of Nags Head, NC

Using GIS technology the town was able to:

- Provide a window into multiple existing databases, allowing staff to map and query information that was not previously available

- Develop a storm damage assessment application that will reduce the time required to conduct damage assessment after a hurricane. In addition, the application will allow staff to more efficiently respond to citizen queries about property damage.

Contact: Jim Northrup 252.441.5508

## Richland County, SC

Using GIS Richland County was able to:

- Develop a database of survey control monuments in the county, assisting in maintaining an accurate GIS database and providing benfit to the local surveying community.
- Develop a 3D Urban Model to assist in analyzing impacts of proposed development
- Implement a vector control application to assist in controlling the mosquito population in Richland County, thereby reducing disease transmission via mosquitos
- Developed a comprehensive database of cell towers in the county to assist in the planning and permitting process for new cell towers
- Developed a parks and recreation map to assist citizens in locating park facilities

Contact: Pat Bresnahan 803.748.5073

## Boynton Beach, FLA

Using GIS technology the City of Boynton Beach, Fla was able to:

- Implement crime mapping and analysis, resulting in more efficient resource allocation to prevent crime
- Improve logistics by implementing routing and scheduling applications for several city departments
- Improve emergency preparedness by leveraging GIS for hazard mitigation
- Provide public access to GIS information, reducing staff time spent responding to citizen inquiries

Contact: Peter Wallace 561.742.6070

## Columbia County, GA

Using GIS Columbia County was able to:

- Conduct a fire station location analysis to determine the optimum location for a new fire station
- Develop a comprehensive GIS database and implement a enterprise data browser that facilitates all multiple operations
- Implement Crime Analysis applications that have assisted law enforcement officials in combating crime countywide
- Provide public access to tax maps and data, reducing staff time spent generating maps for the public

Contact: Marilyn Heuer 706.868.3359

## City of Greenville, NC

Using GIS technology the City of Greenville was able to:

- Integrate existing enterprise data resources stored in an enterprise HTE database with GIS, increasing the value of both investments
- Develop enterprise GIS data resources to support city operations
- Provide public access to GIS data and functionality via the internet, saving staff time in responding to public requests, for information, maps, and reports
- Develop a Hazardous Material location database to support planning and emergency operations

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# Appendix VII – National Flood Plain Insurance Program / Community Rating System (NFIP/CRS)

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## NFIP/CRS

The City of West Sacramento is enrolled in the National Flood Plain Insurance Program (NFIP)/Community Rating System (CRS). The goals and objectives of the City of West Sacramento's NFIP/CRS initiative are to continue to reduce insurance premiums by identifying and participating in more CRS activities. However, with the implementation of an enterprise-wide GIS, many of these activities will be more feasible.

GIS strategies can help to reduce community vulnerability, as well as, increase public awareness and improve public access to information. With sophisticated analytical tools for improved decision-making and mapping capabilities, GIS offers The City of West Sacramento solutions that could save time, lives, and money. The following is a list of the NFIP CRS activities

that would improve flood management operations, and how utilizing GIS can improve the City of West Sacramento's CRS score. Additionally, maximum points refer to the maximum available for that activity and average points refer to the average of all CRS communities nationwide.

## Series 300: The CRS Public Information

| Series Number 300 | Public Information | Maximum Points | Average Points | Notes Geographic Information Systems |
|---|---|---|---|---|
| 310 Elevation Certificates | Maintain FEMA Elevation Certificates for new construction in floodplain (at a minimum a community must maintain certificates for buildings after the date of CRS application) | 142 | 72 | (1) Relational database of all Elevation Certificates should be linked to Cadastral/Parcel digital base map. |
| 320 Map Information | Provision of Flood Insurance Rate Map (FIRM) information to people who inquire and publicize this service. | 140 | 138 | GIS offers advanced opportunities for allowing the public to see flood data via an INTERNET / INTRANET APPLICATION |
| 330 Outreach Programs | Send information about (1) Flood hazards, flood insurance, flood protection measures, the natural and beneficial functions of floodplains to flood prone residents or all residents of a community. | 290 | 81 | GIS offers improved opportunities for identifying area/zones of impact, and developing mailings, mapping products, and the possibility of an on-line application to query & browse flood information. INTERNET MAP SERVER |
| 340 Hazard Disclosure | Real Estate Agents advise potential purchasers of flood prone property about the flood hazard. Regulations require notice of the hazard. | 81 | 24 | A GIS Flood Zone Application would facilitate the rapid dissemination of all flood-related data. This could be used by real estate agents on: laptops/PC's/work-stations |
| 350 Flood protection Library | The Public Library maintains references on flood insurance and flood protection | 30 | 22 | A GIS Flood Zone Application would allow a user- friendly mechanism to view flood data. |

| Series Number 300 | Public Information | Maximum Points | Average Points | Notes Geographic Information Systems |
|---|---|---|---|---|
| 360 Flood Protection Assistance | Give inquiring property owners technical advice on how to protect their buildings from flooding. Publicize this service. | 71 | 57 | GIS mapping and flood information available on-line i.e., *"Homeowners Guide to retrofitting - Six ways to protect your house from flooding"* |
| **TOTAL 300 SERIES** | | **754** | **394** | |

Specific Actions the City of West Sacramento should take to qualify for Series 300 allocated points

## 310 Elevation Certificates:

**Requirement:** Maintain FEMA Elevation Certificates for new floodplain construction.

**Actions:**

1. Conduct an initial effort to collect information on existing elevation certificates.
2. ArcInfo should be used by one designated staff member to create a database that stores attribute information on existing elevation certificates.
3. Appropriate attribute information should be added to a database, including date issued elevation specifics, and corresponding tax parcel ID number of the parcel that each structure is built upon.
4. Track information on all newly issued elevation certificates issued within this database.
5. For the purpose of analysis, the elevation certificate database should be joined with the tax parcel points within ArcInfo or ArcView, using the tax parcel ID as a unique identifier.
6. FEMA flood data layers should be used to identify all tax parcels within 100-year and 500-year flood zones (spatially identify all tax parcels that are intersected by flood zone polygons).
7. The location of tax parcels within flood zones without elevation certificates can be tracked, as well as undeveloped parcels that will require elevation certificates if structures are erected upon them.

## 320 Map Information

**Requirement:** Provide Flood Insurance Rate Map information to people who inquire, and publicize this service.

**Actions:**

1. *Obtain Digital Flood Insurance Rate Maps (DFIRMs) for all of The City*
2. Once FIRM data is obtained, the City of should make this information available.
3. Three options exist for the dissemination of this information:
   - Hardcopy maps can be reproduced and made available to those who inquire,
   - FIRM data can be disseminated through GIS Public Kiosks Applications, or
   - FIRM data can be disseminated via the Internet.
4. A GIS-enabled web site can reach the greatest number of citizens. Those who do not have home access to the Internet should be able to access this information via the Internet at local libraries.

5. Tax parcels must be displayed in conjunction with FIRM data, so citizens and developers may identify which parcels fall within delineated flood zones.
6. This service must be publicized, through local access TV, newspapers, public postings, etc.

## 330 Outreach Programs

**Requirements:** Send information about flood hazards, flood insurance, flood protection measures, the natural and beneficial functions of floodplains to flood prone residents or all residents of a community.

**Actions:**

1. *All information regarding specified material should be posted on The City oft's web site.*
2. *ArcView should be used to select all tax parcels that fall within flood zones.*
3. *Owner and address information for each tax parcel within the flood zones can be exported using ArcView, to automatically create mailing labels and custom form letters, for the purpose of notifying these property owners.*

## 340 Hazard Disclosure

**Requirement:** Allow real estate agents to advise potential purchasers of flood-prone property about flood hazards.
**Actions:**

1. Two methods are available:
   - Notify all real estate agents of availability of flood zone information on the Internet (assuming these capabilities are developed with ArcIMS for the City of West Sacramento's web site –see **310 Map Information**).
   - Or, develop a GIS Flood Zone Application using MapObjects, with pertinent flood zone and tax parcel information, to distribute to real estate agents via CD-ROM, for use on PC's and laptops. This application can be updated and re-distributed regularly to reflect any changes.

## 350 Flood Protection Library

**Requirement:** Public libraries maintain references on flood insurance and flood protection.
**Actions:**

1. Internet access to flood insurance and flood protection material on the City of West Sacramento's web site should be made available, with logical and easy-to-follow instructions for access to this information.
2. Hardcopy information on flood insurance and flood protection material should be made available in its own section.

## 360 Flood Protection Assistance

**Requirement:** Give inquiring property owners technical advice on how to protect their buildings from flooding, and publicize this service.
**Actions:**

1. Create links on the City of West Sacramento's web site to all pertinent information on technical advice on how to protect their buildings from flooding.
2. Include capabilities for citizens to request hard copy information via email on the web site.
3. This service must be publicized, through local access TV, newspapers, public postings, etc.

## Series 400: The CRS Mapping & Regulations Credit

| Series Number 400 | Mapping & Regulations | Maximum Points | Average Points | Notes: Geographic Information Systems |
|---|---|---|---|---|
| 410 Additional flood data | Develop new Flood Elevations, Floodway delineation, wave heights, or other regulatory flood hazard data for an area not mapped in detail by the flood insurance study. Have additional restrictive mapping standards. | 1230 | 148 | GIS offers the most appropriate mechanism for managing digital flood elevation / floodway data. Hydraulic and hydrologic modeling should derive improved delineation about floodways. This data should reside in a GIS for improving decision support. |
| 420 Open Space Preservation | Guarantee that current vacant floodplain parcels are kept free from development. | 900 | 206 | GIS will allow the depiction of all parcels within flood zones. GIS analysis will calculate the vulnerability of a community. |
| 430 Higher Regulatory Standard | Require freeboard/require soil tests or engineered foundations/require compensatory storage. Zone the floodplain for minimum lot sizes of 1 acre or larger. Have regulations to protect critical facilities. | 1650 | 159 – low density zoning | GIS will facilitate the storage, management, analysis, and display of all relational database information about a community. GIS will assist in re-zoning and subdivision design |
| 440 Flood Data Maintenance | Computerize Flood and property data<br>Use improved maps. Maintain elevation reference marks. | 226 | 78 | GIS is proven to be the most efficient software for accomplishing all flood data maintenance tasks. |

| Series Number 400 | Mapping & Regulations | Maximum Points | Average Points | Notes: Geographic Information Systems |
|---|---|---|---|---|
| 450 Stormwater Management | Regulate development throughout watershed areas to ensure post-development run-off is no worse than pre-development run-off. Regulate new construction to minimize soil erosion and protect or improve water quality. | 670 | 132 | The tools afforded by mapping grade GPS will allow a complete cost-effective inventory of all storm water infrastructures. Digital data stored in a GIS about the type and characteristics of all storm water infrastructures will improve decision-making, predict failures, and allow a more pro-active approach to development and run-off. |
| **TOTAL 400 SERIES** | | **4,776** | **723** | |

## Specific Actions the City of West Sacramento should take to qualify for Series 400 allocated points

### 410 Additional Flood Data

**Requirement:** Develop new Flood Elevations, Floodway delineation, wave heights, or other regulatory flood hazard data for an area not mapped in detail by the flood insurance study. Have additional restrictive mapping standards.

Actions:

1. Obtain DFIRM data.
2. This data can be improved upon, with more precise surveying and GPS information, and hydraulic and hydrologic modeling.
3. Updating DFIRM data will require updating the original grid file, from which polygon flood limits are extracted. Therefore, any improvements made to the City of West Sacramento's DFIRM maps will require the use of ArcInfo or ArcView, and the Spatial Analyst extension.
4. Additional restrictive mapping standards can be created from the original and updated DFIRM dataset. This will also require the use of ArcInfo or ArcView, and the Spatial Analyst.
5. At least one staff member in Public Works should receive specialized training for updating DFIRM maps, or, the City of West Sacramento can utilize a consultant to perform this function.

### 420 Open Space Preservation

**Requirement:** Guarantee that current vacant floodplain parcels are kept free from development.

Actions:

1. *Should the City of West Sacramento decide to make restrictions on developing flood zones, ArcView should be used to identify what tax parcels are in delineated flood zones.*

2. Maps should be generated to demonstrate to inquiring developers of property within a flood zone why the property cannot be developed.

## 430 Higher Regulatory Standards

**Requirements:** Require freeboard/require soil tests or engineered foundations/require compensatory storage. Zone the floodplain for minimum lot sizes of 1 acre or larger. Have regulations to protect critical facilities.

**Actions:**

1. *Implement higher freeboard requirement for structures within flood zones, and implement zoning regulations regarding the size of land and type of structure that can be developed with flood zones.*
2. The City of West Sacramento can use ArcInfo to create GIS data layers demonstrating the extent of these zoning regulations.
3. Information on location of soil tests and which structures have engineered foundations or require compensatory storage, can be created in ArcInfo, and spatially displayed.
4. Identify critical facilities within the City of West Sacramento. The location of these critical facilities should be mapped, for further determination of regulations to protect them.

## 440 Flood Data Maintenance

**Requirement:** Computerize flood and property data, use improved maps, and maintain elevation reference marks.

**Actions:**

1. DFIRM data can be improved upon with more precise surveying and GPS information, and hydraulic and hydrologic modeling.
2. Updating DFIRM data will require updating the original grid file, from which polygon flood limits are extracted. Therefore, any improvements made to the City of West Sacramento's DFIRM maps will require the use of ArcInfo or ArcView, and the Spatial Analyst extension.
3. Additional restrictive mapping standards can be created from the original and updated DFIRM dataset. This will also require the use of ArcInfo or ArcView, and the Spatial Analyst.
4. Location of elevation marks can be created as point data within ArcInfo or ArcView.
5. At least one staff member of in Public Works should receive specialized training for updating DFIRM maps, or, the City of West Sacramento can utilize a consultant to perform this function.

## 450 Storm Water Management

**Requirements:** Regulate development throughout watershed areas to ensure post-development run-off is no worse than pre-development run-off. Regulate new construction to minimize soil erosion and protect or improve water quality.

**Actions:**

1. The entire storm water infrastructure of the City of West Sacramento can be modeled and analyzed using ArcGIS.
2. First, the storm water infrastructure must be digitally created, using existing information and GPS data collection, then logically structured within the storm-water data model for ArcGIS.
3. ArcGIS can be utilized in conjunction with the DFIRM maps and the Spatial Analyst Extension to perform analysis of the present storm-water infrastructure versus the surface slope to calculate likely run-off volume, and plan for improvements to the infrastructure.

4. At least one staff member in Public Works should receive specialized training for this type of analysis, or, the City of West Sacramento can utilize a consultant to perform this function.

## Series 500: The CRS Flood Damage Reduction Credit

| Series Number 500 | Flood Damage Reduction | Maximum Points | Average Points | Notes: Geographic Information Systems |
|---|---|---|---|---|
| 510 Floodplain Management Plan | Devote special attention to repetitively flooded areas. | 235 | 34 | GIS can help identify areas that have been repeatedly flooded. |
| 520 Acquisition and Relocation | Acquire and/or relocate flood prone buildings. | 3200 | 177 | GIS will assist in identifying all structures within the flood zones as depicted by FEMA. GIS will isolate structures for acquisition or relocation planning. |
| 530 Retrofitting | Credit is based on the number of flood proofed or elevated pre-FIRM buildings in the floodplain. | 2800 | 66 | GIS will facilitate the identification of all pre-FIRM buildings in the City of West Sacramento, and isolate all structures that are in the floodplain that have not been flood proofed or elevated. |
| 540 Drainage System Maintenance | Conduct periodic inspections of all channels and retention basins, and remove debris as needed. | 330 | 236 | GIS will act as the ideal platform for maintaining inspection data and debris removal activities. |
| **TOTAL 500 SERIES** | | **6,565** | **513** | |

## Specific Actions the City of West Sacramento should take to qualify for Series 500 allocated points

### 510 Floodplain Management

**Requirements:** Devote special attention to repetitively flooded areas.

**Actions:**

1. Historical flooding information can be broadly mapped using known high-water marks or aerial photography showing the extent of flooding.
2. This dataset should be created using ArcInfo and the Spatial Analyst Extension, in conjunction with present DFIRM data.
3. Future flooding can be more precisely mapped, if proper steps are taken to collect as much information about the extent of flooding at the time it occurs, or immediately after. This requires utilizing GPS data collection.

4. Once historical and current flooded areas are mapped, ArcInfo or ArcView can be used to identify parcels that have been subject to repetitive flooding, and this information can be disseminated to the public.

### 520 Acquisition and Relocation

**Requirement:** Acquire and/or relocate flood-prone buildings.

**Actions:**

1. If the City of West Sacramento chooses to acquire or relocate flood-prone buildings, ArcInfo or ArcView can be utilized to determine which structures are within flood zones and/or repetitively flooded areas.

### 530 Retrofitting

**Requirement:** Credit is based on the number of flood-proofed or elevated pre-FIRM buildings in the floodplain.

**Actions:**

1. A database of buildings that have been flood-proofed or elevated should be created within ArcInfo immediately.
2. Buildings within the floodplain that have not been flood-proofed or elevated can then be spatially identified.

### 540 Drainage System Maintenance

**Requirements:** Conduct periodic inspections of all channels and retention basins, and remove debris as needed.

**Actions:**

1. The entire drainage system can be tracked and analyzed using ArcGIS, after all of its features have been collected using GPS and other available sources of information.
2. Once the drainage system has been properly modeled, ArcGIS can track inspection data of all drainage features.

## Series 600: The CRS Flood Preparedness Credit

| Series Number 600 | Flood Preparedness | Maximum Points | Average Points | Notes: Geographic Information Systems |
|---|---|---|---|---|
| 610 Flood Warning Program | Provide early flood warnings to the public Have a detailed flood response plan keyed to flood crest predictions | 200 | 99 | GIS mapping and analytical capabilities will assist with this task |
| 620 Levee Safety | Maintain levees not otherwise credited in the flood insurance rating system that provide some flood protection | 200 | 153 | GIS will help map the location of levee features. |
| 630 Dam Safety | All communities with a dam safety program receive some credit | 120 | 66 | |
| **TOTAL 600 SERIES** | | **1,220** | **318** | |

## Specific Actions the City of West Sacramento should take to qualify for Series 600 allocated points

### 610 Flood Warning System

**Requirement:** Provide early flood warnings to the public. Have a detailed flood response plan keyed to flood crest predictions.

**Actions:**

1. *ArcInfo and the Spatial Analyst Extension should be used to spatially predict likely parcels to be affected based on flood-crest predictions.*
2. Property owners within the likely affected area can be identified with ArcInfo or ArcView based on the previous analysis, and subsequently notified.
3. The entire infrastructure of the City of West Sacramento, including water/waste water, storm water, electric utility features, communications structures, etc, can be modeled in ArcGIS, and features likely to be affected can be identified ahead of time based on flood-crest predictions.

### 620 Levee Safety

**Requirement:** Maintain levees not otherwise credited in the flood insurance rating system that provide some flood protection.

**Actions:**

1. Information on current levees can be collected, created, and tracked within ArcInfo.
2. Analysis of the DFIRM data using ArcInfo and the Spatial Analyst Extension can help identify locations for new levees.

### *Total CRS Credit*

| | | | |
|---|---|---|---|
| TOTAL CRS CREDIT | | **8,145** | **1,555** |

***** This information was provided by FEMA

### *CRS and Storm Water Management Recommendations*

*The City of West Sacramento needs to consider the NFIP CRS in conjunction with Storm Water Management activities (NPDES). The following table documents the recommended uses of GIS for the NFIP CRS and storm water management activities. Nine GIS applications have been identified.*

## GIS Recommendations - NFIP CRS & Storm Water Management

| | Recommended GIS Application |
|---|---|
| ***1*** | Use GIS to **Track and Issue** Elevation Certificates. A GIS application would allow the City of West Sacramento to identify the flood vulnerability of a parcel and organize and track existing, non-existing elevation certificates. |
| ***2*** | Utilize State-of-the-art GIS **internet and intranet capabilities to make flood data available** in a user-friendly manner. |
| ***3*** | Use GIS for **Hazard Identification**. This will allow the City of West Sacramento to determine areas that will be affected by flooding and other related issues. It will allow all parcels to be identified that are repeatedly flooded. |
| ***4*** | Use GIS for **Hazard Disclosure**. This will allow the residents to be better informed about flooding and flood prone areas. This could possible involve the Internet or developing a CD with parcel and flood information. |
| ***5*** | A GIS should be used to **store, analyze, and map all newly acquired field inventory data** i.e., storm water, water, and sewer. Any GIS initiatives will involve database creation, storage and graphic depiction. GIS should be the relational database engine for all external databases created within the City of West Sacramento. Note: There is a compelling reason to inventory all storm water infrastructures. "The unseen storm water management facilities (i.e. the piping systems which have been installed in subdivisions) have recently become an increasing concern. The most common type of pipe used in many of the subdivisions constructed during the 1970's and 1980s was corrugated metal pipe. This pipe typically has a design life expectancy of 20 years; therefore many of the storm water piping systems in these subdivisions will need to be repaired or replaced over the next few years." Storm water management, the NFIP, and the CRS are inter-dependant and need to be addressed together. GIS offers that capability. |
| ***6*** | Use GIS to produce **better maps and map products**. Thematic mapping illustrating hazard prone areas will improve the City of West Sacramento's CRS. |
| ***7*** | GIS should be used as the **mechanism to store all flood zone delineation** (i.e. Q3, DFIRM) and all future engineering studies. Any hydrologic and hydraulic engineering studies that produce improved floodway delineation should be stored in the GIS. This data together with other important digital descriptions (i.e., cadastral) will improve the decision making process. |
| ***8*** | GIS should be used to **link all external relational databases** that relate to flooding of hazard mitigation. |
| ***9*** | Use the tools afforded by GIS to **improve the City of West Sacramento's community rating**. Most of the CRS activities could be improved with the application of GIS technology. It is recommended that the City of West Sacramento work closely with the CRS/ISO specialist to determine how best to use GIS for improving the CRS discount. |