Statewide GIS Base Mapping Program Business Plan

Prepared by Office for Information Resources
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Executive Overview

A Geographic Information System (GIS) is composed of people, hardware, software, data, and processes that allow users to analyze and display spatially oriented information. While each of these components play a vital role in contributing to the success or failure of a GIS implementation, a strong argument can be made that the foundation upon which this system is built is data. This Business Plan proposes the development of a comprehensive spatial database that will dramatically move GIS within the State of Tennessee to the leading edge of the technology. The people, hardware, software and process components of the equation are already in place within all levels of government in the State. This Business Plan calls for providing these users, and those that will implement a GIS in the future, a digital base map upon which other specific data sets can be added and results of analysis be displayed.

Prior to the preparation of this document, many factors were examined in developing a sound business plan for the successful completion of the project. First, a detailed assessment of the specifications was conducted and a high level overview of the specifications is presented. Any changes to these specifications are incorporated into total cost. Next, an explanation of implementation strategy was developed. Subsequently, accurate and reliable cost information for production of these products has been obtained. Cost/benefit information is provided, and cost recovery options are discussed.

Within each topic discussed, recommendations are made that pertain to the specific topic. Ultimately, a recommended course for acquisition and implementation based upon reliable information is proposed.

In summary, the cost to produce the products described in this business plan is $54 million. A variety of cost recovery options are available to the State. Using the scenario presented in this Business Plan, between $26 million and $35 million could be recovered from a variety of sources available to the State. The net investment by the State will be $28 million to $19 million.

Background

Nearly all decisions State and local governments make are influenced by spatial components: what is an appropriate strategy for determining land use characteristics; where should emergency services be located; what is an appropriate tax to be levied against a property owner considering socioeconomic conditions in the surrounding community; what is an appropriate route for a new highway that will alleviate congestion and minimally impact the environment.

In fact, legislation passed during the 100th General Assembly called for the establishment of Growth Plans, Planned Growth Areas, Rural Areas, and Urban Growth Boundaries. The goals and objectives of the legislation are to provide uniform, compact and contiguous development of local communities; establish consistent public service; and to conserve, protect and promote the quality of life across the state of Tennessee. Geographic Information Systems (GIS), with its capacity to provide cost-effective and timely analysis of spatial problems, provides the ideal tool for addressing these issues; and, in order to make the most informed decisions, the best available data must be used.

Many departments and agencies within state government have developed and utilized GIS for their own needs. Each of these systems is independent and created with limited ability to share data from agency to agency. These agencies include:

Comptroller of the Treasury
Department of Agriculture
Department of Economic and Community Development
Department of Environment and Conservation
Department of Finance and Administration
Department of Health
Department of Transportation
Tennessee Advisory Commission on Intergovernmental Relations (TACIR)
Tennessee Emergency Management Agency
Tennessee General Assembly
Tennessee Wildlife Resources Agency

The full functionality and benefits of GIS will only be realized when users from each of these agencies can share their data seamlessly and without the burden of incompatible formats. In order to accomplish this, a common framework or digital base map must exist upon which these data sets can be created. This business plan calls for the creation of just such a framework by creating digital imagery and parcel data which will serve as a base map that is unprecedented in accuracy and detail.

The Comptroller of the Treasury currently maintains Parcel Maps for 81 of 95 counties within the State. Fourteen counties perform their own daily maintenance on their Parcel Maps. Parcel data for all 95 counties were manually mapped by the State in 1963. The result is a base map in a common coordinate system for the entire state, which eliminates the major barrier to statewide parcel mapping: a common base from which to start which has inherent continuity across the state. In addition, the Comptroller of the Treasury maintains property assessment attribute data for 90 of 95 counties, resulting in the characteristics or attribute data for each parcel within the state being centrally located and readily available in an identical format. The remaining five counties within the state not participating in the assessment system have already made significant investments in producing similar GIS data products. Each of these counties currently maintains their own attribute data.

In 1996, the Comptroller of the Treasury undertook a Pilot Program to develop technical specifications for a statewide parcel-mapping program. Maury and Lewis counties were chosen as the first phase geographic sites to develop the specifications. The major products produced as a result were digital orthophotographs, planimetric data, digital parcel data, and technical specifications for the development of these products.

With growing interest in the potential of digital statewide mapping of unequaled accuracy, review of this first phase of the Pilot Program resulted in a decision to test the specifications in a second phase against areas with significantly different geographic and socioeconomic conditions. It was determined that Hamilton, Montgomery and Sullivan Counties have ideal characteristics to validate the specifications developed in the first phase. These counties represent data conversion efforts currently underway. In early Spring of 1998, aerial photography for Fayette and Cumberland Counties were acquired in an effort to test a new technology that has the potential to save over $3.1 million over the course of the statewide program.

Specifications

The specifications can be broken down into four major areas: aerial photography, ortho imagery and planimetrics, parcel data, and dual delivery data formats.

Aerial Photography:

The components of the aerial photography specifications include the actual acquisition of aerial photography, ground control, aerial triangulation, and photo laboratory processes. These specifications currently call for use of widely accepted, tested and proven techniques. No changes to these specifications should be made. This component of the project specifications does, however, offer the greatest area for

savings from new technologies over the course of the project. Development is currently underway which will significantly reduce or possibly eliminate the aerial triangulation process by capturing this information at the same time that the photography is acquired. Additional improvements in the Global Positioning System (GPS) should reduce further the need for costly ground control surveys. Research efforts are underway to develop a digital airborne camera, reducing or eliminating the traditional photographic lab work and scanning processes, which must take place using current technologies. Although commercial satellite imagery programs may offer some savings for the smaller scale imagery, these ventures have had several setbacks and are not yet operational.

Ortho Imagery and Planimetrics:

This specification includes scanning of the aerial photographs, creation of the surface and planimetric data, rectification of the digital imagery, format/delivery of the final product, and production of hard copy mylar ortho. The current process and specifications for the scanning component are more than adequate. The processes and specifications associated with the collection of surface data are acceptable. Currently, the deliverable format of the imagery is in GeoTIF, and this is rapidly becoming the GIS industry standard. As such, no changes should be made to either of these components.

The planimetric features that are currently called for in the specifications are hydrography, ridgelines, transmission lines and towers, and street centerlines at all scales. The larger scale (1"=100') data files call for visible pavement edges to be captured as well. The hydrography and ridgelines must remain because these features are commonly used as property lines throughout the State. Transmission lines should be eliminated from the specifications since they are of little value to State and local government GIS users. As defined in the specifications, only the Tennessee Valley Authority (TVA) values them. Should TVA choose to align itself with the State on this project, it is recommended that it bear the expense of including transmission lines and towers. Careful consideration must be given to pavement edges and street centerlines. Both are significant surface features that will impact the ortho imagery rectification process and should remain features collected for defining the surface. Since the bulk of the tangible costs associated with collecting these features are included in the surface data collection, no significant savings would be realized in the production costs.

Upon completion of data conversion, intangible savings in maintenance and administration can be realized from eliminating street centerlines and pavement edges as deliverable planimetric features. As defined in the current specifications, both of these data layers provide no added value for any analysis applications based upon these products. In the case of pavement edges, there is no attribute information associated with the lines. The most common application of pavement edge data is in pavement management systems which allow highway and road departments to manage transportation infrastructure. In order to perform this type

of analysis, attribute data must be added to this data set and additional photo interpretation must be conducted. The same circumstances exist for the street centerline data layers. There are no attribute data associated with the centerline layer nor has this layer been digitized for network routing applications. Further, the minimum geographic area for a network application is a service area that most often is at least the size of a county jurisdiction. The result is that more effort would be required to administer and maintain these layers than would be required to include them as a deliverable product in the specifications. The intangible costs that can be realized by eliminating these two features are in management and administration of the statewide database: the fewer the layers, the lower the overhead for maintenance.

Significant cost savings can be realized by eliminating the hard copy mylar ortho image as a deliverable product. During the course of the first and second phase of the Pilot program, this product has been used exclusively in the quality control process. To date, no print reproductions have been made. With the required hardware and software for this program, paper plots will more than adequately replace mylar in the quality control process without any degradation of the quality of the parcel data. Comparable costs for producing the mylar version as called for in the specifications versus plotting a paper print are $50 each versus approximately $5 each.

Parcel Data

Several specific technical deficiencies have been identified as a result of continued testing, but these changes will not impact production costs or long-term maintenance. During the course of the second phase of the Pilot, a number of issues arose as a result of efforts to test the specifications against more urban environments. All of these issues stem from each of the three counties having performed their own parcel mapping for many years, resulting in slight modifications to manual procedures in each county. Since the specifications were developed based upon methodologies used in the Comptroller's Office, slight differences become major paradigm changes for the local governments. Educating appropriate staff in each county regarding the differences in methods and how these translate to the digital arena have overcome these issues. Since the intent is to create a uniform base map and parcel mapping system across the State, the current specifications will satisfy this goal.

The database design as called for in the specifications was developed primarily upon performing parcel mapping and maintenance at the county level. Although enabling GIS at the county level is one of the goals of this project, a detailed review of the database design as relative to statewide parcel mapping and maintenance should be conducted. It should be noted that this business plan covers only the production of the geographical data sets required by GIS. The attribute data describing each parcel is contained in the Comptroller's assessment database. To date, no formal analysis or investigation has been conducted to determine if the spatial database design is optimized for the assessment database and its design. At the

State level, it will be absolutely crucial that the resulting database be seamless in order to fulfill the goal of performing statewide spatial analysis. Although no major changes are expected, it is recommended that the State contract for an independent review of the database design in the specifications by experts in both the software environment being used by the State and in parcel mapping and maintenance.

The most important specification consideration relating to the parcel component is the lack of digital soil data. It has been made clear by each of the counties, as well as staff of the Comptroller's Office, that digital soils play a critical role in the property assessment process, especially in rural areas. Current specifications do not include any accommodations for digital soils mapping to proceed concurrently with the State's digital parcel mapping.

U.S. Department of Agriculture, Natural Resources and Conservation Service (NRCS) plans call for completion of quarter quad based digital soils mapping by 2002. The specifications for these products, while being adequate for federal level applications, can satisfy State and local government requirements if the NRCS makes modifications to its specifications. Specifically, it is in the State's interest that the NRCS use the State's digital ortho imagery for its production efforts. Significant pressure should be brought to bear on the NRCS for modifications at the request of Tennessee, to allow for soils mapping at a scale equivalent to the State's specifications.

Dual Delivery Data Formats

Currently, this component of the specifications call for the Digital Terrain Model (DTM) and vector products to be delivered in dual formats: Environmental Systems Research Institute, Inc Arc/Info (ESRI) and Intergraph Design File (DGN). This requirement was specified to support both software packages. Earlier in the software development cycle of these two packages, dual delivery formats were a necessity for organizations that had installations using both software packages. Current developments in both of these software packages have resulted in the ability of each software package to import the other's proprietary formats. In addition, there is a growing professional trend toward an open GIS environment in which there is a commonly used data format standard for all software manufacturers.

In August 1993, the Information System Council (ISC) adopted ESRI Arc/Info as the standard software for GIS within State government. The Comptroller's Office has adopted this as its standard for maintenance of parcel data, and they commissioned the development of a parcel maintenance application as part of the Maury and Lewis Counties Pilot programs.

Continued implementation of dual delivery formats will eventually result in parcel data sets of different formats that have not been concurrently maintained. Significant administrative overhead will have to be

expended to track concurrence, and duplication of the actual update process will occur. Eventually, this may lead to potential liability problems in the event outdated data is distributed as the current data set of record.

Therefore, it is recommended that dual delivery formats be dropped as a specification and that ESRI Arc/Info be the delivery format. Functionality to convert from one format to the other is a standard feature of the software and is provided on demand. This will likely have minimal impact on the State's acquisition cost but will have a major impact on continued maintenance and administration of the data sets. Because this decision represents a major commitment to the ESRI product line, continued monitoring of their software functionality and service to the State must take place.

Recommendations

In summary, the specifications should be modified as noted in the preceding discussion. The aerial photography and associated specifications should remain as developed. The ortho imagery and planimetric specifications should be modified to eliminate all vector products except for ridgelines and hydrographic features. The hard copy mylar ortho images should be eliminated from the specifications. The parcel specifications should remain intact. Soil data should be added to the specifications. The addition of soil data, if acted upon as indicated, should have no significant impact on the cost of acquisition of the data products.

Acquisition and Implementation Strategy

Project Management

It is recommended that all aspects of project management should be outsourced. Acquiring the necessary contractors, insuring product quality and production management would be the responsibility of the contractor. The State would work closely with the contractor on administrative issues such as scheduling and transport of source documents to and from the conversion vendor(s). Appropriate control mechanisms would need to be instituted by the State to assure that the contractor is delivering the product to specification. This represents the methodology that is being used in current production efforts.

Custodianship

In this approach, the parcel data set(s) would fall under the custodianship of the Office of the Comptroller of the Treasury while the Office for Information Resources will be responsible for all other data products and program oversight and administration.

As custodians of the parcel data layer, the Comptrollers Office would be responsible for insuring that the parcel data is maintained, either internally, or by each county's Property Assessor Office. Currently, the Comptrollers Office maintains parcel maps for 81 of the 95 counties in Tennessee. As a result of the first phase pilot study, Lewis and Maury counties have agreed to maintain their parcel data locally. The Comptroller's Office expects that an additional 35 to 45 counties will also maintain their own parcel data. This includes the 14 counties that the Comptroller's Office does not currently maintain and accounts for the possibility that one or more of these counties may choose not to continue local maintenance. Therefore, when the project is complete, the Comptroller's Office expects a reduction of 20 to 30 counties. As a result of this decreased workload, the Comptroller's Office expects, at some point in time, a reduction in its staff dedicated to parcel maintenance. This reduction in staff can be translated into some measure of cost savings to the State. The remaining staff will continue to maintain among 50 and 60 counties on an annual or bi-annual basis.

This does not eliminate responsibility for counties that choose to maintain their parcel maps digitally. Each county's Assessors Office will be required to furnish an annual copy of their digital parcel data to the Comptroller's Office. The Comptroller's staff will monitor the accuracy and completeness of these data sets to insure quality and standardization. If they determine the parcel data is not in compliance, these counties will jeopardize the continuation of their local maintenance. In these situations, the Comptroller's Office will attempt to resolve these problems, but if they continue the Comptroller's Office will be prepared to conduct county parcel maintenance and charge the county Assessor Office accordingly. In summary, the Comptroller's Office will be a proactive custodian to secure the state's investment and provide a quality product for distribution.

Distribution

It can be expected that two data distribution systems will be implemented. The Comptroller's Office will be required to implement a system that will handle distribution of digital parcel data to and from county Assessor Offices as well as field offices maintained by the Division of Property Assessments. The data contained in this system would be considered "live" and access to and distribution from would be restricted to authorized personnel. A second system will be required to handle distribution to State agency users and

potential consumers of the data sets. This system would be considered static and be periodically updated by transfers from the Comptroller's Office.

For both cases, the distribution system for the data sets could be done in a server environment for on-demand downloads of parcel data and on-order distribution by CD or other media for the ortho imagery and planimetric data to State and local government GIS users. Appropriate configuration control mechanisms would have to be implemented to track data updates and distribution, notification systems to users, and user services to assist with technical problems encountered either in the download or upload at the user's site.

Because of rapidly changing network, computational and storage technology environments and the quantity of data to be produced, significant additional investigation will be required do determine the most cost effective storage, retrieval, and configuration system for this project. Also impacting this issue is the outcome of participation in Vice President Gore's Digital Globe, discussed in detail in the Cost Recovery section.

Schedule

This plan calls for the completion of the statewide mapping program in a four-year period. Completion of the program is defined as acquisition of all data products. Maintenance, update and distribution will be on-going activities that will occur as long as the data set(s) exist. Considering that data conversion per the State's specifications typically takes between 9 and 16 months, the logistics of completing this effort for 81 counties and acquiring data for the remainder are critical. A detailed schedule will be developed depending upon the funding and cost recovery options selected.

Costs

Because the State's final cost to produce these data products will vary depending on the implementation strategy chosen, the financial data provided here are based upon a traditional approach which follows the framework used in the Pilot program: contracting for a project manager whose responsibilities include acquisition of all data products and necessary subcontractors, quality control and review, and final delivery of products to the State. Total costs to be recovered are presented as follows:

Table 1

Imagery and Planimetric Products:

	Number of Sheets	Aerial Photography	Ortho Imagery Planimetrics	Total
100 Scale	25,692	$5,747,010	$18,395,472	$24,142,482
400 Scale	11,810	$2,332,475	$8,367,516	$10,699,991
			Subtotal	$34,842,473

Parcel Data Products

	2,605,318	**Total Parcels at**	$5.50 Ea.	$14,329,249
			Subtotal	$49,171,722
			Project Management (@10% of Product Cost)	$4,917,172
			Grand Total	**$54,088,894**

Notes:
1. These figures represent production costs for the entire State. No adjustments have been made for completed counties, work in progress or any other existing data sets.
2. All recommendations for changes to the specifications discussed above have been accounted for in the figures above.
3. Typically, Parcel data are priced on a per parcel basis as opposed to sheet by sheet. All costs associated with conversion of the parcel data are included in the figures shown.

Adjustments to Costs

Because two counties were completed as part of the Pilot program and three counties are underway as part of the second phase of the Pilot program, adjustments can be made to reflect costs to complete the remainder of the State. These are presented as follows:

Table 2

Imagery and Planimetric Products:

	Number of Sheets	Aerial Photography	Ortho Imagery Planimetrics	Total
100 Scale	22,995	$5,159,340	$16,464,420	$21,623,760
400 Scale	11,184	$2,192,250	$7,864,473	$10,056,723
			Subtotal	$31,680,483

Parcel Data Products:

	2,316,622	**Total Parcels at**	$5.50 ea.	$12,741,421
			Subtotal	$44,421,904
			Project Management (@10% of Product Cost)	$4,442,190
			Grand Total	**$48,864,095**

Existing Data Sets

Additional adjustments to the cost figures shown above could be made as a result of incorporating data sets from local governments which have already made an investment in developing spatial data products for their own jurisdictions. The following graphics represent the existing data sets identified:

Figure 1 East Tennessee

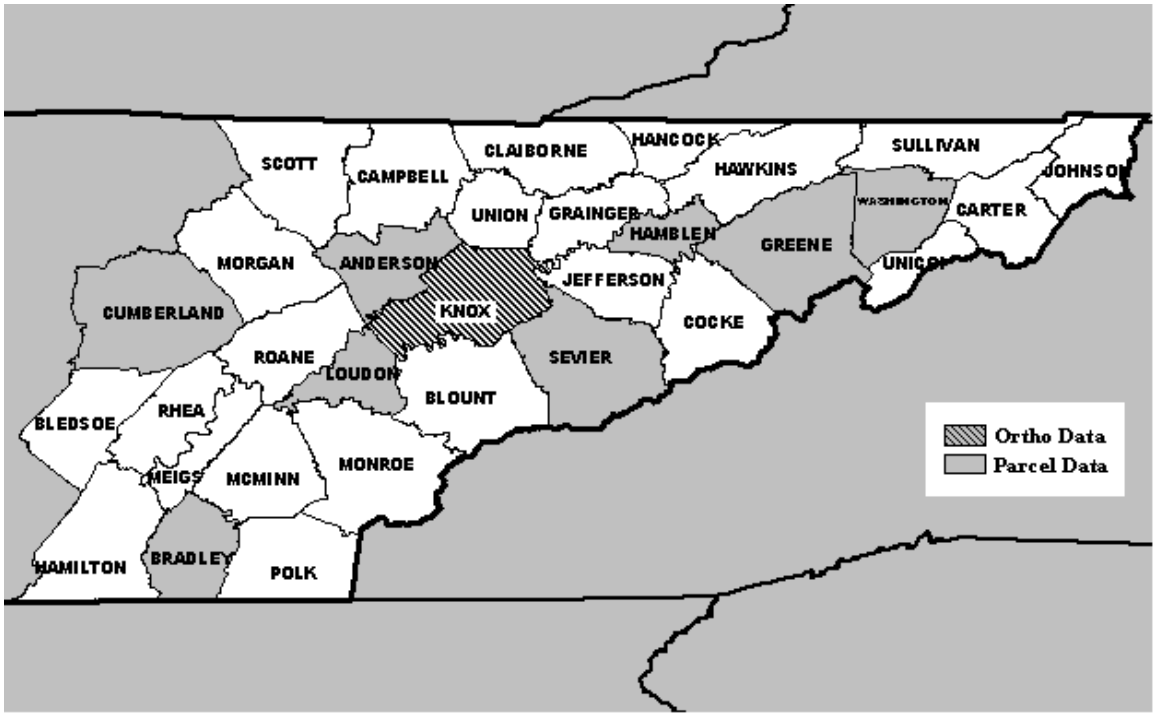


Figure 2 Middle Tennessee

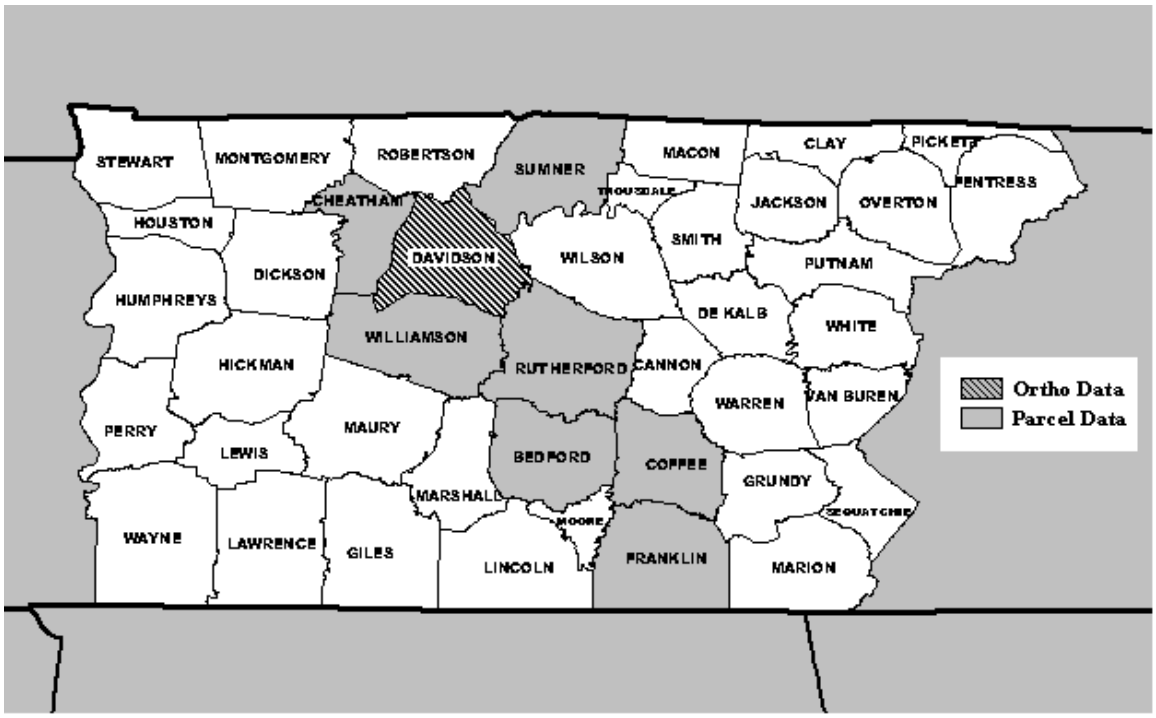


Figure 3 West Tennessee

Although not comprehensive, the following list is representative of these data sets and the products that have been determined to be a close match. Note that in several counties only selected cities have been completed:

Table 3

County	Status
Anderson	Clinton parcel data complete.
Bedford	Shelbyville parcel data complete.
Bradley	Parcel data complete.
Cheatham	Kingston Springs and Pegram parcel data complete.
Coffee	Tullahoma parcel data in progress.
Cumberland	Parcel data complete.
Davidson	Parcel data complete. Orthos in Progress.
Franklin	Parcel data complete.
Greene	Greenville and Tusculum parcel data complete.
Hamblen	Parcel data in progress.
Knox	Parcel data complete. Orthos complete.
Loudon	Parcel data in progress.
Madison	Ortho data complete.
Rutherford	Murfreesboro parcel data complete (partial)
Sevier	Gatlinburg, Sevierville and Pigeon Forge parcel data complete.
Sumner	Parcel data in progress.
Shelby	Parcel data in progress.
Washington	Parcel data complete.
Williamson	Parcel data complete.

In all of the above cases, varying levels of effort will be required to incorporate these data sets into the statewide mapping program. The parcel data shown above needs to be brought into compliance with current specifications. In several cases, the parcel data has not been consistently maintained and will have to be brought up to date. The ortho imagery that exists for Knox, Davidson and Madison counties holds the greatest promise for some cost savings; however, even these will have some costs associated with acquisition: reformatting, indexing and cost of acquisition.

An estimate of the savings to the State for incorporating the countywide parcel data sets shown above is $2,873,880. This figure does not, however, include costs for acquiring the data from the counties and municipalities. In several cases, a data swap of ortho images for parcel data would likely result in the State achieving this estimate of cost savings. In other cases, there may likely be little or no interest in orthos and pending legislation, the State would necessarily purchase these data sets.

For the existing ortho imagery data sets in Davidson, Knox and Madison Counties, acquiring these products, reformatting them and incorporating them into the statewide mapping program could save approximately $1,948,477. This estimate infers that acquisition and reformatting would be no more than 50% of cost to produce these products. Only in Madison County could some type of data exchange be arranged for potential additional savings because both Knox and Davidson counties already have digital parcel data.

In summary, incorporating these data sets into the statewide mapping program could save up to $5 million. Because this is an estimate only and the issues discussed above must be evaluated in detail on a case-by-case basis, it is recommended that no additional adjustments to the costs shown in Table 1 and Table 2 be made at this time.

Benefit Cost

Typically, data conversion and production efforts as discussed herein are performed at a county or city level. At that level, performing a cost/benefit analysis is fairly straightforward. However, expanding such an effort to include 95 counties and the enterprise of State government, the task of performing a meaningful cost/benefit analysis is unfeasible. It is complicated by the fact that what is being proposed by the State has simply not been done before. Provided below is the best available information regarding the factors that should be examined in a cost/benefit analysis and a conservative estimate of the benefit to State government that can be expected from this effort.

A cost/benefit analysis of starting, expanding, or continuing a GIS system is a critical component of any strategic plan. A variety of industry approaches have been used in the past for determining the cost benefit ratio of a GIS. Determining the cost for creating the data products that compose this project are straightforward. Several additional cost factors must be considered in determining what the potential benefits will be. Other cost that must be included are: administrative costs associated with contracting, managing the program, and additional overhead; the cost of additional staff and equipment; the cost of a storage and distribution system.

Quantifying the benefits resulting from an effort of this magnitude is even more difficult. Even the categories of benefits to calculate are varied: primary, secondary; tangible, intangible; tactical, strategic. In several industry cost/benefit studies reviewed, benefits from implementing a GIS were divided into four categories: direct, agency, government, and external. Direct benefits are those which are accrued as a result of using GIS as a method of storing and producing information and documents. Agency benefits are a reflection of increased productivity, improved quality and more timely responses to requests for information. Governmental benefits are those which result in benefits to more than one agency or agency-to-agency benefits. Included are reductions or elimination of duplication of efforts between agencies. External benefits are those which accrue to outside entities such as the environment or the public at large. These are very nearly impossible to quantify because it becomes difficult to determine what value the recipients place on the benefits, and in some cases, some benefits are intangible for which no measures exist. In the latter case, determining what value can be placed on better information that prevents destruction of a nonrenewable resource is a debatable exercise.

Research of industry cost/benefit studies conducted for several county and municipality GIS implementation programs indicates that a valid benefit/cost ratio for an effort such as the statewide mapping program range from 3:1 to as much as 20:1. Based upon a 10-12 year life cycle of the data sets being produced at present, the State can expect a benefit/cost ratio conservatively estimated at 2:1.

Cost Recovery Options

Several options for cost recovery of the initial investment in these data products exist. The most promising are local government cost sharing, federal government cost sharing, private sector cost sharing and data sales.

Local Government

The previous draft Business Plan anticipated uniform 25% participation from local governments across the State. This level of local participation, while certainly ideal, now appears unrealistic. There are many counties that struggle to meet basic services for their citizens and will never be able to afford any level of participation in creating this data. A more realistic estimate of local participation is that the State can expect up to 25% local participation from the 35-40% most progressive counties in the State. Defining "progressive" can be somewhat problematic. Based upon population growth, parcel growth and economic factors such as sales tax revenues as indicators of progressive counties, it is estimated that $6,507,589 could be generated from local participation. This represents 12% of the State's total cost from participation by local government.

Discussed below in the Data Sales section, a scenario is proposed which replaces the uniform 25% model whereby a greater portion of the State's costs per county could be recovered by approaching each county and municipal government as consumers of the data sets in a sales environment. The same concept can be applied to local government participation, but county and municipal governments would be considered partners.

Federal Government

A significant portion of the State's investment can be recovered from federal participation. It is estimated that between $10-15 million in cost could be obtained for the statewide mapping program. However, several major obstacles must be overcome. Currently there are over three dozen grant, cost-share, or in-kind funding programs, all administered by different federal agencies and organizations. Most of these administrative bodies have their own specification requirements as well as administrative requirements.

Among these programs, the U.S. Geologic Service (USGS) has the closest match to our specifications and the fewest administrative requirements. From this program, $1,673,100 could be recovered for the ortho imagery component. In addition, the USGS has cost share programs for the digital elevation data being produced by this product. An additional $836,550 could be recovered from this program.

There are several other programs from which funds could be obtained such as the Federal Emergency Management Agency, Environmental Protection Agency, Department of the Interior, Department of Commerce, and Department of Health and Human Services. The net amounts received from each of these will prove to be inconsequential when the administrative costs associated with each are added. Also diminishing the returns from these programs are increases in State costs that are a result of reformatting State data products to meet the specifications of these programs.

Based upon several factors at work on a national level, it is highly probable that the State could establish a unique program for federal participation. A single channel of funds from the federal government would characterize this program. In exchange for eliminating the administrative overhead of multiple programs, the State could produce products that meet federal specifications. The output products would remain in the public domain. This approach would require considerable effort, as there currently does not exist a program of this nature. It has been estimated that $15 million could be recovered from this unique approach.

Just such an opportunity exists with Vice President Gore's concept of a Digital Globe. In January 1998, Vice President Gore shared his vision of a multi-resolution, three-dimensional representation of the Earth for allowing unparalleled discovery and learning about our planet. He has termed this effort the "Digital Globe". Key technologies that have been identified as needed to make this vision a reality are computational science, mass storage, accurate and detailed spatial data, broadband networks, and interoperability. In Tennessee, we have various organizations that are currently involved in either research or development of each of these components: the State is proposing to produce accurate and reliable digital data and is continuing its investment in broadband networking with TNII; Oak Ridge National Laboratory houses one of the two fastest computational facilities in the world and have been actively involved in mass storage research, high speed networks, and computational research; and, the University of Tennessee has been designated as a point of presence for the development of the next generation Internet – Internet II.

We have proposed that the State of Tennessee serve as a prototype for the Digital Earth by partnering with the Federal government to bring each of these institutions together to a central facility and take the first steps towards making the Digital Earth a reality.

Private Partnership

Several opportunities exist for significant private sector partners. Among the potential partners is TVA (Power Generation). The Southern Company and Florida Light and Power are two of the TVA's future competitors which are actively producing data products exactly like those called for in these specifications. Very recently, Bell South has shown interest in data products similar to those the State is producing. Bell Atlantic has even commissioned the creation of digital orthos for their service area. On a smaller scale, Tennessee One Call has shown significant interest in these types of data products.

Each of these opportunities is being investigated. To date, although a great deal of interest has been shown, no significant offers have materialized. Each of these should continue to be pursued since a partnership will look considerably more attractive once the State commits to completing this project.

Data Sales

Among the most intense issues currently facing State and local governments is the ability to recover the development costs of producing data products such as those called for in this project. Should the State choose to pursue cost recovery through data sales, appropriate legislation will need to be enacted in order to do so. Because complete analysis and investigation on data sales is being conducted separately as indicated in the OIR Strategic Plan, the discussion presented here will concentrate on other important issues that must be considered in attempting to sell and market these data products.

The first consideration must be an examination of the current market potential of the data products. Digital ortho imagery represents the data with the greatest market potential as evidenced by the amount and variety of data resellers that are currently in the business of repackaging and selling data. Although the need for accurate digital ortho imagery is apparent in governmental activities, it is a data product that has only become available in the past 10 years. As discussed above, it is a product that can result in governments being more efficient and providing better services. It also has a broader appeal when examined from a GIS discipline perspective.

The parcel data, on the other hand, has been a basic part of government activities since property ownership began. A majority of government revenues are generated from property taxes, a process that requires using parcel data. However, if viewed from the perspective of analytical capability, the parcel data has far greater value than the digital ortho imagery data. Based upon recent legislative activities in Tennessee, there is an apparent high demand for this data from the private sector. Despite this demand though, there is very little evidence that suggests an appropriate pricing strategy or complete market potential for the parcel data. And, as indicated in recent legislative action, research and investigation in this topic is ongoing.

This discussion of cost recovery and market potential will focus on the digital ortho imagery and associated data sets. In all cases in the following discussion, the costing, recovery, and percentages shown refer to recovery of the ortho imagery only. Research to date indicates that the parcel data has a significant market potential, and some costs may be recovered from the sale of this data. However, insufficient information precludes estimating the amount that could be recovered.

For purposes of this Business Plan, a data sale refers to selling a license to use the data products within an organization. In order to protect the State's investment, redistribution of the data products by a purchaser must be prohibited and reproduction of the data products in digital form must be for internal use only. Various levels of organizational hierarchy must be considered for licensing company-wide, department-wide, individual versus multiple users, government-wide, or agency-wide. In order to simplify the licensing process, it is recommended that the State develop a license that allows for agency or department wide usage of the data products with a price structure that is based upon the number of images within the organization's geographic service area. Pending demand for such, single-user license should be considered.

Market Analysis

By far, the largest single market component for the sale of these data products is the various agencies within county and city governments. The most obvious departments at the county level are the assessor of property followed very closely by local planning and development agencies. Also, there exists a high potential for using this data by the various engineering-related departments: roads, water and sewer, facilities, and in those municipalities where they exist, engineering departments. The second major market share for these data sets is the various utility districts and boards. The use of digital ortho imagery and, particularly, parcel data sets, is already a widely used and common practice in this market segment. Related to the local utility boards but covering a wider ranging geographic region are telecommunication service providers such as BellSouth and cable television vendors. Other users of this type of data are the parcel delivery businesses, i.e.: United Parcel Service, Federal Express, Roadway Parcel Service. Real estate agents and multiple listing services are other potential users of these data sets.

Careful consideration should be given to defining the market segment that the State targets for cost recovery. Should the State seek local government participation, a significant share of the data resale market will be eliminated. Because the State has such an unprecedented and historical level of involvement with county and municipal governments, attention must be given to this option. A creative option to consider would be developing a pricing structure for local government agencies that would represent no more than 20% of the production costs if they acquired these products themselves. This still allows each

county government and city government to acquire the data products at significant savings while still maintaining the desired level of local participation.

As an example using the cost figures for efforts currently underway, the following represents the potential cost recovery in this approach. The 100 scale ortho imagery costs $940 each while the 400 scale ortho imagery costs $906 each. The table below shows each of these municipalities, number of 100 scale and 400 scale sheets, and a licensing fee equal to 20% of the State's development costs. Also included here are the numbers for a county government license at the same rate.

Table 4

Unit Cost:

	100' Scale	400' Scale
Current Cost per Sheet	$ 940	$ 906
20%	$ 188	$ 181

	Number of 100 Scale Sheets	Number of 400 Scale Sheets	100' Scale Fee	400' Scale Fee	Total Fee	
Hamilton County	1243	178	$233,684	$ 32,218	$ 265,902	
Chattanooga	559	51	$105,092	$ 9,231	$ 114,323	
Collegdale	47	9	$ 8,836	$ 1,629	$ 10,465	
East Ridge	52	6	$ 9,776	$ 1,086	$ 10,862	
Red Bank	47	7	$ 8,836	$ 1,267	$ 10,103	
Signal Mountain	33	7	$ 6,204	$ 1,267	$ 7,471	
Soddy-Daisy	94	14	$ 17,672	$ 2,534	$ 20,206	
	Recovery		$390,100	$ 49,232	$ 439,332	
				Current Cost	$1,300,960	**34%**
Montgomery County	503	161	$ 94,564	$ 29,141	$ 123,705	
Clarksville	314	41	$ 59,032	$ 7,421	$ 66,453	
	Recovery		$153,596	$ 36,562	$ 190,158	
				Current Cost	$ 564,410	**34%**
Sullivan County	786	142	$147,768	$ 25,702	$ 173,470	
Bristol	118	20	$ 22,184	$ 3,620	$ 25,804	
Kingsport	224	35	$ 42,112	$ 6,335	$ 48,447	
	Recovery		$212,064	$ 35,657	$ 247,721	
				Current Cost	$ 782,755	**32%**

Performing this same exercise for a representative sample of counties and municipalities across the State, an average cost recovery of 32% per county in Metropolitan Areas can be expected from this approach.

It is reasonable to expect that, between the various other entities such as Bell South, local utility companies, etc., cumulatively the State could sell a minimum of two additional countywide data sets. With additional

sales of only two countywide data sets at these same rates (20%), the following can be included in cost recovery:

Table 5

Unit Cost:

	100' Scale	400' Scale
Current Cost per Sheet	$ 940	$ 906
20%	$ 188	$ 181

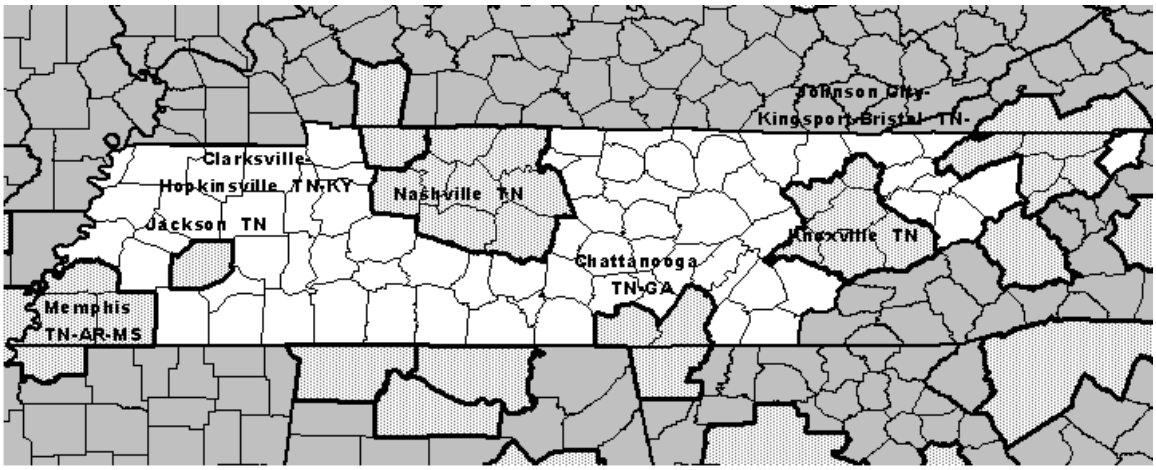
	Number of 100 Scale Sheets	Number of 400 Scale Sheets	100' Scale Fee	400' Scale Fee		
Hamilton County	1243	178	$233,684	$ 32,218	$ 265,902	
Montgomery County	503	161	$ 94,564	$ 29,141	$ 123,705	
Sullivan County	786	142	$147,768	$ 25,702	$ 173,470	
			$476,016	$ 87,061	$ 563,077	
					x2	
	Recovery				$1,126,154	
				Current Cost	$2,648,125	**43%**

These recovery figures do not include market potential for out-of-state sales. Several organizations that perform GIS activities on a national basis have been identified which may have an interest in acquiring the ortho imagery and the digital elevation data sets. Additional investigation is required to determine what level of recovery can be expected from these businesses.

Market Area

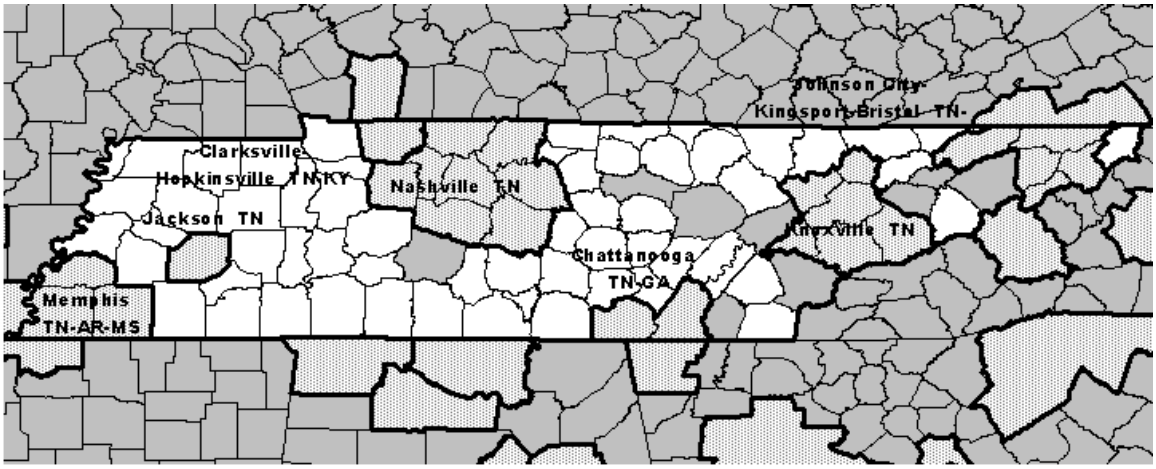
The preceding Market Analysis discussion provided details and an example of the market potential for the data products developed from the statewide mapping program. For the same reasons that uniform local participation at 25% was unreasonable, it is unreasonable to expect uniform sales geographically across the State. It can be expected that the data products will have the greatest value and market potential is highest within the metropolitan areas of the State. U.S. Census Bureau Metropolitan Areas (MA) are a widely accepted indicator of metropolitan and urban areas. The most recent geographic definitions of MA occurred in 1996 by the U.S. Office of Management and Budget. In Tennessee, there are seven metropolitan areas, as shown in Figure 4.

Figure 4 Metropolitan Areas



There are a total of 26 counties currently in MAs. Since another census of the population will take place during the four-year production phase of this program, it is reasonable to expect that these MAs will likely be modified to include additional counties.

Figure 5 Projected Growth of Metropolitan Areas



In summary, 38% of the State's cost for developing the digital ortho imagery can be expected from the licensing of the ortho imagery and associated data sets. As discussed in the Data Sales section, additional cost recovery can be expected from the parcel data sets, but accurate and reliable estimates are not available.

Strategy

If legislative obstacles are cleared in order for the State to recover development costs, consideration must be given to the tasks associated with this model of cost recovery. Standard licensing agreements will have

to be drafted; distribution and media production facilities will have to be established; administrative, accounting and tracking systems will have to be implemented; marketing and promotional materials will have to be produced; and, a marketing organization will have to be established.

Because the concept of the State proactively marketing and licensing data is a significant departure from traditional government activities, it is recommended that data resale and licensing, as defined herein, be outsourced to a private sector firm specializing in this activity. An alternate strategy would be to include the marketing and resale responsibilities with the acquisition of a program manager. During the initial acquisition stage, the program manager must have distribution and media production facilities in place as part of their program management duties.

This option may be met with some level of controversy. However, the personnel and business skills needed to be competitive and successful in the data resale arena simply do not exist within State government. A very strong argument can also be made that State government should focus its efforts on providing the highest possible quality services to the citizens as opposed to attempting to openly compete in the private sector.

Summary of Cost Recovery

In the above discussion of Market Analysis, it was proposed that local governments be approached as potential purchasers of the data sets. Using 20% per unit cost factor, nearly 32% of the State's per county costs can be recovered from local government in the Metropolitan Areas of the State. This same rate of return can be applied to local government participation using the same conceptual model but modifying the approach to treat county and local governments as partners. Using this approach, a conservative estimate of 8% of costs can be used for recovery from data sales.

Based upon the factors presented here, the State can conservatively expect cost recovery through licensing and sales to be in excess of over $3 million while applying this model to location participation will yield $7.8 million. Anticipating that the State will succeed in obtaining the federal government cost sharing expectations as discussed, these funds are included in cost recovery. However, it should be noted that these dollars would likely not begin accruing until the second or third year of the statewide program. Table 6 as follows provides a conservative summary of expected cost recovery.

Table 6

Imagery and Planimetric Products:

	Number of Sheets	Aerial Photography	Ortho Imagery Planimetrics	Total
100 Scale	25,692	$ 5,747,010	$ 18,395,472	$24,142,482
400 Scale	11,810	$ 2,332,475	$ 8,367,516	$10,699,991
			Subtotal	$34,842,473

Parcel Data Products:

2,605,318	**Total Parcels at**	$5.50 ea.	$14,329,249
		Subtotal	$49,171,722

Project Management (@10% of Product Cost)		$4,917,172
Total Investment		**$54,088,894**
Local Participation(15%)	$	(7,855,640)
Data Sales (8%)	$	(3,927,820)
		$42,305,434
Participation from Federal Government		($15,000,000)
Net State Investment		**$27,305,434**

Notes:
1. All of the cost recovery figures shown are for the Ortho and Planimetric products only.
2. The figures shown for Local Participation reflect a 32% return and is limited to the areas shown as projected growth of MA's (Figure 5).

Additional cost recovery can be expected from local participation in counties and municipalities outside of the MA's. There are few reliable models to base these estimates on, therefore no estimate for this revenue is included above. There exists significant potential for cost recovery from the parcel data set(s) produced from this project but there is no reliable cost recovery information available.

Should investigation of existing data sets be favorable and determined to be a very close match with the State specifications, additional cost recovery can be expected. There are several counties and municipalities outside of the Metropolitan Areas that have shown a significant interest in participating with the State on this program. The State can also expect some savings due to technological advances, especially the developmental efforts that are currently underway by the Office for Information resources. Factoring each of these into the total cost and cost recovery yields the following results:

Table 7

Imagery and Planimetric Products:

	Number of Sheets	Aerial Photography	Ortho Imagery Planimetrics	Total
100 Scale	25,692	$ 5,757,780	$ 18,422,680	$24,180,460
400 Scale	11,810	$ 2,350,843	$ 8,433,408	$10,784,250
			Subtotal	$34,964,710
			Technology Advances:	$ (3,139,290)
Parcel Data Products:				
	2,605,318	**Total Parcels at**	$5.50 ea.	$14,329,249
			Subtotal	$46,154,669
			Existing Data Sets:	($4,822,357)
			Project Management (@10% of Product Cost)	$4,615,467
			Total Investment	**$45,947,779**
			Local Participation (15%)	$ (7,855,640)
			Data Sales (8%)	$ (3,927,820)
				$34,164,319
			Local Participation - Non-MA:	($764,329)
			Participation from Federal Government	($15,000,000)
			Net State Investment	**$18,399,989**

Based upon the information discussed, between $26 million and $35 million can be either recovered or reduced through inclusion of existing data sets, technology advances, sales, federal and local participation. The net investment by the State will be $28 million to $19 million.

Recommendations

The following recommendations are presented in priority order:

1. Commit to establishing and completing the program from the highest level of State government. Identification of appropriate funding source(s) should be included. This commitment will allow the State to aggressively pursue private sector partners for the remainder of the program and it will allow the State to continue seeking Federal participation.
2. Establish the organizational structure within the Office for Information Resources to provide oversight for the execution of the program and development of the data products.
3. Through the appropriate procurement process, immediately acquire the consulting services of ESRI for review and analysis of the specifications with particular emphasis on the parcel layer(s). This effort must be completed by January, 1999 in order to implement any changes and recommendations to existing data sets previously produced as well as to implement changes for Spring, 1999 aerial photography acquisition.
4. Passage of legislation that will enable the State to recover developmental and maintenance costs associated with producing and maintaining these data sets by data sales must be aggressively pursued.
5. Continue investigation into an appropriate costing strategy for the parcel data sets produced by this project. This should provide additional cost recovery for the State's investment.
6. Based upon legislative precedent, seek passage of a local option real-estate transfer fee that will provide a source of funding for any county or municipal government to participate in the state-wide mapping program as identified in this plan.
7. Through appropriate procurement processes, seek a multi-purpose program manager whose responsibilities will include project management, data acquisition (including any necessary subcontractors), quality control and assurance, data resale and licensing, and consulting services with emphasis on internet based GIS and Mapping applications and implementation.
8. Continue investigation into the most appropriate and cost-effective technologies for storing and distributing the data products produced from this program.

Alternative(s)

There are several alternative strategies that warrant mention:

Data Purchase

This option is conceptually very similar to the topic of data resale described above, with one major distinction. There may be opportunities that would allow for the development costs to be reduced to 50% or less of the costs shown. These savings would be obtained by giving up ownership rights to the ortho imagery component and securing a license to use the data within State government. This option has several very appealing aspects: maintenance of the data would be the responsibility of the owner of the data, as would the cost associated with marketing the data. Obviously this is a significant departure from traditional practices, but in the professional discipline, there are indications that the time may be right for testing this concept.

Production Credit

This is a hybrid concept that combines several of the concepts discussed so far. It is characterized by production credits or royalties to be paid to the State and any other investors for each data sale. For example, if the State secured 25% funding from local sources and funded the remaining costs, then a proportionate return could be made to the "investors" each time a data product is sold. This return could be in the form of cash rebates or production credits if the project manager were also marketing and reselling the data.

Definitions

aerial triangulation – The process of developing a network of horizontal and vertical position from a group of known positions using measurements taken from aerial photographs and mathematical computations.

attribute data – Characteristic or descriptive information about a geographic feature (points, lines, or areas) stored in either tabular format or relational format.

base map – A map containing geographic features, used typically for locational reference and for overlaying specific, discipline data.

coordinate system – A system to measure horizontal and vertical distances so that a geographic feature true position can be established in relation to an accepted public reference system such as State Plane or Universal Transverse Mercator (UTM) coordinate systems.

data formats – The specific patterns into which data are systematically arranged for use by a computer or specific software. There are both proprietary data formats and public-domain data formats.

Geographic Information System (GIS) – An organized collection of hardware, software, data, and personnel designed to input, analyze and display geographically referenced information.

GeoTIFF – A binary digital image format commonly used by GIS software that is characterized by reference information imbedded in the file header as opposed to an external file.

Global Positioning System (GPS) – A satellite-based system for recording positional information and other data about a geographic feature. Ground positions are calculated by using signals from satellites orbiting the Earth.

ground control – Physical points on the ground whose positions are known with respect to some horizontal coordinate system and/or vertical datum. When identifiable on both the ground and an aerial photograph, ground control can be used to establish the true position of the aerial photograph.

hydrography – Geographic features that represent streams, lakes, reservoirs, rivers, and other drainage features.

imagery – A graphical representation of an object produced by an optical or electronic device (photograph).

Metropolitan Area (MA) – As defined by standards set by the U.S. Office of Management and Budget (OMB), metropolitan areas must have at least one city of 50,000 or have a Census Bureau defined urbanized area and a total metropolitan population of at least 100,000.

network routing – An interconnected set of lines representing possible paths for the movement of resources, people, or traffic from one location to another. Routing involves determination of an optimum path across the network from one location to another.

Orthophotograph – Aerial photographs that have been processed to correct for scale variations and image displacement resulting from relief or terrain variations and camera tilt.

parcel data – Data representing the geographic limits of property ownership as defined by some legal instrument. It is normally a multi purpose public record designed to show real property ownership within a jurisdiction, the basis for property valuation, and other data used by government officials.

pavement edges – The line demarcating the end of an impervious ground cover and the beginning of unconsolidated materials along a traveled path.

photo laboratory process – The chemical process of converting a latent image in an emulsion layer to a visible, stable image. It involves developing, fixing, washing, and drying the photograph.

planimetric data – Data about features on the Earth surface that are represented only by their correct horizontal position. Distinguished from a topographic map by the omission of relief in a measurable form.

property assessment

quarter quad – One-quarter area of a four-sided quadrangle that depicts 7.5 minutes of latitude and 7.5 minutes of longitude on a side. Used as a standard surface area mapping unit by the U.S. Geologic Survey.

rectification – The process of eliminating photo scale variations and relief displacement. In digital image processing, it also refers to correcting for geometric distortions, radiometric calibrations, and noise removal.

ridgelines – A line representing the intersection or top between opposite slopes. Commonly used as a parcel line.

satellite imagery – Imagery that is collected using a space-borne remote system that is in orbit around the Earth.

street centerlines – A real or imaginary line that is equidistant from the sides (usually pavement edges) of a travel path. Typically, these are the basis for network routing applications.

surface data – Information about variations in the surface of the Earth that are referenced to a known coordinate system and vertical datum. A required component of the orthophoto rectification process.