Estimating GIS Return on Investment the Empirical Way

Computing the Costs, Benefits, and ROI of GIS Products and Services

This guideline outlines a standardized method by which your organization can assess the net benefits of implementing, upgrading, and using its GIS resources. These resources include staff, software, data, application programs, training and time spent using the GIS.

This method is empirical. It is based on experience - the experience of the authors (of NSGIC) - of people with decades of practice implementing and using GIS for useful purposes. It is designed to collect and express the specific experience of GIS users and managers in your organization, using a systematic methodology, so that the conclusions are identified as their conclusions - rather than the "pet project" of the person who conducts the ROI Study.

Why Should We Analyze Costs-Benefits and Calculate Return on Investment (ROI)?

- To Answer the question: "OK, Now that I know how much it's going to cost, is it worth the money (and time & effort)?"
- Even if it is worth the investment, how do the benefits compare with other potential projects?
- Even if it is worth the investment, when will the benefits show up?
- As a tool to allocate the organization's limited resources.
- As a justification for budgetary allocation of GIS operation.

This empirical method builds a computational model for calculating the costs of maintaining or upgrading an organization's GIS technology, and the financial benefits to the organization from each member's, and each department's, use of specific GIS applications that fulfill, promote, and enhance its duties. The net return (benefits minus costs) is calculated for a series of years to conclude what the ROI will be over time.

- The model is very flexible; cost and benefit assumptions can be modified, and the timing for implementing the cost items and receiving the benefits can be changed.
- Assumptions are explicit; they can be seen, understood, and changed.
- The calculations are transparent; they follow a logic that is clearly laid out.
- The model's "facts" are derived from your organization's own users and managers; they review the initial formulation and can negotiate changes.

With these characteristics, the model may be challenged, but it can't be dismissed. It represents the common, shared consensus of an organization's members who affect and are affected by GIS. Where consensus is difficult, the model can be run with alternative scenarios to enable discovery of how different the impact may be from different facts and assumptions, to respond to concerns like: "What happens if we delay a project until next year?" or "Suppose the expected benefit only turns out to be half as much?"

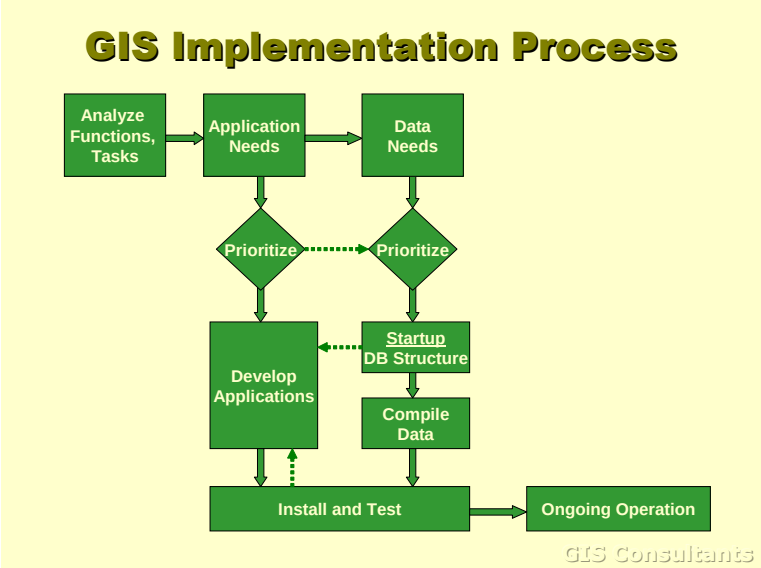
Identifying ROI Model Elements

The underlying philosophy of this method is that GIS is valuable to an organization only as its application products assist and improve the organization's operations. Relevant GIS applications are the root of the model. The prioritized list of GIS applications determines

which data need to be collected, updated and maintained, and which software and staffing need to be deployed to conduct the GIS applications. The usage of GIS applications is the basis for calculating the benefit GIS technology is, or will be, providing to your organization.

A simplified diagram of the GIS implementation process shows a map for identifying the factual and assumption "elements" of the model's cost and benefit calculations. This process applies to both implementing GIS technology in organizations where it doesn't already exist, as well as to significantly upgrading GIS capabilities and applications in an organization.

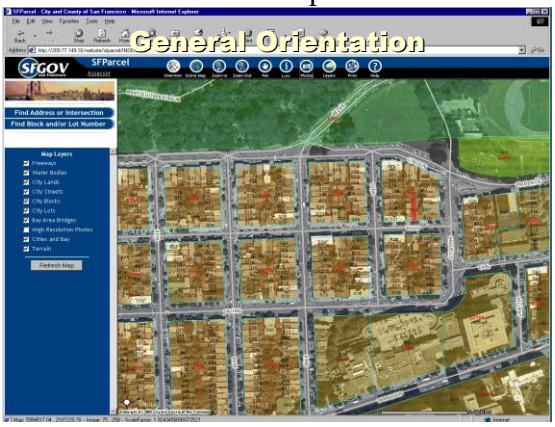
We begin with an analysis of the tasks and functions that the departments and individuals in an organization actually conduct, and may need to improve. Many of the tasks that involve geographic information, location, and spatial relationships could be improved through the application of GIS technology. We identify these as "Application Needs." Each of these possible GIS applications in turn requires certain specific types of data upon which the GIS programs would work to conduct operational methods that are more efficient or effective than current methods. A long list of GIS applications is typically generated (example below), which needs to be prioritized since we can't solve all problems simultaneously. Similarly, the data that would be collected to "feed" the applications are prioritized as well. Several initial startup steps are necessary, including designing a database structure, in order to develop (program) the selected priority applications. After data is compiled and loaded into the database, the GIS applications are tested and revised where necessary. Successful GIS applications are then deployed for the organization's ongoing operation. These implementation process steps are the basis for calculating the costs of developing or significantly upgrading GIS technology in an organization. These costs are fully described below.

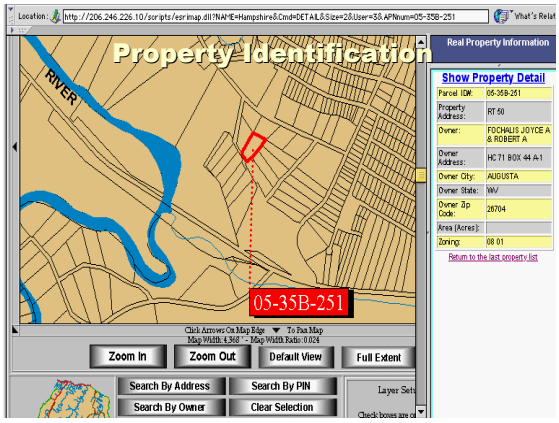


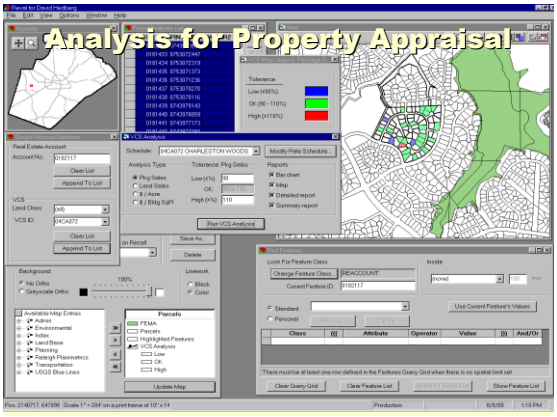
Applications Drive GIS Implementation

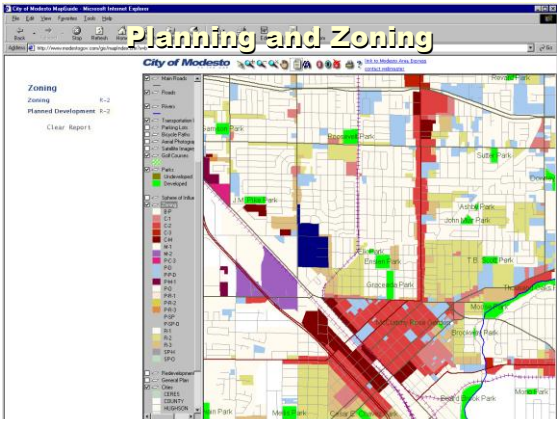
We identify the specific departmental tasks and functions that the organization could improve through application of GIS technology. Some GIS applications may be useful to a single departmental function, such as mapping the pattern of crimes and comparing it

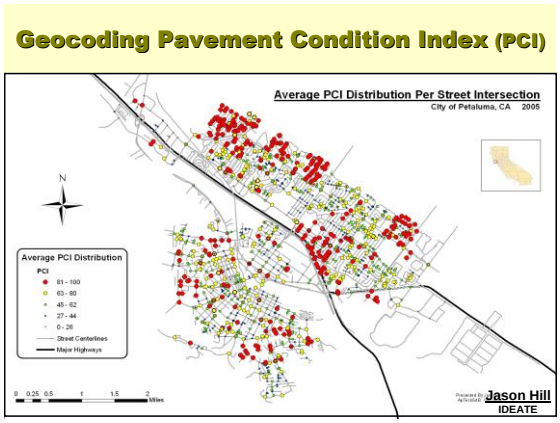
with the deployment of police resources. Other GIS applications provide a general purpose benefit to many departments and tasks, for example, a parcel basemap that identifies land ownership.











Prioritizing Applications and Data

All the potential GIS applications that could benefit the organization are compiled into a list, along with a tally of the departments that could use them and the number of different potential users there are in total.
In this example, the needed applications are colored by the primary department that would use or be responsible for them, and the number of departments that would use them is indicated.

App. No.	Dept	GIS Applications	ED	FD	F/IS	P&B	PW	P&	Count	F	Need	Imp	Win
1.00		**Economic Development & Housing**											
1.01	ED	Parcel Information	X	u	u	X	u	u	6	F			W
1.02	ED	Parcel Environmental Data	X	u		u	u		4		N		
1.03	ED	Business Information Research	X		u	u			3			I	
1.04	ED	Public Notification (noticing)	X	u	u	X	u	u	6		N		W
1.05	ED	Pin Maps/Code Violation Inspectio	X	u		u			3		N		
1.06	ED	Virtual City Tour	X			u			2			I	
1.07	ED	Real Estate Availability	X			u			2			I	
2.00		**Fire**											
2.01	FD	Fire Dispatch (by Oakland)		X					1			I	
2.02	FD	Fire Run Book/digital map		X				u	2		N		
2.03	FD	Traffic Flow		X		u	u	u	4			I	
2.04	FD	Block Plans		X		u		u	3		N		
2.05	FD	Fire Pre-Plans		X					1		N		
2.06	FD	Field Access to Building Data		X				u	2		N		
2.07	FD	Pin Maps/Fire Inspections, Incidents		X					1		N		
2.08	FD	Hydrant Connection to Water Network		X			u		2			I	
2.09	FD	Plume Management		X		u			2		N		
2.10	FD	Soils Information		X			u		2			I	W
3.00		**Finance/Information Services**											
3.01	F/IS	Enterprise-wide DB Repository	u	u	X	u	u	u	6	F			
3.02	F/IS	System Support	u	u	X	u	u	u	6	F			
3.03	F/IS	Addressing Schema	u	u	X	u	u	u	6	F			
3.04	F/IS	Pin Map of Business Licenses	u	u	X				3			I	W
3.05	F/IS	Business License Review	u		X				2		N		
3.06	F/IS	Document Scanning with Map Ref	u	u	X	u	u		5		N		
4.00		**Planning & Building**											
4.01	P&B	Parcel-based Spatial Analysis	u			X	u		3		N		W
4.02	P&B	Address Mapping/Reconciliation	u	u	u	X	u	u	6	F			
4.03	P&B	Streetscape Design Review	u			X	u		3			I	
4.04	P&B	Development Project Pin Map	u			X			2		N		W

These GIS applications are also classified according to a typology that will help prioritize which to develop first, and thereby determine the sequence of GIS development costs and the resulting benefits. Our typology includes six classifications:

- Foundational - applications that provide an information base for more specific applications, for example building basemap layers such as parcels, roads, addresses, topography, and imagery.

- Needed - applications that have a high potential utility for at least one department's function; often they have a high potential for several departments, for example, mail notification to property owners.

- Important - applications that have a potential utility, but not as strong, nor as prevalent as the "needed" applications.

- Hot Button - applications that support a task, project, or function of particular interest to the organization's decision-makers, for example a City Council member who was elected on the platform of repairing potholes might want a GIS application that maps and classifies potholes and clearly illustrates the progress of their repair.

- Early Win - some applications may have less important potential utility, but they are easy to build and quick to demonstrate progress and products resulting from the GIS implementation. They help build credibility for GIS development of the more expensive and time-consuming applications that are foundational and highly useful.

- Targeted Funding - Often outside grants and funding are available for specific programs that could employ GIS technology to their advantage, for example, mapping critical assets for homeland security protection, or mapping the sources and areas affected by pollution runoff. Frequently, target programs provide the funding basis for an organization's creation or expansion of its GIS capabilities, which can subsequently be applied to many more organizational tasks and needs.

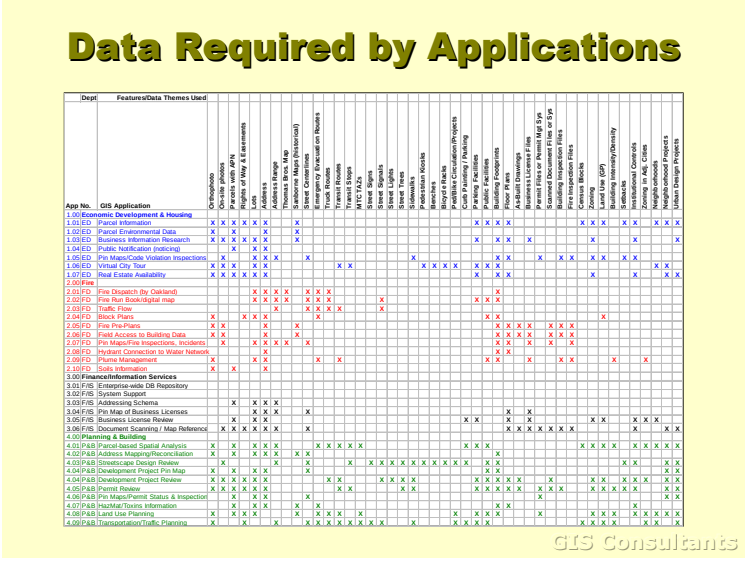
The compiled list of potential GIS applications classifies them according to this typology, so that, by sorting applications according to type and number of potential users, we can prioritize them for development and implementation. Now comes the artful process of selecting GIS applications from the list for prioritization according to classification and number of potential users. It is not an exact calculation, and therefore it provides a significant opportunity for collaboration among the organization's GIS users and potential users. We construct a prioritized list in a group context in which participants express their preferences, and differences are negotiated. Expertise with GIS implementation by some of the group's members, or by outside consultants, informs the group when certain applications require others as a prerequisite, and helps to assure that a good balance of application types and popularity is achieved. By collaborating in the prioritization process, the organization's members begin to see potential benefit to their departmental operations and they begin to vest their support in the project.

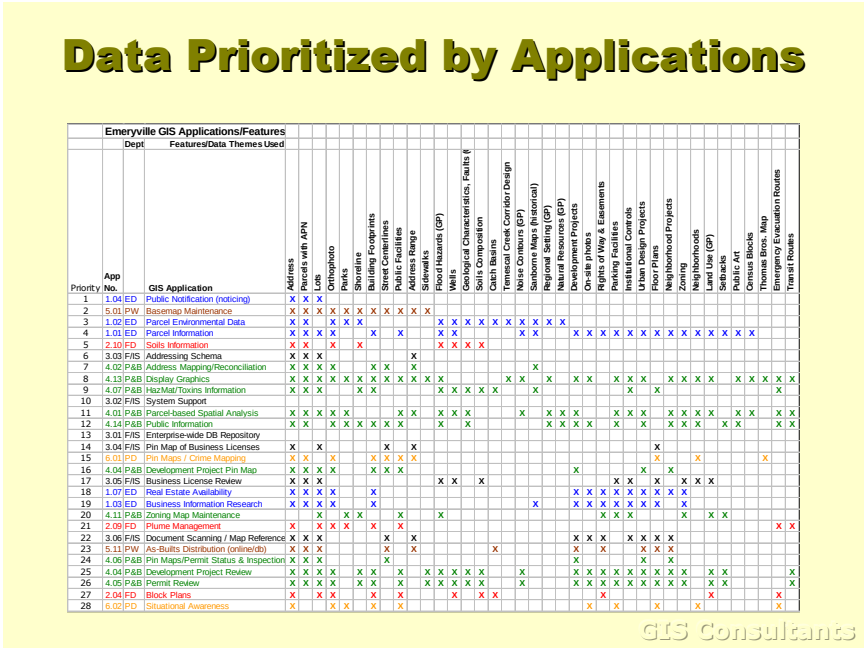
Prioritized Applications

Priority	App. No.	Dept	GIS Application	Count	Type	
1	1.04	ED	Public Notification (noticing)	6	N	W
2	5.01	PW	Basemap Maintenance	6	F	
3	1.02	ED	Parcel Environmental Data	4	N	
4	1.01	ED	Parcel Information	6	F	W
5	2.10	FD	Soils Information	2	I	W
6	3.03	F/IS	Addressing Schema	6	F	
7	4.02	P&B	Address Mapping/Reconciliation	6	F	
8	4.13	P&B	Display Graphics	5	F	W
9	4.07	P&B	HazMat/Toxins Information	5	N	
10	3.02	F/IS	System Support	6	F	
11	4.01	P&B	Parcel-based Spatial Analysis	3	N	W
12	4.14	P&B	Public Information	5	N	W
13	3.01	F/IS	Enterprise-wide DB Repository	6	F	
14	3.04	F/IS	Pin Map of Business Licenses	3	I	W
15	6.01	PD	Pin Maps / Crime Mapping	3	N	W
16	4.04	P&B	Development Project Pin Map	2	N	W
17	3.05	F/IS	Business License Review	2	N	
18	1.07	ED	Real Estate Availability	2	I	
19	1.03	ED	Business Information Research	3	I	
20	4.11	P&B	Zoning Map Maintenance	2	N	

Each GIS application requires a specific set of data types in order to perform. As we collect information about a department's functions and vision for potential applications of GIS, we identify the types of data needed. The data types are associated with each application in a spreadsheet, as illustrated. A specific type of data may be necessary for several GIS applications, and nearly all applications require several data types.

After documenting the association of applications with data types, the spreadsheet is sorted according to the priority of applications that was derived in part by a collaborative process among organizational stakeholders. The result is a sorted list of data to be collected or updated that corresponds to the priorities of the applications that will feed upon the data.





Calculating the Costs

Whether implementing GIS technology for the first time, or expanding the scope and capabilities of your organization's GIS operation, the following categories of cost should be considered.

- Startup
- Application Development
- Data Development
- Hardware / Software / Communication Network
- Installation, Testing, Training
- Ongoing Operation

Each of these cost categories is detailed with a set of subcategories. Each cost element is measured or estimated on a "cost per unit" basis. This enables the ROI model to enlarge or reduce the project scope while maintaining a consistent method for estimating costs. Different cost elements have a different "unit" basis, as illustrated below.

Startup Costs

Some "startup costs" occur at the beginning of an upgrade or new development project; other startup costs occur later during the project. Generally, they occur once during an upgrade iteration.

- Workflow Analysis - reviews current methods of fulfilling departmental tasks, and proposes the GIS applications that could improve operational efficiency and effectiveness. The analysis identifies - for each task or function: What data is needed? Where does it come from? Who gets the resulting information? The analysis formulates procedures for improved flow of information, and identifies the data needed for each GIS application.

- Geodatabase Design - creates a systematic arrangement for storing the data so that the GIS applications can access it efficiently. The database design must be generic enough to enable many types of applications to access the data, and usually the design must integrate with non-geographic database files used throughout the organization. "Geodatabase" refers to the geographic data, but it is part of the enterprise database system.

- Installing the Geodatabase - refers to the time and effort needed to program the database management system with a specific geodatabase design.

- Staff Training - time and cost required for training staff are estimated for any and every new expansion of GIS capabilities. The GIS tools are only as effective as the organization's staff's ability to use them.

- System Installation and Upgrades - the computer hardware and software components of the GIS system require startup time to install. Costs are also estimated for software upgrades and hardware replacements which occur periodically.

The cost basis for each of these Startup costs is estimated in terms of person-days of effort. Startup tasks for which the organization's staff do not have adequate experience would be conducted by consultants, or perhaps by hiring temporary staff. The startup cost basis assumes a percentage of the total estimated task time to be conducted by consultants. These assumptions, as with all the assumptions in the model, are subject to review, discussion and modification, which then automatically modifies the ROI model and calculated conclusion.

NOTE: all of the quantities shown in this model are for illustrative purposes only.

Applications Cost

Cost Basis: Startup

	days	consultant service	consult %	temporary staff	cost	subtotal	Notes
Startup, Design, Installation							
Initial Database Design	4	$1,800	75%	$300	$2,100		Consultant 3 days + collaborate w/ staff
Workflow Analysis	6	$2,340	65%	$630	$2,970		
GeoDatabase Design	5	$2,400	80%	$300	$2,700		Consultant 4 days + collaborate w/ staff
Workflow Procedure Formulation	10	$3,000	50%	$1,500	$4,500		
Enterprise-wide DB Repository	4	$600	25%	$900	$1,500		SQL Server Configuration
Enterprise-wide GIS DB Repository	3	$1,800	100%	$0	$1,800		SDE Database Configuration
System Installation & Upgrades	3	$180	10%	$810	$990		Staff install software, upgrades, per packag
Staff Training by consultant	1	$600	100%	$0	$600		Train staff per day, staff practice is ongoing

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The cost of developing GIS application programs includes both general and specific costs. The general costs, which apply to all application programs, include establishing standard methods for the organization's user interface to make the operation of the programs understandable for "occasional" users. Many users may engage a specific GIS application only occasionally. They need to recognize a standard user interface for all the organization's programs so they won't need to spend a lot of time relearning each particular program whenever they need to use it. The productivity and benefit of GIS applications depends on the number of users and times it is used.

Cost Basis: Applications

App No.			days	consultant service	consult %	temporary staff	cost	subtotal	Notes
		Application Development							
1.04	ED	Public Notification (noticing)	1	$600	100%	$0	$600		Configuring existing capabilities
5.01	PW	Basemap Maintenance	5	$3,000	100%	$0	$3,000		setup tools, training for ArcGIS basemap update
1.02	ED	Parcel Environmental Data	2	$1,200	100%	$0	$1,200		subset of "drill down" program
1.01	ED	Parcel Information	5	$3,000	100%	$0	$3,000		"drill down" program, after data is complete
2.10	FD	Soils Information	1	$600	100%	$0	$600		subset of "drill down" program
3.03	F/TS	Addressing Schema	3	$1,170	65%	$315	$1,485		Consultant 2 days + collaborates w/ staff
4.02	P&B	Address Mapping/Reconciliation	2	$1,200	100%	$0	$1,200		Testing & display
4.13	P&B	Display Graphics	6	$2,520	70%	$540	$3,060		Setup tools for ongoing map requests
4.07	P&B	HazMat/Toxins Information	3	$1,800	100%	$0	$1,800		"Drill down" linking to floor plans
4.01	P&B	Parcel-based Spatial Analysis	6	$3,600	100%	$0	$3,600		Set up analyses for web-based operations
4.14	P&B	Public Information	2	$1,200	100%	$0	$1,200		
3.04	F/TS	Pin Map of Business Licenses	1	$600	100%	$0	$600		Configure existing capability, link to Biz Lic files
6.01	PD	Pin Maps / Crime Mapping	1	$600	100%	$0	$600		Configure existing capability, link to PD files
4.04	P&B	Development Project Pin Map	1	$600	100%	$0	$600		Configure existing capability, link to iles
3.05	F/TS	Business License Review	6	$3,600	100%	$0	$3,600		"Drill down" for surrounding area, link to files
1.07	ED	Real Estate Availability	2	$1,200	100%	$0	$1,200		Similar to pin map, link to C of C files
1.03	ED	Business Information Research	1	$600	100%	$0	$600		

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In addition to designing general interface standards, each application design includes building or modifying the information flow within and between departments, programming the application, testing and modifying where necessary, documenting the program and training the users. These subtasks are estimated as the Applications Cost Basis, similarly to the startup costs. Time allotted for each subtask is allocated between outside consultants and the organization's staff.

Data Costs

The costs for compiling the data required for each GIS application is a function of the amount of data to be collected and "cleaned" (removing data errors and omissions). For some types of data, for example compiling addresses or creating orthoimagery, the cost basis is estimated for a unit of quantity, such as cost per parcel or cost per square mile. For other types of data, for example compiling a layer of public parks or fire stations, the cost is estimated in terms of time required. As with the previous cost bases, the time-cost may be allocated to internal staff or consultants, or usually, a combination. Where staff are experienced or where a data type will be compiled and updated frequently, it is more economical to utilize internal staff. Consultants are useful for unique data compilations and for teaching staff how to continue the process internally. The data are listed in the same priority as they will be needed by the prioritized applications.

Cost Basis: Data

Data Priority	Data Theme/Feature	days	consultant service	consult %	temporary staff	cost/ parcel	cost	Notes
1	Address					2.00	$9,600	Reconcile with APN
2	Parcels with APN					0.65	$3,120	Register, Check & update
3	Lots					0.85	$4,080	Digitize, adjust to parcels, place address
4	Orthophoto						$250	Available from other agencies
5	Parks	1	$150	25%	$300		$450	Staff adds to GIS basemap, consultant assist
6	Shoreline						$500	Import from GP, adjust
7	Building Footprints					0.45	$2,160	Digitize
8	Street Centerlines					0.25	$1,200	Digitize, adjust
9	Public Facilities	2	$300	25%	$600		$900	Staff encodes condition, consultant assist
10	Address Range					0.25	$1,200	Concurrent w.Centerlines
11	Sidewalks	2	$300	25%	$600		$900	Staff encodes condition, consultant assist
12	Flood Hazards (GP)						$500	Import from GP, adjust
13	Wells	2	$600	50%	$600		$1,200	Staff adds to GIS basemap, consultant assist
14	Geological Characteristics, Faults (GP)						$500	Import from GP, adjust
15	Soils Composition						$500	Import from GP, adjust
16	Catch Basins					0.40	$1,920	Import from AutoCAD, annotate
17	Temescal Creek Corridor Design	1	$450	75%	$300		$750	Requires accurate digitizing
18	Noise Contours (GP)						$500	Import from GP, adjust
19	Sanborne Maps (historical)	2	$300	25%	$600		$900	Available from other agencies, scan internally
20	Regional Setting (GP)						$500	Import from GP, adjust
21	Natural Resources (GP)						$500	Import from GP, adjust
22	Development Projects	3	$180	10%	$900		$1,080	Staff adds to GIS basemap, consultant assist
23	On-site photos	5			$1,500		$1,500	Taken by staff as needed
24	Rights of Way & Easements					0.50	$2,400	Digitize
25	Parking Facilities	1	$150	25%	$300		$450	Staff encodes condition, consultant assist
26	Institutional Controls	5	$300	10%	$1,500		$1,800	Enter text, link documents to parcel
27	Urban Design Projects	3	$180	10%	$900		$1,080	Staff adds to GIS basemap, consultant assist
28	Floor Plans	10	$1,500	25%	$3,000		$4,500	Scan & link to DB and footprints

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In addition to compiling data for the new applications, costs must be estimated for quality control (checking and correcting the data), for metadata documentation, and for regularly-scheduled ongoing update of the data. These cost items are labeled "data maintenance."

Scheduling Costs

The prioritized applications are scheduled for development in specific years of a multi-year project. Usually, annual budget constraints limit how many new applications the organization can afford to develop. Moreover, some applications require development of prerequisite applications; all can not be developed simultaneously. The application development schedule can be modified by moving the applications into an earlier or later timeslot, and the resultant annual costs will be recalculated automatically.

Data Cost over time

	Cost Base	2006 Qty.	2006 Cost	2007 Qty.	2007 Cost	2008 Qty.	2008 Cost	2009 Qty.	2009 Cost	2010 Qty.	2010 Cost
Data Development											
Address	$9,600	100%	$9,600								
Parcels with APN	$3,120	100%	$3,120								
Lots	$4,080	100%	$4,080								
Orthophoto	$250	100%	$250								
Parks	$450	100%	$450								
Shoreline	$500	100%	$500								
Building Footprints	$2,160	100%	$2,160								
Street Centerlines	$1,200	100%	$1,200								
Public Facilities	$900	100%	$900								
Address Range	$1,200	100%	$1,200								
Sidewalks	$900	100%	$900								
Flood Hazards (GP)	$500			100%	$500						
Wells	$1,200			100%	$1,200						
Geological Characteristics, Faults	$500			100%	$500						
Soils Composition	$500			100%	$500						
Catch Basins	$1,920			100%	$1,920						
Temescal Creek Corridor Design	$750			100%	$750						
Noise Contours (GP)	$500			100%	$500						
Sanborne Maps (historical)	$900			100%	$900						
Regional Setting (GP)	$500			100%	$500						
Natural Resources (GP)	$500			100%	$500						
Development Projects	$1,080	100%	$1,080								
On-site photos	$1,500			100%	$1,500						
Rights of Way & Easements	$2,400			100%	$2,400						
Parking Facilities	$450			100%	$450						
Institutional Controls	$1,800			100%	$1,800						
Urban Design Projects	$1,080			100%	$1,080						
Floor Plans	$4,500			100%	$4,500						
Neighborhood Projects	$1,440			100%	$1,440						
Zoning	$2,700			100%	$2,700						
Neighborhoods	$900			100%	$900						
Land Use (GP)	$1,200			100%	$1,200						
Setbacks	$7,500			100%	$7,500						
Public Art	$720					100%	$720				
Census Blocks	$250			100%	$250						
Thomas Bros. Map	$250			100%	$250						
Emergency Evacuation Routes	$900					100%	$900				
Transit Routes	$900					100%	$900				
Truck Routes	$900					100%	$900				
Housing and Mixed Use	$900					100%	$900				
Transit Stops	$900					100%	$900				
Street Signals	$1,800					100%	$1,800				
Building Intensity/Density	$1,350					100%	$1,350				
Zoning in Adj. Cities	$900					100%	$900				

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Applications Cost over time

	Cost		2006		2007		2008		2009		2010	
	Basis	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost
Application Development												
Public Notification (noticing)	$600	100%	$600									
Basemap Maintenance	$3,000	100%	$3,000									
Parcel Environmental Data	$1,200			100%	$1,200							
Parcel Information	$3,000			100%	$3,000							
Soils Information	$600			100%	$600							
Addressing Schema	$1,485	100%	$1,485									
Address Mapping/Reconciliation	$1,200	100%	$1,200									
Display Graphics	$3,060	100%	$3,060									
Haz/Mat/Toxins Information	$1,800					100%	$1,800					
Parcel-based Spatial Analysis	$3,600			100%	$3,600							
Public Information	$1,200	100%	$1,200									
Pin Map of Business Licenses	$600	100%	$600									
Pin Maps / Crime Mapping	$600					100%	$600					
Development Project Pin Map	$600	100%	$600									
Business License Review	$3,600					100%	$3,600					
Real Estate Availability	$1,200			100%	$1,200							
Business Information Research	$600			100%	$600							
Plume Management	$1,200					100%	$1,200					
Document Scanning / Map Referen	$1,200									100%	$1,200	
As-Builts Distribution (online/db)	$1,200									100%	$1,200	
Pin Maps/Permit Status & Inspecti	$600							100%	$600			
Development Project Review	$1,200							100%	$1,200			
Permit Review	$1,800									100%	$1,800	
Block Plans	$1,200							100%	$1,200			
Situational Awareness	$1,800									100%	$1,800	
Fire Pre-Plans	$2,400							100%	$2,400			

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The development sequence of GIS applications automatically determines the sequence for compiling the various types of data. As application development is rescheduled, data compilation will follow accordingly. This capability enables interactive exploration of development alternatives by the organization's stakeholders. As with other interactive engagements using the model, stakeholders build an interest and support for the project through their collective negotiation via the model manipulation.

Data maintenance costs are calculated by the model for every year as well. In each year, the cost of data to be compiled is subtotaled and a fixed percentage is added to cover quality control and correction costs. The assumed QC percentage is visible and subject to discussion and modification by stakeholders.

Creation and maintenance of a metadata catalog, as well as updating and maintaining the database are ongoing costs that are explicitly included in the model. As the GIS database grows throughout a sequence of years, its value is assumed to be the cumulative value of the cost of each year's contribution. Maintaining the metadata and updating the database are assumed to be a fixed percentage of the cumulative database value. These assumptions are explicit and open for discussion and modification by stakeholders.

Data Maintenance Cost

	Cost		2006		2007		2008		2009		2010
	Basis	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost
Permit Files or Permit Mgt Sys	$11,250							100%	$11,250		
Building Inspection Files	$9,000							100%	$9,000		
Fire Inspection Files	$5,400					100%	$5,400				
As-Built Drawings	$6,750									100%	$6,750
Scanned Document Files or Sys	$9,000							100%	$9,000		
Water Lines and Valves	$1,000							100%	$1,000		
Storm Drain	$3,600							100%	$3,600		
Sewer Lines	$3,600									100%	$3,600
Manholes	$1,200									100%	$1,200
Hydrants & Hydrant Flow	$1,500							100%	$1,500		
Garbage Cans	$720							100%	$720		
Data QC Checking	5%		$1,632		$1,695		$1,311		$1,871		$578
Data subtotal			**$34,272**		**$35,585**		**$27,531**		**$39,291**		**$12,128**
Data Update Maintenance											
cumulative value of database			$34,272		$69,857		$107,866		$163,337		**$199,965**
Maintain Metadata/Catalog	5%				$3,493		$5,393		$8,167		$9,998
Update, Maintain, Add New Data	10%				$6,986		$10,787		$16,334		$19,996
Data Update subtotal					**$10,478**		**$16,180**		**$24,501**		**$29,995**
Data Development & Maintenance subtotal			**$34,272**		**$46,063**		**$43,711**		**$63,792**		**$42,122**

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Startup costs are also scheduled over the timeframe of the project. While some startup tasks, such as workflow analysis and database design must be completed in the early years, other tasks may be conducted over several years, such as formulating workflow procedures when each new application becomes available. Training of the organization's staff is scheduled on an annual basis with the explicit assumption of how many people to train and the unit cost of training. Training is the critical investment that can assure maximum productivity from the investment in this GIS infrastructure.

Startup Costs over time

	Cost	2006		2007		2008		2009		2010	
	Basis	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost
Startup, Design, Installation											
Initial Database Design	$2,100	100%	$2,100								
Workflow Analysis	$2,970	35%	$1,040	35%	$1,040	35%	$1,040	35%	$1,040	35%	$1,040
GeoDatabase Design	$2,700			35%	$945	35%	$945	35%	$945	35%	$945
Workflow Procedure Formulation	$4,500	35%	$1,575	35%	$1,575	35%	$1,575	35%	$1,575	35%	$1,575
Enterprise-wide DB Repository	$1,500	100%	$1,500								
Enterprise-wide GIS-DB Repository	$1,800			100%	$1,800						
System Installation & Upgrades	$990	2	$1,980	2	$1,980	1	$990	1	$990	2	$1,980
Staff Training by consultant	$600	5	$3,000	5	$3,000	5	$3,000	5	$3,000	5	$3,000
Startup subtotal			**$11,195**		**$10,340**		**$7,550**		**$7,550**		**$8,540**

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The costs of acquiring computer hardware (workstations, plotters, mobile devices, servers, routers, etc.) and the costs of acquiring software are loosely linked according to the manner in which software is deployed. Hardware and software may be scheduled for initial acquisition and additional acquisition over a series of years. The model allows entry of the number of HW and SW items to be purchased and automatically calculates the cost based on unit costs. Each additional workstation assumes a staff person will be assigned to use it, and the model includes training costs and subsequently, a multiplier for the productivity benefits calculation. Each new workstation or mobile device enables one more staff person to become more productive through use of the GIS applications.

Sales tax and installation costs of the hardware and software are included as a fixed percentage of the annual purchase cost. The annual cost of supplies, as well as the annual depreciation cost are included as fixed percentages of the cumulative HW/SW investment.

Hardware/Software Costs over time

	Cost	2006		2007		2008		2009		2010	
	Basis	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost
Hardware/Software On-Line Subscription											
PC Workstation / Server	$7,000	2	$14,000	1	$7,000					1	$7,000
Large Display Screen	$1,200	2	$2,400							1	$1,200
Digitizing Board	$4,800	1	$4,800								
36" color inkjet plotter	$1,000	1	$1,000								
Software											
SQL Server Standard Edition	$6,000			1	$6,000						
SLQ Server client	$146			1	$146	1	$146	1	$146		
ArcGIS/Edit	$6,300	2	$12,600							1	$6,300
ArcSDE	$10,000			1	$10,000						
ArcAnalyst extensions	$2,500					1	$2,500	1	$2,500	1	$2,500
subtotal Purchase			$34,800		$23,146		$2,646		$2,646		$17,000
Cumulative Value			$34,800		$57,946		$60,592		$63,238		$80,238
Maintenance/depreciation	12%				$4,176		$6,954		$7,271		$7,589
Sales Tax & Installation on Purchase	10%		$3,480		$2,315		$265		$265		$1,700
Supplies, furniture	3%		$1,044		$1,738		$1,818		$1,897		$2,407
Software Vendor Training Class	$800	2	$1,600								

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Ongoing Operating Costs

Staff time is allocated and included in the cost analysis for general support tasks that are additional and complementary of the cost of using specific GIS applications. Such ongoing costs include GIS management and coordination, database administration, general enterprise system support, and ongoing staff education which includes travel expenses for conference attendance or training classes. The staff time that will be needed to actually operate the GIS applications in conducting each department's functional operations are also included in this cost analysis as "spatial analysis" and "display graphics." These tasks do not imply hiring additional staff members, but rather reassigning existing staff after they have been trained to use the more efficient GIS applications. Their greater efficiency enables fewer people to conduct current departmental tasks and to conduct additional tasks or to reduce the backlog of tasks.

As with the other cost elements, a unit cost for each type of operational expense is based on the explicit assumption of the number of hours or days required per year and the staff member's hourly or annual pay rate. Ongoing operating expenses (mainly staffing) is scheduled for deployment year by year, typically reflecting a "ramping up" as more applications are developed and more staff members are using the system to conduct their departmental duties. Ongoing education, including travel expenses for training, are built into the model and subject to discussion and modification. Typically, a few staff members will be given high-intensity education (often from the software vendor) and will be expected to teach other staff members what they have learned upon return. Staff time is explicitly allocated for training, including "each one teach one" training.

Ongoing Operations Cost over time

	Cost	2006		2007		2008		2009		2010	
	Basis	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost
Ongoing Support											
GIS Coordination / Management	$37,500	50%	$18,750	75%	$28,125	100%	$37,500	100%	$37,500	100%	$37,500
Database Administration	$5,100	50%	$2,550	75%	$3,825	100%	$5,100	100%	$5,100	100%	$5,100
System Support	$3,600	50%	$1,800	75%	$2,700	100%	$3,600	100%	$3,600	100%	$3,600
Display Graphics	$16,500	50%	$8,250	75%	$12,375	100%	$16,500	100%	$16,500	100%	$16,500
Parcel-based Spatial Analysis	$12,000	20%	$2,400	40%	$4,800	60%	$7,200	80%	$9,600	100%	$12,000
Ongoing Staff Education	$1,500	2	$3,000	3	$4,500	4	$6,000	4	$6,000	4	$6,000
Travel Expenses for training	$1,250	2	$2,500	2	$2,500	2	$2,500	3	$3,750	4	$5,000
Ongoing Support subtotal			**$39,250**		**$58,825**		**$78,400**		**$82,050**		**$85,700**

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The amount of detail and the explicit assumptions in this cost model help to build organizational and management support for the GIS implementation and ongoing operation in two ways. First, they show that all possible and related costs have been taken into consideration, building credibility for the cost-benefit results to be calculated. Second, each cost element and assumption is visible and changeable, thereby enabling its assignment through interactive, consensus-building negotiation and manipulation. The stakeholders' support is built through their participation in the ROI modeling.

Cost Summary

The annual cost estimates of each cost element (startup, data development, application development, HW/SW acquisition, and ongoing operation) are tallied into a single summary spreadsheet table. Personnel costs are disaggregated from the totals according to whether the cost is allocated to organizational staff or to non-staff consultant services and product (HW/SW) acquisition.

Project Costs: Summary over time

	Cost Basis		2006		2007		2008		2009		2010
		Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost
COST SUMMARY											
Data Development & Maintenance subtotal			$34,272		$46,063		$43,711		$63,792		$42,122
Startup subtotal			$11,195		$10,340		$7,550		$7,550		$8,540
Application Development subtotal			$12,945		$11,400		$26,400		$11,400		$21,600
HW/SW Online subtotal			$55,924		$33,775		$14,082		$14,479		$31,096
Ongoing Support subtotal			$39,250		$58,825		$78,400		$82,050		$85,700
TOTAL COST			**$153,586**		**$160,402**		**$170,142**		**$179,270**		**$189,057**
Staffing Cost	**%Staff**	**FTE**		**FTE**		**FTE**		**FTE**		**FTE**	
Data Development & Maintenance su	49%	0.2	$16,904	0.3	$22,719	0.3	$21,559	0.4	$31,464	0.3	$20,776
Startup subtotal	26%	0.0	$2,896	0.0	$2,675	0.0	$1,953	0.0	$1,953	0.0	$2,210
Application Development subtotal	2%	0.0	$225	0.0	$198	0.0	$459	0.0	$198	0.0	$375
HW/SW Online subtotal											
Ongoing Support subtotal	83%	0.4	$32,535	0.7	$48,761	0.9	$64,987	0.9	$68,013	0.9	$71,039
Staffing Total		**0.7**	**$52,560**	**1.0**	**$74,354**	**1.2**	**$88,959**	**1.4**	**$101,628**	**1.3**	**$94,399**
Non-Staff Cost											
Data Development & Maintenance subtotal			$17,368		$23,344		$22,152		$32,328		$21,346
Startup subtotal			$8,298		$7,664		$5,596		$5,596		$6,330
Application Development subtotal			$12,720		$11,202		$25,941		$11,202		$21,225
HW/SW Online subtotal			$55,924		$33,775		$14,082		$14,479		$31,096
Ongoing Support subtotal			$6,715		$10,064		$13,413		$14,037		$14,661
Non-Staff Total			**$101,025**		**$86,048**		**$81,183**		**$77,642**		**$94,658**

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Calculating the Benefits

This model estimates the dollar-value of benefits to your organization accrued from using its GIS applications to conduct its duties and functions. Each GIS application is assessed for its benefit through four criteria:

- Increased Efficiency - estimated (or calculated) reduction in staff time and resources needed to conduct current operations and functions. Time, and therefore staff costs, are saved doing tasks previously done without GIS applications. Less time is spent looking for information because it is stored and retrieved with geographic (locational) indices. Often organizations observe reduced redundancy as geographic data and analysis products are shared among departments and work groups. As a result of the workflow analysis upon which GIS implementation was based, operational duties are redesigned to be performed more efficiently and quickly.

- Cost Avoidance - mistakes and errors occur occasionally; but they can be very costly, for example, an ambulance going to the wrong address, or an emergency response crew failing to find a cut-off valve. GIS applications help reduce costly errors by connecting relevant information to locations through the geodatabase and by providing quick access to the relevant information.

- Better Decision Making - faster access to relevant information enables a more reliable and accurate basis for decisions. GIS applications combine and present a wide variety of information based on location as the organizing principle, which enables a more comprehensive basis for decisions. Customers and citizens who are the recipients of the organization's operational decisions may experience greater satisfaction with the result of their interaction and with the way their interaction was handled.

- Increased Revenues - increased efficiency and customer satisfaction may result in increased revenues and profits for a private company. Public agencies may experience increased tax revenue from increased economic development resulting from faster and better decision making. Many agencies have used GIS applications to make tax collection more effective thereby increasing revenue without increasing tax rates.

Traditionally, some of these benefits (efficiency, revenues) have been considered "quantitative" while others (cost avoidance, decision making) have been considered "qualitative." The qualitative benefits are sometimes dismissed because they can't be quantified. Nevertheless, all four types of benefits can be, and are being, quantitatively monitored by the staff who actually conduct the various organization's functions, and by their managers who budget their expenditures and evaluate their performance. Experienced managers generally know how much time and cost their staff should expend to conduct a task, and how much time and cost they actually do expend.

The benefit model uses staff and managers' experience to assess and estimate the dollar value of each GIS application (both the ones currently being used and the ones being planned). Initially, departmental managers or their staff will assess the value of each GIS application being used according to these four criteria. For example:

- A public noticing application may save staff a known amount of time ("it now takes us minutes what used to require days") which can be tallied (considering the number of times the task is conducted) for an annual cost saving due to greater efficiency.

- The reduction in mistakes accrues as cost saving over time (e.g., fewer bad address dispatches, or fewer repairs needed because the initial response was wrong). If, say, a million dollar lawsuit is avoided every ten years, the financial benefit accrues as $100,000 per year.

- Revenues from more effective tax collection can be measured (for example, correctly assigning the franchise tax revenue from cell phone towers to the appropriate jurisdiction, after geographic analysis). Increased economic activity generates additional revenue from property tax on increased property value, as well as increased business tax revenue and permit fees.

- Using geographic analysis to better deploy police resources may reduce crime, thereby increasing citizen satisfaction, increasing property values, and encouraging economic development. Using geographic analysis to more efficiently deliver products to customers increased customer satisfaction, brand loyalty, revenues and profits. Experienced people can successfully estimate a value for these kind of benefits that accrue from better decision making.

These individual assessments are combined in a common benefits basis table which is suitable for examination and discussion among the organization's stakeholders, and for

modification of the estimated value of the benefits. The discussion among stakeholders serves to refine these estimates and assessments of GIS benefit as well as to further engage stakeholders in the process of determining the appropriate level of support for GIS operations in the organization.

A specific application may have benefit components from several categories (efficiency, satisfaction, cost avoidance, revenue) which are totaled for each application. Each specific application's benefits comes under scrutiny by the stakeholders, thereby increasing credibility of the total benefit from all the applications.

The GIS application benefits are then entered into the application implementation schedule, with each application's benefits assume to begin accruing the year following the application's implementation.

Benefits Basis

App No.			Efficiency Factor	Efficiency (Staff Days)	Efficiency	Accuracy Decisions, Satisfaction	Costs Avoided	Increased Revenue	Benefit	Notes
		Application Development								
1.04	ED	Public Notification (noticing)	0.060	15	$4,500		$1,500		$6,000	Efficient Noticing, redundant public meetings avoided.
5.01	PW	Basemap Maintenance	0.000		$0	$1,500			$1,500	Map/data more available to other users
1.02	ED	Parcel Environmental Data	0.016	4	$1,200	$1,500			$2,700	
1.01	ED	Parcel Information	0.032	8	$2,400	$4,500			$6,900	More efficient than OSIRIS or manual research
2.10	FD	Soils Information	0.008	2	$600		$3,000		$3,600	
3.03	F/IS	Addressing Schema	0.000		$0				$0	Supports accurate addresses
4.02	P&B	Address Mapping/Reconciliation	0.040	10	$3,000	$6,000	$1,500		$10,500	Benefit of accurate addresses
4.13	P&B	Display Graphics	0.020	5	$1,500	$3,000			$4,500	Better decisions through graphic understanding
4.07	P&B	HazMat/Toxins Information	0.008	2	$600		$4,500		$5,100	Safer emergency response
4.01	P&B	Parcel-based Spatial Analysis	0.000		$0	$3,000	$1,500		$4,500	Manual analysis not possible, therefore no efficiency calculated
4.14	P&B	Public Information	0.016	4	$1,200	$3,000		$3,000	$7,200	Citizen satisfaction increases sales tax, property values
3.04	F/IS	Pin Map of Business Licenses	0.032	8	$2,400	$1,500	$1,500		$5,400	Updates HazMat files from Biz data
6.01	PD	Pin Maps / Crime Mapping	0.000		$0	$1,500			$1,500	Crime mapping already in PD, improves image of City
4.04	P&B	Development Project Pin Map	0.012	3	$600	$1,500			$2,400	Better project planning and development
3.05	F/IS	Business License Review	0.036	9	$2,700	$1,500		$3,000	$7,200	Faster review, increases business development
1.07	ED	Real Estate Availability	0.000		$0	$3,000		$4,500	$7,500	Real estate broker/developer satisfaction =
1.03	ED	Business Information Research	0.012	3	$600	$1,500		$3,000	$5,400	more business and sales tax revenues
2.09	FD	Plume Management	0.004	1	$300		$4,500		$4,800	Similar to HazMat application
3.06	F/IS	Document Scanning / Map Reference	0.060	15	$4,500				$4,500	

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Project Benefits over time

	Cost Basis	2006 Qty.	2006 Cost	2007 Qty.	2007 Cost	2008 Qty.	2008 Cost	2009 Qty.	2009 Cost	2010 Qty.	2010 Cost	TOTAL COST
GIS Application Benefits	Benefit											
Public Notification (noticing)	$6,000				$6,000		$6,000		$6,000		$6,000	
Basemap Maintenance	$1,500				$1,500		$1,500		$1,500		$1,500	
Parcel Environmental Data	$2,700						$2,700		$2,700		$2,700	
Parcel Information	$6,900						$6,900		$6,900		$6,900	
Soils Information	$3,600						$3,600		$3,600		$3,600	
Addressing Schema												
Address Mapping/Reconciliation	$10,500				$10,500		$10,500		$10,500		$10,500	
Display Graphics	$4,500				$4,500		$4,500		$4,500		$4,500	
HazMat/Toxins Information	$5,100								$5,100		$5,100	
Parcel-based Spatial Analysis	$4,500						$4,500		$4,500		$4,500	
Public Information	$7,200				$7,200		$7,200		$7,200		$7,200	
Pin Map of Business Licenses	$5,400				$5,400		$5,400		$5,400		$5,400	
Pin Maps / Crime Mapping	$1,500								$1,500		$1,500	
Development Project Pin Map	$2,400				$2,400		$2,400		$2,400		$2,400	
Business License Review	$7,200								$7,200		$7,200	
Real Estate Availability	$7,500						$7,500		$7,500		$7,500	
Business Information Research	$5,400						$5,400		$5,400		$5,400	
Plume Management	$4,800								$4,800		$4,800	
Document Scanning / Map Reference	$4,500											
As-Builts Distribution (online/db)	$3,000											
Pin Maps/Permit Status & Inspection	$4,500										$4,500	
Development Project Review	$6,300										$6,300	
Permit Review	$9,300											
Block Plans	$5,100										$5,100	
Situational Awareness	$3,600											

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Applications Cost over time

	Cost Basis	2006 Qty.	2006 Cost	2007 Qty.	2007 Cost	2008 Qty.	2008 Cost	2009 Qty.	2009 Cost	2010 Qty.	2010 Cost
Application Development											
Public Notification (noticing)	$600	100%	$600								
Basemap Maintenance	$3,000	100%	$3,000								
Parcel Environmental Data	$1,200			100%	$1,200						
Parcel Information	$3,000			100%	$3,000						
Soils Information	$600			100%	$600						
Addressing Schema	$1,485	100%	$1,485								
Address Mapping/Reconciliation	$1,200	100%	$1,200								
Display Graphics	$3,060	100%	$3,060								
HazMat/Toxins Information	$1,800					100%	$1,800				
Parcel-based Spatial Analysis	$3,600			100%	$3,600						
Public Information	$1,200	100%	$1,200								
Pin Map of Business Licenses	$600	100%	$600								
Pin Maps / Crime Mapping	$600					100%	$600				
Development Project Pin Map	$600	100%	$600								
Business License Review	$3,600					100%	$3,600				
Real Estate Availability	$1,200			100%	$1,200						
Business Information Research	$600			100%	$600						
Plume Management	$1,200					100%	$1,200				
Document Scanning / Map Reference	$1,200									100%	$1,200
As-Builts Distribution (online/db)	$1,200									100%	$1,200
Pin Maps/Permit Status & Inspection	$600							100%	$600		
Development Project Review	$1,200							100%	$1,200		
Permit Review	$1,800									100%	$1,800
Block Plans	$1,200							100%	$1,200		
Situational Awareness	$1,800									100%	$1,800
Fire Pre-Plans	$2,400							100%	$2,400		

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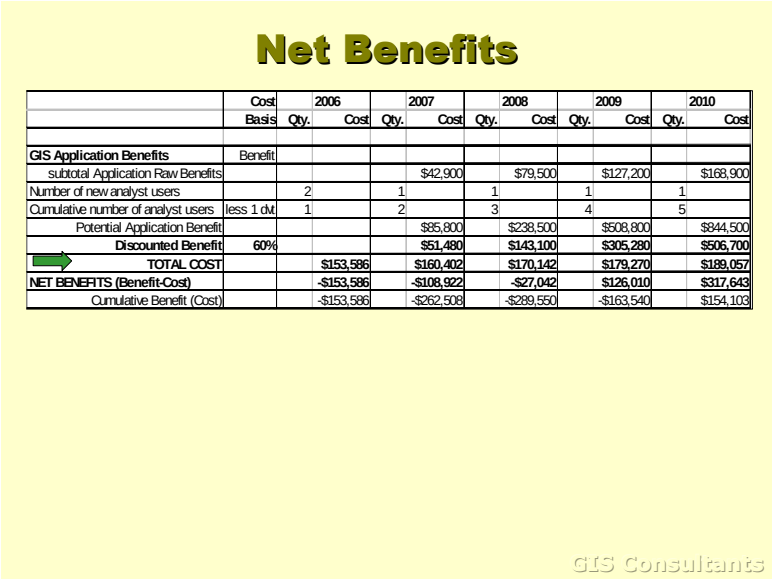
Calculating the Return On Investment

The annual costs of implementing the GIS applications and operating the ongoing GIS capability are subtracted from the annual tally of benefits (both assessed and estimated). The result (benefits minus cost) is the net benefit, calculated on an annual basis. These annual costs may be characterized as an annual investment from which the financial benefit of using the GIS applications derives. Initially, the costs are invested, but it takes a year or more until the benefits of the applications are realized, due to scheduling of application implementation, time required to change current operating procedures, time to train staff and to reach a level of efficiency and productivity equal to or greater than the current, non-GIS, methods of operation.



	Cost Basis		2006		2007		2008		2009		2010
		Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost
GIS Application Benefits	Benefit										
subtotal Application Raw Benefits					$42,900		$79,500		$127,200		$168,900
Number of new analyst users		2		1		1		1		1	
Cumulative number of analyst users	less 1 dvt.	1		2		3		4		5	
Potential Application Benefit					$85,800		$238,500		$508,800		$844,500
Discounted Benefit	**60%**				**$51,480**		**$143,100**		**$305,280**		**$506,700**
TOTAL COST			**$153,586**		**$160,402**		**$170,142**		**$179,270**		**$189,057**
NET BENEFITS (Benefit-Cost)			**-$153,586**		**-$108,922**		**-$27,042**		**$126,010**		**$317,643**
Cumulative Benefit (Cost)			-$153,586		-$262,508		-$289,550		-$163,540		$154,103

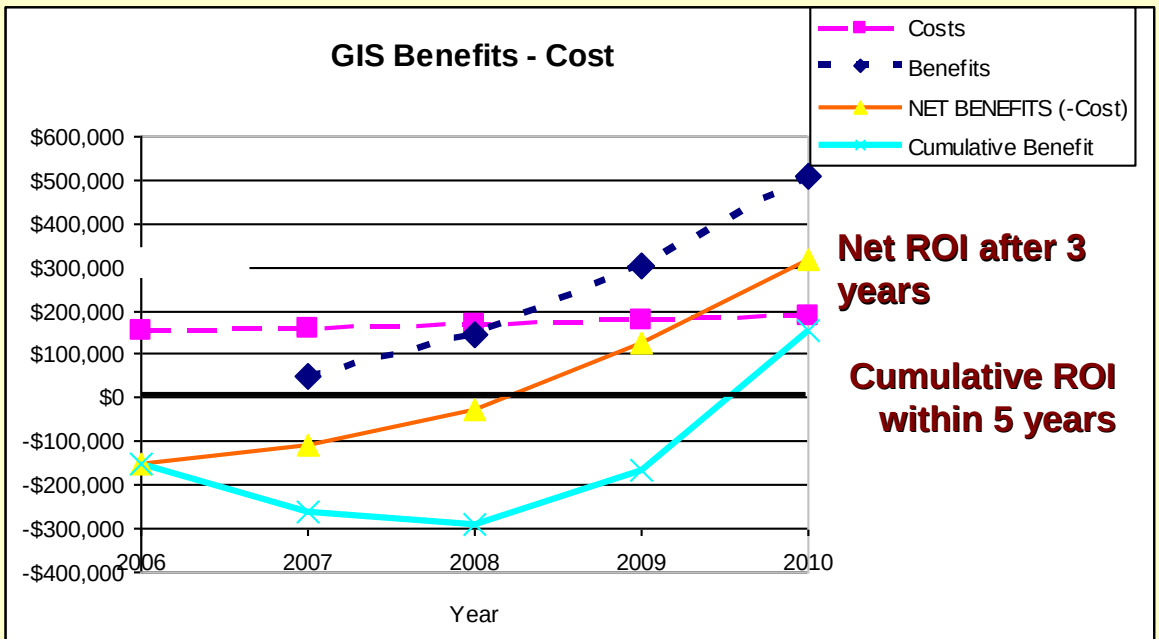
The potential benefit of GIS applications is increased proportionally by the number of people using them in the organization. As the number of staff members are trained to conduct GIS analysis for their duties and functions, the net benefit to the organization is increased. The net benefit calculation tracks the assumed number of staff using the GIS, and tabulates their cumulative effect. Training another staff member to use the GIS every year increases the total number of skilled users year by year. This acts as a multiplier to increase the total value of net benefit year by year.

In addition to calculating the annual net benefit, the cumulative benefit is tabulated by summing each year's net benefit. Over time, a productive system will accrue more benefits than costs which will reduce and then pay back all the initial expenditures.

Sometimes the assumptions for annual and cumulative benefit reach unbelievable proportion. Unknown factors may delay development or otherwise reduce the amount of expected benefit. Therefore a benefit discount factor is included in the model. A discount percent can be estimated collectively by the stakeholders to reduce the calculated benefit total and mitigate against exuberant expectations.

As the annual costs and benefits are tracked, the net benefits are seen to be negative for several years until the annual value of the benefits exceeds the annual cost. This is often expressed as a net return on investment time.

Cumulative Benefits



Tracking the cumulative costs and benefit indicates a timeframe in which all the initial investment will be repaid by the ongoing GIS operation's benefits. This is expressed as the cumulative return on investment time.