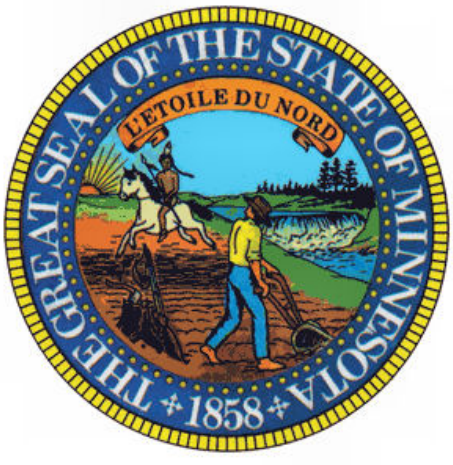
A Program for Transformed GIS in the State of Minnesota:

Program Design & Implementation Plan

FINAL

February, 2009



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Empowering People with Spatial Solutions

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Prepared on behalf of
The Enterprise GIS Steering Team

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February, 2009

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The authors would like to acknowledge the outstanding cooperation and input received from the entire Enterprise GIS Steering Team. In addition, Drive to Excellence sub-cabinet members, Commissioner of Administration Dana Badgerow and Chief Information Officer, Gopal Khana provided critical support and encouragement throughout the planning process. Finally, the authors would like to acknowledge the important direct contributions of David Arbeit, Fred Logman and the entire LMIC staff whose efforts toward producing this document and the successful completion of this project were invaluable.

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Executive Summary

In January 2008, the Minnesota Drive to Excellence (DTE) sub-cabinet designated enterprise GIS as a DTE initiative. This report presents the culmination of analysis conducted for that project. More importantly, it contains recommendations for *transforming* state government GIS activity from a series of loosely coupled departmental efforts into a more cohesive enterprise activity that spans all of state government. This transformation builds on more than 30 years of GIS development within Minnesota and, if fully implemented, will result in enhanced and effective deployment of GIS within state government, along with increased efficiencies and reliability. It will also restore Minnesota to national leadership in a field where it was an important early pioneer.

Process

This project was conducted by Applied Geographics, Inc. and the DTE project team in an open and transparent fashion that engaged as broad a set of Minnesota GIS stakeholders – both inside and outside of state government – as possible. Stakeholders were engaged in three separate large group workshops, staff meetings and interviews at 17 state agencies, and by providing information and feedback using survey methods. In addition, the project team regularly communicated with and reported to the DTE GIS Steering Committee that was responsible for overseeing this project. There is broad and strong consensus that the findings and recommendations presented in this plan are needed and appropriate for Minnesota.

Findings

During the past five years, GIS growth within state government and the public's awareness of GIS have exploded. As the cost and complexity of the technology has decreased, and as Google Earth, MapQuest and automobile navigation systems have become familiar, GIS activity and interest within all levels of government have steadily increased. This project revealed the extent to which this has been the case within Minnesota state agencies. GIS is prominently used in established programs within large agencies like MnDOT, DNR, and MPCA and in smaller agencies like Agriculture, BWSR and others. Some larger agencies, such as Public Safety and Human Services, have smaller GIS programs with enormous potential to grow and enhance performance and services to the public. The Land Management Information Center (LMIC), with its extensive experience with GIS, has assumed a *de facto* role of leading coordination within state government, but it does not have explicit authority for that function. This comprehensive assessment reveals that Minnesota has a solid base upon which to build a highly integrated approach to GIS. This approach, which is consistent with the overall DTE philosophy, can serve as a model for the nation for efficiently and effectively enhancing the geospatial services that are offered by state government.

Every day, state agencies use GIS for a broad range of purposes such as: responding to emergencies, protecting the environment, ensuring public safety, implementing the social safety net, ensuring the smooth flow of transportation, regulating dangerous materials, and many other vital functions. The state currently spends at least $12.5 million annually on GIS infrastructure and staff. Implementing the recommended program would provide an important range of benefits that include:

- Improved coordination that captures synergies and opportunities for co-investment
- Reduced duplication through the development and implementation of shared resources

- More efficient and effective data storage, data management and software licensing
- Coordinated and strategic geospatial data acquisition to address unmet agency demand

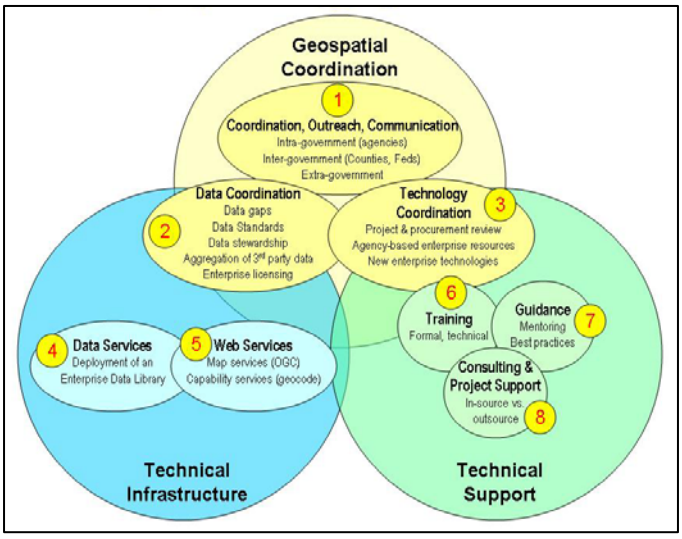
Research on Minnesota's GIS usage and needs indicates that the value of GIS will continue to drive increased expenditures -- even during an economic downturn. However, fully implementing the recommendations of this study should reduce the rate of growth of future GIS expenditures by half through strategically deployed enterprise services, reduced redundancies and other operational efficiencies.

Recommendations

This plan recommends a fundamental transformation in how Minnesota plans, implements, and supports GIS. Rather than an agency-focused approach, the plan recommends that Minnesota formally establish and fund an office responsible for coordinating GIS within the state and implementing enterprise GIS services that support all of its agencies. With GIS use continuing to expand and the state government GIS landscape becoming increasingly complex, significant opportunities are being missed by relying on the current informal *ad hoc* coordination model.

This plan recommends the creation of a new Minnesota Geospatial Information Office (MGIO), headed by a Geospatial Information Officer (GIO). The MGIO would be created to transform the current LMIC operation by redefining its mission and building on its current capacity and resources. It is critical that both the MGIO's and GIO's outlook be state government-wide with an aim of complementing departmental GIS efforts through active coordination and by facilitating the development of a common and shared GIS infrastructure of data and services. The recommended organizational framework and mandate for the newly constituted MGIO is composed of three major activities and eight distinct program elements:

1. **Geospatial Coordination**
   - Leadership, Outreach & Communication
   - Data Coordination
   - Technology Coordination
2. **Technical Services**
   - Data Services
   - Shared Web Services
3. **Support & Guidance**
   - Training
   - Technical Guidance
   - Consulting & Project Support



Conclusion

This plan contains a practical and realistic program for improving the state's utilization of geospatial technology and enhancing its delivery of services. The plan properly recognizes the progress that has been made over the past three decades and leverages existing resources to the greatest extent possible. Recognizing current fiscal constraints, the recommendations include a range of investment levels that can be pursued incrementally and over time. Ultimately, GIS has great potential to fulfill the overarching objective of DTE which is to encourage "government to act together as an enterprise, rather than as a loose confederation of somewhat independent agencies". The path ahead has been identified. It is now time to move forward.

1 Project Background

The State of Minnesota has been making investments in Geographic Information System (GIS) for more than 30 years. Much of the investment has been made by larger agencies such as the Department of Transportation and the Department of Natural Resources, but most agencies now either invest in GIS or plan to do so. Despite its widespread use, no organization is chartered to coordinate GIS on a statewide basis or within state government.

Even without a coordinating agency, the state's GIS community has a notable history of working together. The Land Management Information Center (LMIC) has often served as the *de facto* coordinator and provides some technical services that serve the GIS community. At times, staff from other agencies have helped fill that role. However, as the use of GIS has continued to grow, personal relationships are no longer enough to provide the coordination needed to derive the potential benefits that GIS offers.

The need for more effective coordination has become especially apparent as agencies discover they are unable to keep up with the growing demand for GIS to support their activities. Much of the state's GIS capacity exists within agency silos, even within divisions of some agencies. The result is agencies manage their own GIS programs, at times investing in redundant infrastructure, while GIS capabilities remain spread unevenly between "have" and "have not" agencies. More effective coordination is the key to effectively responding to this growing demand.

In January 2008, The Governor's Drive to Excellence (DTE) Sub-Cabinet initiated a project to develop, recommend and implement an organizational and functional framework for coordinating GIS as a state "enterprise" activity. The project was originally sponsored by the Commissioner of the Minnesota Pollution Control Agency until he left State government and is now sponsored by the Agriculture Commissioner. Further, both the Commissioner of Administration and the State's Chief Information Officer (CIO) are proponents. The DTE Project Steering Committee is chaired by the Agriculture Commissioner and is comprised of CIOs and senior executives from nine state agencies.

In April 2008, Applied Geographics, Inc. (AppGeo) was engaged to help plan for the functional transformation of GIS within Minnesota state government. AppGeo has undertaken a detailed analysis of GIS capabilities and needs, based on workshops, interviews, surveys and comparisons of GIS coordination within other states. Based on that work, this document lays out a program design and implementation path for transforming GIS in Minnesota. In parallel, the Strategic Planning Committee of the Minnesota Governor's Council on GIS has assessed options for an organizational transformation of GIS and has recommended creating a Minnesota Geospatial Information Office and advisory groups through legislation. These two efforts have been closely linked and, together, provide a blueprint for a fully transformed GIS operation for state government.

2 Project Findings

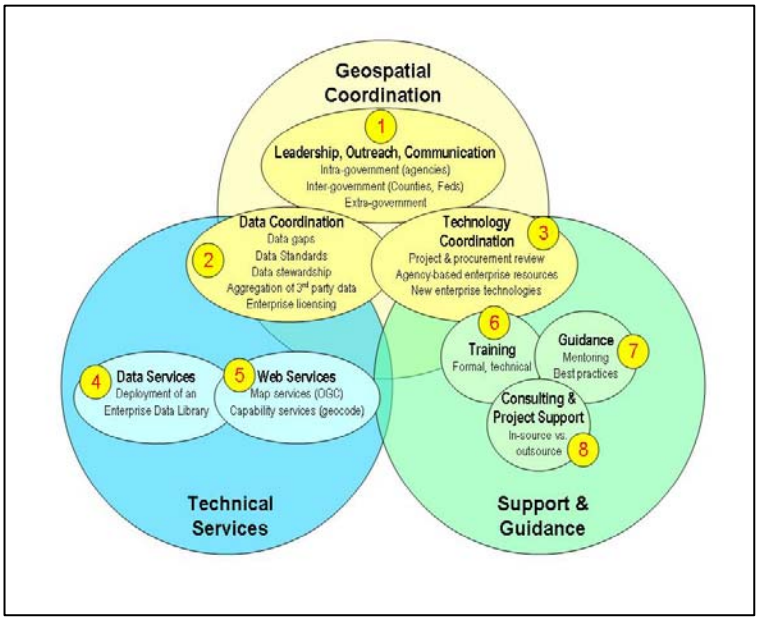
The core recommendation of this project is the formal establishment and funding of an entity that would be responsible for planning, coordinating, guiding and supporting the implementation of an enterprise GIS program comprising eight key program elements. This entity has been named the **Minnesota Geospatial Information Office (MGIO)**. By establishing the MGIO, Minnesota would join a growing number of states that have created offices to coordinate geospatial technology resources within state government and would instantly be recognized as an important leader within the nation.

The placement of the MGIO within state government was beyond the scope of this study, but the Strategic Planning Committee of the Minnesota Governor's Council on Geographic Information has recommended that the MGIO be initially created as a unit within the Department of Administration, empowered with authorities delegated by the State Chief Information Officer. That recommendation was endorsed by the Drive to Excellence Sub-Cabinet at its October 29, 2008 meeting.

2.1 MGIO Program Elements

The eight responsibilities for the MGIO, illustrated in Figure 1, reflect needs identified through interviews, surveys and workshops that engaged more than 200 participants between April and October of 2008.[1] They are identified here and described in greater detail later in this document.

- Leadership, Outreach and Communication
- Data Coordination
- Technology Coordination
- Data Services
- Web Services
- Training
- Guidance
- Project Support Services



Minnesota's Geographic Information Office would offer enterprise services in 3 areas with 8 activities.

The recommendation to create the MGIO was initially presented at a State Government GIS Stakeholder Workshop in August, 2008.[2] At that

[1] Seventeen individual state agencies that are involved in GIS were interviewed as part of this project.

[2] Workshop feedback has been consolidated into a document titled "State Government GIS Stakeholder Workshop Summary".

workshop, attended by 72 state government GIS stakeholders, participants closely reviewed and discussed each of the program elements and offered ideas for effectively refining and deploying them so that they would add maximum value to existing state agency GIS efforts while disrupting them as little as possible.

2.2 The Business Case for the MGIO

As early as 2004, the Minnesota Governor's Council on Geographic Information (CGGI) recommended that an executive branch agency be formally authorized to fill the coordination gap[3]. The analysis conducted for this project confirmed the need for stronger coordination and the other activities recommended for the MGIO. By serving as an enterprise resource for geospatial technology within state government, the MGIO would benefit all agencies -- not only those that already have well-developed and agency-wide GIS programs, but those with emerging or limited programs as well.

- **Late Adopters and Emerging Programs.** These agencies either have no GIS program or are only beginning to develop programs and need guidance or help. The departments of Public Safety and Commerce, for example, understand the need for GIS but have only limited capability to address this need on its own. Others, like Corrections, need help understanding how GIS can contribute to meet agency priorities. The MGIO would help less developed agencies learn about available enterprise services, best practices, and training opportunities and provide technical assistance services that would make it easier and less costly to implement GIS projects and programs when they are ready.

- **Specialized Adopters.** Several agencies, including Health, Education and DEED, have implemented GIS within specific business areas but have not been able to extend GIS services to other programs that need it. These GIS programs may be isolated from the agency's information technology (IT) mainstream and often are expected to do too much with too little. The MGIO, which would promote best practices and coordinate services and training across the enterprise, will encourage consistent practices and balanced deployment within these agencies and assist them in leveraging the investments they have already made.

- **Mature Adopters.** Agencies with mature operations, such as Transportation and Natural Resources, have developed comprehensive and agency-wide GIS programs that support offices and programs throughout the state. GIS efforts within these agencies are well-integrated with their agency IT programs. However, they often need greater access to geospatial data from other agencies and can reduce their costs by participating in the development of a coordinated, enterprise data infrastructure and web services strategy. In addition, there is great potential to further leverage the GIS investments that these agencies have made to serve other units of state government. These agencies are among the strongest supporters of the MGIO, both as beneficiaries and as contributors.

The benefits that would derive from establishing the MGIO, as recommended, are substantial, based upon the experiences of other states and an estimate of costs savings and avoidance that would result from its services. The benefits are described in detail later in this document.

[3] See *A Foundation for Coordinated GIS*, which includes this and other recommendations to strengthen GIS coordination statewide.

Collectively and conservatively these benefits are estimated to represent a return on investment of $2 to $3 for every additional dollar invested in the new office during the first 10 years after it is established.

2.3 Implementing the MGIO

By establishing the MGIO, Minnesota would join a growing number of states that have created offices to coordinate geospatial technology resources. In general, they are self-contained units that either report to, or work closely with the state's Chief Information Officer and receive advice from stakeholder advisory groups. This model for coordination has been endorsed by influential national groups that include the National States Geographic Information Council (NSGIC)[4] and the National Association of State Chief Information Officers (NASCIO)[5].

The most successful of these state GIS offices receive annual appropriations in excess of $3 million and are responsible for most, but not all, of the eight activities recommended for the MGIO. By comparison, Applied Geographics recommends a total annual budget of $1.8 million for MGIO operations. This includes the current general fund base budget for the Land Management Information Center, which was the first state GIS organization in the nation when created in 1978. The MGIO would not eliminate LMIC's functions, but would build on LMIC's success by transforming LMIC into the state's geospatial information office. An additional $1.25 million per year is recommended to support long-term data development needs.

The analysis of state needs and opportunities supports the full implementation of the program recommended here within the next two years. But, it is recognized that the necessary funding may not be available in the short term. Several options for phased implementation are also identified as contingencies, based upon priorities identified by state agencies participating in this project. However, scaling back the effort will also scale back the benefits of transforming GIS into an enterprise activity. Thus, it is strongly recommended that the MGIO be created with a budget appropriate to carry out its important and challenging set of new responsibilities. The need is great, expectations are high, and anything less would jeopardize the potential for success.

Details about state agency activities, the benefits of an enterprise GIS capability, the recommended program activities, and the implementation strategies follow.

[4] NSGIC has developed a profile of attributes for successful GIS coordination within states and encouraged states to strengthen their capabilities as part of FGDC's and NSGIC's "Fifty States Initiative." For more information, see http://www.nsgic.org/hottopics/fifty_states.cfm.

[5] NASCIO has identified GIS as a high priority and has published *Governance of Geospatial Resources: "Where's the Data? Show Me" - Maximizing the Investment in State Geospatial Resources* (July 2008) as a guide for states. It is available at http://www.nascio.org/committees/EA/pubArchive.cfm.

3 Overview of State GIS Activities

GIS is now deployed extensively within state government and these deployments cover a spectrum that ranges from beginning efforts to advanced, departmental efforts. In some cases GIS is deployed extensively throughout the programs of large agencies, and in other cases it is found within niches dedicated to specialized projects. With no formalized mechanism for coordinating these efforts, no comprehensive overview of the State's investment in geospatial technology has ever been compiled – until now. This section provides a general overview of GIS activities within state agencies and includes an estimate of the current State investment in GIS. Together, they portray how broadly and deeply GIS has been integrated into Minnesota state government and the value that this technology adds to a variety of programs.

3.1 Agency Profiles

During this project's information gathering phase – which included, workshops, interviews and an on-line survey – more than 20 interviews were conducted with state agencies, the Metropolitan Council, the Legislative GIS Office and a federal agency focus group. These interviews were conducted with varying combinations of GIS practitioners, CIOs, and program managers to characterize the major commitments to GIS that each agency has made, with a specific focus on the agency's perspective about developing an enterprise GIS solution for state government.

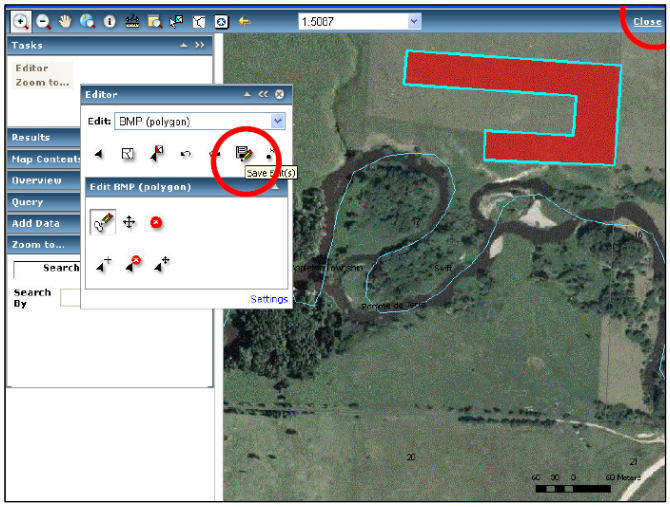
The interviews provided a snapshot of GIS use throughout state government as well as agency perspectives on enterprise GIS related issues and their potential solutions. The information gained from these interviews helped inform the overall program design and strategy for transforming GIS within Minnesota that is embodied in this document. Fuller details on agency GIS programs documented in the interviews are compiled in the companion document titled *A Program for Transformed GIS in the State of Minnesota: Agency Interviews*.

3.1.1 Board of Water and Soil Resources

Geospatial technology supports six main business areas within BWSR. Landowners submit agricultural conservation best management practices on-line in order to receive Soil and Water Conservation District grant money. Conservation easement geometry data from Reinvest in Minnesota, a program that protects water and soil resources by removing marginal and sensitive cropland from production, is collected to produce a statewide data layer. The Minnesota "Ditch Law" mandates the maintenance of watershed and watershed district boundary files. Minnesota wetlands are defined, violations are detected, and construction mitigation credits are tracked through the use of aerial photography and GIS/GPS tools and systems. Approximately 80% of Minnesota's published soil survey data has been digitized and contributed to the USDA Natural Resource Conservation Service soil database.

BWSR, a small but mature adopter, has been using GIS for over 10 years. Two full-time GIS professionals report to the IT manager, who has a GIS background and is a member of the senior management team. There are 17 ESRI Desktop licenses used throughout the agency and AutoCad is used for reading engineering and construction drawings. LandView, an open source GIS developed by the Minnesota Department of Natural Resources, is used as a desktop data viewer and for simple map production, such as best management practice mapping for local

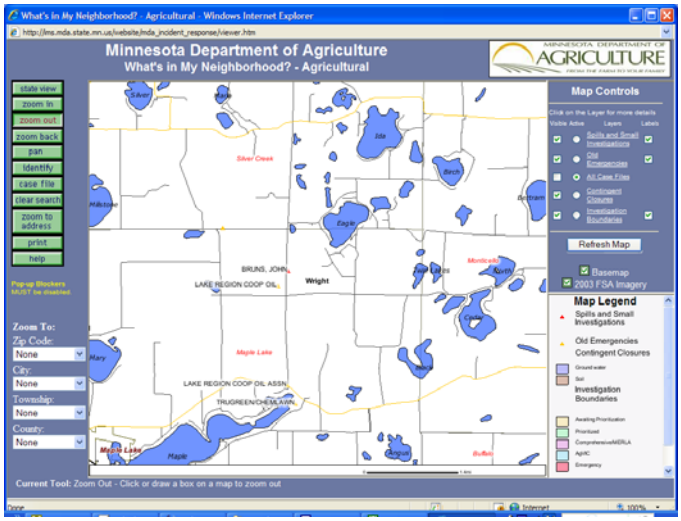
review. A geodatabase of frequently requested data simplifies the map production process. Interns use a GPS enabled tablet with ArcEditor to collect wetland information. BWSR relies on data access and distribution and other geospatial support from DNR, LMIC and other state agencies. The GIS staff supports major geospatial enabled applications such as: eLink for plotting best management practice implementation areas and NRDSS for soil survey data query and download. Several web-based applications are maintained to support the business processes described above. The GIS team's approach makes GIS tools and capabilities available to as many people as possible and GIS projects are tied to specific business processes wherever feasible.



eLink's Web Data Entry tool

3.1.2 Department of Agriculture

Geospatial technology is integrated into a number of key MDA business processes. Each year mobile technology is further integrated into approximately 20,000 inspections of farm and food production facilities to monitor regulated agricultural chemicals, enforce food related state regulations, and track reports of food contamination. Digital terrain analysis is used to identify critical conservation areas and best agricultural management practice locations are collected from landowners. Invasive plants, disease locations, and insect infestations are tracked and profiled. Water drainage and soil productivity analysis is performed and surface/ground water is tested for pesticide and fertilizer runoff. Public access to MDA data is provided by web applications, such as "What's In My Neighborhood – Agricultural Interactive Mapping" which identifies known and potential agricultural chemical and ground water contamination sources.



What's in My Neighborhood?

MDA, a mature adopter of GIS, has a GIS staff of 3 led by the agency GIS Coordinator within the CIO's Information Technology Division. This small agency-wide support group, funded by the agency divisions, is responsible for coordinating the use of GIS and GPS technology, enabling geospatial data sharing, and implementing data standards. In the last 5 years the agency's use of GIS has matured significantly. There are 30 to 40 core desktop GIS users and about 150 field inspectors who use approximately 100 GPS devices to collect geospatial data in

the field. Current development of a Compliance Information System (CIS) will incorporate synchronization of this field information with department servers at the end of each day. MDA also has a substantial GIS server environment that supports almost 20 web-based applications; about half of these are for internal use. Overall, the MDA user community understands how GIS can contribute to business operations and is forward thinking in new ideas for how GIS can be applied. For example, the availability of 2003/2004 aerial imagery has generated considerable interest in new and innovative uses for GIS technology.

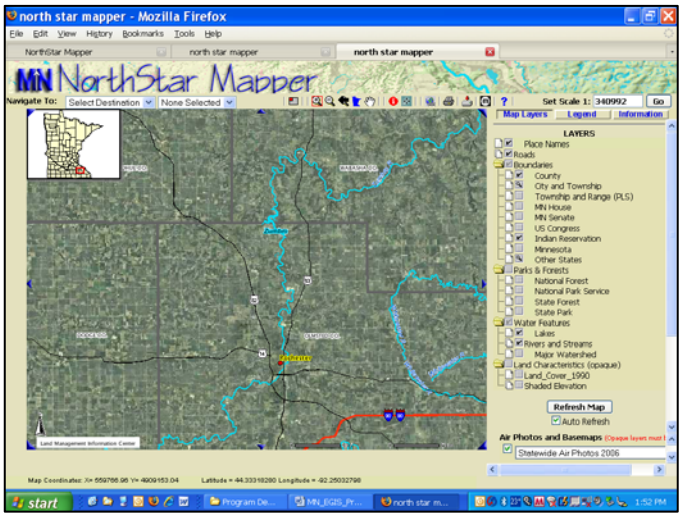
3.1.3 Department of Administration

The Department of Administration has begun to use GIS within a few of its programs, especially to support demographic, environmental, and archaeological analysis and real estate management, but most of Administration's GIS capabilities are found within the Land Management Information Center (LMIC).

LMIC was the first state program anywhere to use GIS when it was established in the 1978, but has since evolved into the unofficial statewide geospatial coordinator. LMIC maintains the Minnesota Geospatial Data Clearinghouse and provides custom mapping and GIS services to a variety of customers, primarily other state agencies. LMIC maintains a wide array of geospatial technology including ESRI desktop and server products, open source server products, Maptitude, GeoPDF, EPPL7, and both Oracle and SQL Server database platforms.

LMIC's consulting services are funded using a cost-recovery model. LMIC supports coordination using a matrix management style, drawing resources from other LMIC programs as necessary. Details about LMIC and its services follow.

Data and Map Product Distribution. LMIC serves as a single state agency point of contact for geographic data, including data directories, interactive data searches, and public access to data, maps and web services over the Internet.



The Minnesota Geospatial Data Clearinghouse (MGDC) is a collection of geospatial data sources coordinated by LMIC. The MGDC is used to distribute data to state and federal agencies, local governments, the general public, and the private sector. There are 20 federated MGDC nodes; each maintains their own servers. LMIC's node has over 250 data sets and serves as an archive for other state agencies and a host for state agencies without their own node. GeoGateway is an MGDC tool that enables metadata searches across all nodes and links to web pages at each node describing the content and data access instructions. LMIC also maintains web mapping image services (WMS) that allow many state agencies and county governments to easily access specific image extents over the Internet.

GIS Coordination. LMIC acts as the liaison with federal agencies and national organizations, such as the National States Geographic Information Council (NSGIC), an organization of state GIS coordinators. LMIC also provides administrative and technical support to the Minnesota Governor's Council on Geographic Information and maintains a list of GIS contacts for all Minnesota counties.

LMIC also coordinates the state's involvement in the National Agricultural Imagery Program (NAIP) which produces county-based digital mosaics of color, leaf-on aerial imagery. This program is funded by contributions from eight state agencies -- PCA, Mn/DOT, DNR, MDA, BWSR, Health, Public Safety and LMIC. LMIC orchestrates the state's involvement and has contributed significant staff time and technical resources to the effort.

Consulting and Project Services. LMIC's service bureau provides a full-range of practical GIS solutions and services to other federal, state and regional agencies. Rates are set yearly to recover costs. Most of the current workload is related to data development and there is a smaller volume of web application development.

Examples of fee-for-service projects include: Assistance with the deployment and operational support of DisasterLAN, the MN Homeland Security and Emergency Management incident management system; Development of a storm water system for Met Council; Litigation support to US Department of Justice on a tribal law suit; Application development to manage wind turbine and pipeline permitting for the Department of Commerce.

3.1.4 Department of Commerce

There are many program tasks within the Department of Commerce that could be enhanced with greater use of geospatial technology. Commerce is a citizen advocate during the energy facilities permitting process that covers wind farms, power plants, pipelines, and transmission lines. It also performs environmental and resource planning and produces 25 year energy use forecasts. Solar resource maps are created for solar energy production planning. Commerce maintains and publishes the locations of 300 E85 Ethanol pumping stations and annually inspects every fuel pump at the state's 2,500 fueling stations. Underground fuel storage tanks are located and analyzed to determine removal priorities. Every grocery and commercial food scale is annually inspected and calibrated. A fleet of 50 vehicles is required to support the 40 field inspectors and the agency's fraud investigators. Efficient inspector routing that includes fueling stops at E85 stations – a governor's mandate for all state vehicles – is strongly desired.

The Department of Commerce, a late adopter, has no dedicated GIS staff. The Office of Energy Security has some map production capability and maintains 3 ArcGIS licenses. GIS reference data is stored on network drives and both the LMIC clearinghouse and the DNR Data Deli are accessed for other geospatial information.

3.1.5 Department of Education

The DOE uses geospatial technology in two primary areas. First, school locations, districts, and attendance area boundaries are maintained, and updated annually (manually using marked up PDF maps). These data sets are used within the agency, and locally for a variety of purposes, such as planning bus routes and projecting student populations. Second, the Food and Nutrition Service (FNS) uses GIS to support the administration of the USDA's Child Nutrition program

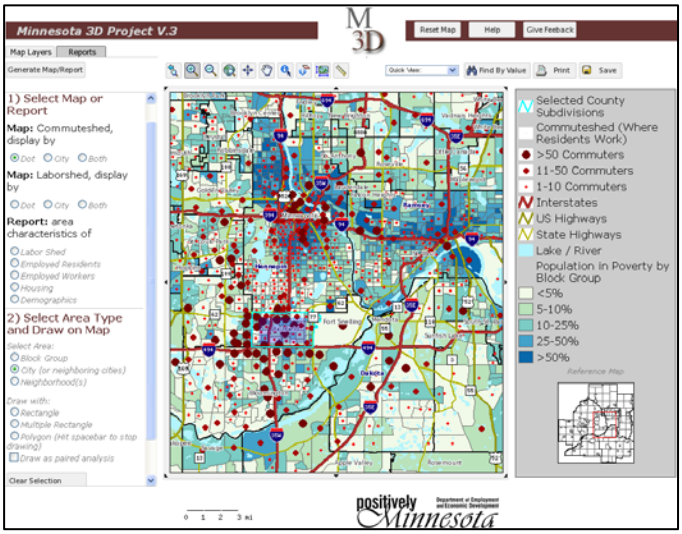
that partners with over 1,000 public and private sponsoring organizations located in schools, child care centers, adult care centers and summer feeding sites.

DOE, a specialized adopter, has a full-time GIS coordinator, another .5 FTE, and a few additional proficient GIS users in various divisions. Approximately 35 map requests are produced each year. DOE is building a GIS infrastructure including ArcGIS Server with an ArcSDE database to support several FNS applications. The FNS must determine client site spatial locations through geocoding or using locations supplied by vendors using 10-year-old GPS equipment. Current geocoding capabilities are inadequate and deliver inaccurate locations, especially in remote areas of the state. DOE could reduce the cost of GIS operations and would benefit tremendously from access to enterprise GIS services such as ArcGIS server for application hosting and an accurate geocoding web service.

3.1.6 Department of Employment and Economic Development

DEED is largely responsible for supporting employers and job seekers. It manages data sets detailing the location of over 160,000 employers, 2.5 million jobs, 200,000 Unemployment Insurance (UI) claims and a variety of other administrative data as well as forty seven work force centers aimed at supporting job seekers and businesses. One of DEED's core business drivers is data analysis and publication. The agency views GIS technology as key to effective analysis and presentation of many types of employment, economic development, and program data.

DEED developed an early on-line GIS web-site that published dynamic Census Origin-Destination commute-shed maps and reports along with other economic data layers for the seven county Metro region. DEED also provides geographic analysis on a variety of labor market and administrative program data. DEED is currently planning to geo-enable some of its existing workforce development web-sites (e.g. MinnesotaWorks.Net) so that users can see maps of job locations in association with relevant facilities such as schools, child care and public transportation. The MNPRO economic development website allows businesses and developers to search for available commercial and industrial real estate. DEED is interested in adding a mapping component to display the distribution of available properties.



While DEED is a specialized adopter with a modest program, they are taking geospatial technology seriously. The agency maintains one full-time GIS application developer and has convened an internal GIS Steering Committee. The agency currently maintains ESRI desktop technology and is investigating the near-term purchase of a commercial GIS web-server. The agency also gained early experience with Open Source GIS tools built on top of the MapServer for Windows package.

3.1.7 Department of Human Services

As a late adopter with an emerging program Human Services has only begun to use geospatial technology. However, it has begun planning for broader utilization. Many of the examples below include what is planned and hoped for in the near to mid-term.

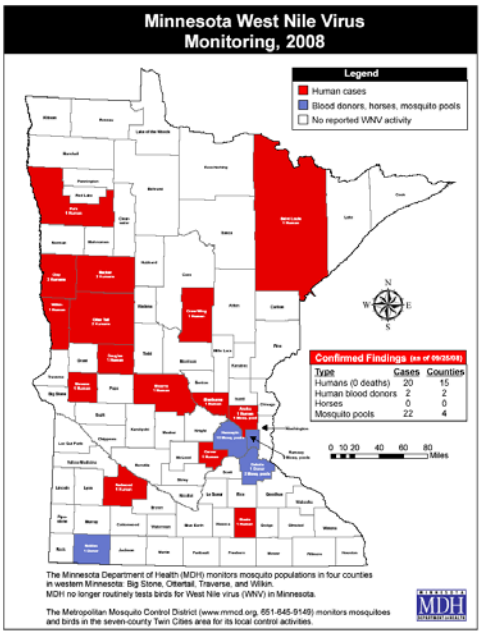
Many Human Services policies have "proximity" criteria. For example, when moving a child from his or her home, the agency should attempt to move the child to another home that is "close" to his or her current neighborhood. GIS will help Human Services better make those determinations from candidate homes. Human Services is involved with over 14,000 child care centers across the state and would like to accurately map all of these facilities. Human Services is involved with 44 child abuse prevention councils and would like to map their service areas to identify service gaps. Human Services envisions using GIS in emergency situations to identify group homes that may require prioritized or assisted evacuations. Child Safety currently uses GIS to produce a variety of maps such as county-based maps showing concentrations of children with different disabilities or the distribution of children in foster care and other out-of-home care.

Currently, Human Services has very limited desktop GIS capacity. At present there is one copy of ESRI's ArcGIS software and one copy of MapInfo. Recently, Human Services completed a Strategic Plan for the 2008-2012 time period. The plan emphasized "data driven decisions" and the development of "business intelligence systems." GIS is identified as a business intelligence system of interest in that plan.

As a new user, Human Services would benefit greatly from an enterprise approach and the assistance and resources that would become available. In addition, Human Services would benefit from collaborative data sharing with other agencies such as DEED for employment information, Health for birth and death registries, and even the DNR for boating licenses which can be germane in identifying people capable of making child support payments that they are delinquent on.

3.1.8 Department of Health

Many MDH programs are supported, to varying degrees, by geospatial technology. Drinking water source areas are mapped, water quality is analyzed, groundwater is modeled, and well heads are protected. Outbreaks of 95 reportable diseases are geographically identified, located and tracked. County based maps of disease and injury rates are produced and distributed. Public health preparedness and response activities are managed with simple map production. Birth and death records are kept statewide. Nursing homes, mortuaries and cemetery complaints are investigated and "report cards" are created for nursing homes. Disaster areas, emergency shelters, and drug stockpiles are mapped during emergency responses. Noxious cloud releases are modeled to determine potentially affected areas.

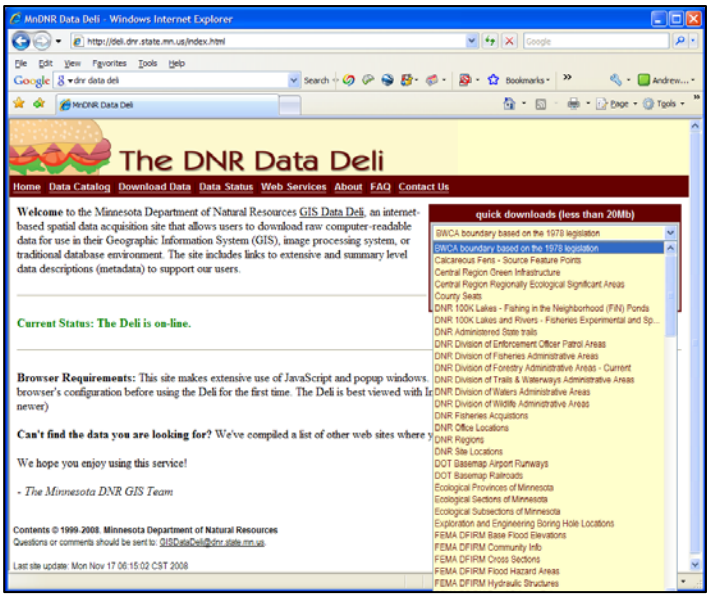


MDH is a specialized adopter of geospatial technology.

Though Health does not have a coordinated program, GIS and mapping are used within many of its divisions, with a few full-time GIS managers and over 100 non-GIS professionals who use GIS on a regular basis. The Environmental Health division has been using GIS for 15 years and has an advanced geospatial infrastructure that supports interactive map viewers, while other divisions produce simple county maps using Microsoft Word templates. Citrix servers make GIS applications accessible to seven district offices. All divisions recognize the value of GIS and are eager to put it into greater practice, but they are constrained by funding. One significant constraint, imposed by federal grants, requires that 95% of funding be spent within the program. This makes sharing geospatial expertise across divisions difficult.

3.1.9 Department of Natural Resources

GIS is instrumental to dozens of business processes across DNR's business units. A few examples include: Mapping county biological rare animal survey data; publishing interactive and paper recreational maps; tracking forest fire locations; demarcating areas of scientific and natural importance; performing regional hydrogeologic assessment; providing time-sensitive response to natural disasters by conducting fly-overs to create spot imagery. DNR has significant business requirements for geospatial collaboration with other state agencies including: Development of the National Hydrology Dataset with LMIC; forest inventory and assessment with the USDA Forest Service, stream gauging and other water management efforts with PCA and USGS; multiple activities with the Department of Health; rare species data collaboration with NatureServe, a non-profit affiliated with the Nature Conservancy; coordination of coastal zone issues with Canada and other states; collaboration and coordination with the Bureau of Indian affairs and several tribal governments.



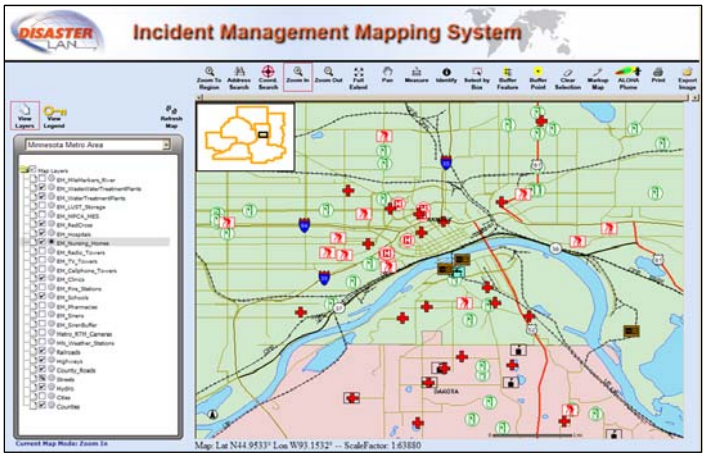
DNR, a mature adopter, has made significant and sustained investments in GIS technology since the 1980s. An 8-person GIS section, under the direction of the CIO, provides GIS operational and technical assistance and support to Department Management and field staff. The agency also maintains at least 7 additional full-time GIS staff throughout the agency. DNR implements a wide variety of GIS software including ESRI desktop products, Open Source server products, and both PostGIS and Oracle Spatial database products. Mobile computing is becoming increasingly important and "real-time update" versus "detached synchronization" methods are being explored. DNR has developed the Data Resource Site and a strong metadata management framework for making statewide GIS data available to all agency staff through replication to over 75 DNR offices locations. DNR's self-service Data Deli is an innovative application that makes DNR and other agency geospatial data publicly available via the Internet. DNR has a strong interest in obtaining access to data, such as parcels, maintained by county entities and has entered into data sharing agreements and

collected data from approximately 30% of counties. These agency efforts provide a model for a statewide framework that can be used by all agencies.

3.1.10 Department of Public Safety

Many of the Department of Public Safety's divisions – ranging from Driver and Vehicle Services to the State Patrol to Justice Programs – use geospatial technology to support business needs, but DPS has not fully capitalized on its potential and is considered a specialized adopter and emerging program.

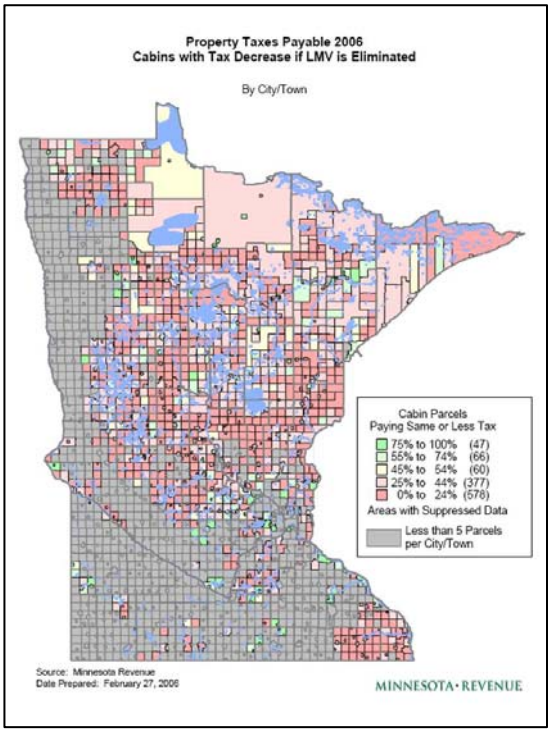
The State Patrol has an advanced system that provides 911 computer aided dispatch (CAD) and automated vehicle locating (AVL) to support emergency response and fleet visualization. Driver and Vehicle Services use GIS to support the geocoding and mapping of over 87,000 accidents per year and uses this information to help establish priorities for roadway safety improvement projects. The Bureau of Criminal Apprehension uses GIS to map registered predatory offenders and assess their proximity to schools and day care centers. The Homeland Security and Emergency Management (HSEM) division works with the federal government on mapping major infrastructure facilities, such as nuclear power plants, for hazard mitigation and event pre-planning efforts. There are also near term plans to provide GIS capabilities within the state's emergency operations center (EOC). The State Fire Marshall's office uses geospatial technology to support inspections and accident after-action reporting on the 65,000 miles of pipelines that traverse the state. The Office of Justice programs use GIS for a variety of mapping activities such as assessing the efficacy of grants given to support crime prevention and victim services. Maps include grantee locations and their service areas, facilities to support juvenile justice issues, and identifying hotspots that may help target future grants.



DisasterLAN Incident Management System

Despite the importance of geography, most geospatial technology is implemented at the program or division level, with limited interaction between geospatial practitioners. In addition, much of the activity is not fully integrated into divisional workflows. Currently, there is no department-wide activity, although the Office of Technology Support Services and the CIO are increasingly interested in pursuing agency level enterprise solutions. For instance, there are opportunities to directly integrate geospatial technology with HSEM's new DisasterLAN software within the EOC. The DPS utilizes the geospatial offerings of both Intergraph (largely through the State Patrol) and ESRI. The State Patrol's AVL system has the potential to serve as a model and/or enterprise resource for other agencies that are interested vehicle locating systems.

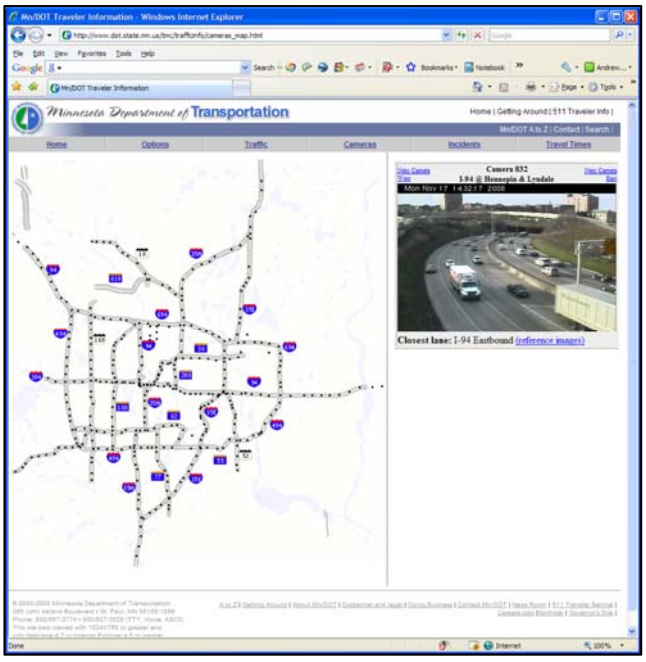
3.1.11 Department of Revenue



Revenue employs geospatial technology in several business processes, such as supporting the Streamlined Sales Tax Governing Board, a consortium for collecting and distributing local sales tax generated by catalog and Internet sales. Neighborhood analysis is performed on tax returns to discover anomalies and identify potential audit candidates. Agricultural field valuations that span multiple DOR regions are compared to help understand regional tax differences. GIS analysis and mapping are applied to a variety of business and research questions, such as geocoding classes of taxpayers or taxable entities for analysis to determine trends and/or patterns. Ad hoc maps are produced to support a variety of reporting and presentation functions, such as the series of 10 thematic maps that are produced twice a year to illustrate the decreases, increases, and other changes in tax revenue.

DOR, a specialized adopter, has one full-time position located within the Tax Research Division. This position provides GIS support and mapping capability to multiple agency divisions. MapInfo Professional is the primary GIS software used by DOR. Google Earth assists in quality control evaluations of roads data. MapMarker, MapInfo's geocoding engine, is employed to determine X, Y coordinates for all businesses and individuals that report to DOR. This geocoding capability is sophisticated and is used by other agencies, such as LMIC, for bulk address geocoding.

3.1.12 Department of Transportation



Mn/DOT is a heavy user of GIS and CAD technologies throughout the agency. Real-time information on traffic incidents, road conditions, construction delays, and images from Twin Cities Metro Area traffic cameras are reported via the "511 Traveler's Information" web site (see image at right) and phones/PDAs. A number of federal government mandates define GIS supported business needs (e.g. safe routes to schools, environmental justice, and census). GIS is used for engineering and planning highway and bridge improvements as well as archeological site protection. Maintenance operations such as emergency management, vehicle crash mapping, roadway striping, vehicle routing, asset management and

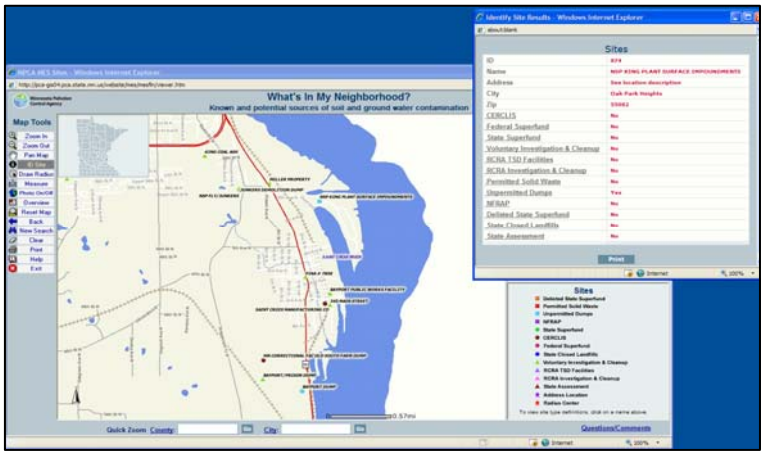
integrated work order management all use geospatial technology. Both mobile and web-based applications provide view and query capability to Mn/DOT geospatial data that is derived from 179 different data sources.

Mn/DOT, a mature adopter, has a well established 7-person Enterprise GIS unit within the Information Technology group. Though GIS strengths vary by division, 27 of 39 Mn/DOT offices use 84 ESRI desktop product licenses. There are roughly 850 GIS and 800 CAD users throughout the organization. Though it is estimated that about 95% of users only need to view and query geospatial data, the conversion of CAD engineering drawings to GIS spatial features is cumbersome and results in significant challenges to efficient agency-wide data workflows. Mn/DOT maintains 30 map services and 15 web-based applications. Older applications are currently being converted from ArcIMS to ArcGIS Server using a Geocortex web site template. The 511 information site is in the process of being migrated to Google maps. Mn/DOT also operates a 30 station, statewide geodetic control network and mobile GPS/GIS units are used for in-field mapping work, while RTK GPS receivers are used for survey grade work. Mobile geospatial computing is seen as the largest growth area over the next two years.

3.1.13 Pollution Control Agency

GIS permeates numerous programs and business activities throughout PCA. Contamination sources are determined through the use of analytical models, up/down stream load analysis is performed and existing discharges/contributions are identified. Storm water management is supported, through the University of Minnesota, with land use/land cover and impervious surface analysis. Surface water investigations are enhanced through satellite data analysis to locate contamination signatures and to prioritize water quality monitoring sites. Rules are applied for locating sites for new landfill facilities. Annual recycling survey results are mapped to document county-based participation and electronics disposal availability. Remediation sites are mapped to identify potential impacts to people and resources. Ground water contours are developed and plumes are modeled to determine contaminant movement. Emission sources that impact air quality and contribute to regional haze are identified. Facility-based models assist the emission permit approval process and prioritize permit holders who are in violation. Environmental justice is supported by examination of water impairments and with assistance and prevention programs for underserved populations.

PCA, a mature adopter, is among the largest and most sophisticated users of GIS technology in Minnesota state government. PCA has a 5-person "Lateral Team" that provides agency-wide GIS leadership from within the Information Services Office (ISO). PCA recently reexamined agency-wide data management practices, including GIS, and established a formal Data Services Section with one of the ISO GIS positions slated to be the geospatial data champion on behalf of the agency. Throughout the agency there are

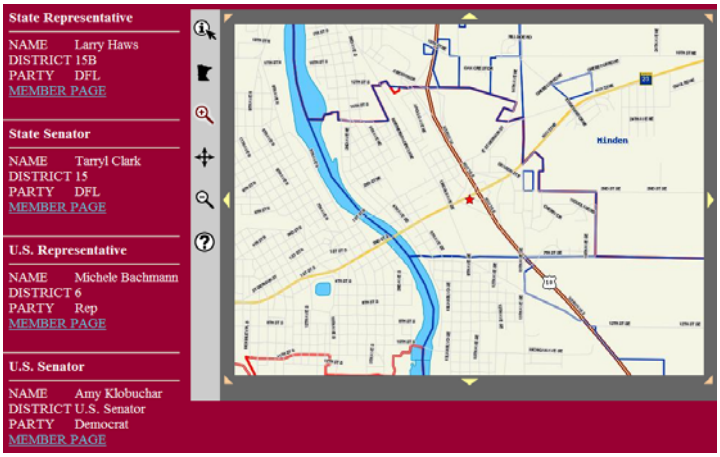


What's in My Neighborhood?

approximately 5.5 additional FTE dedicated to GIS activities. The power-user and casual-user community at PCA is estimated to be over 100. There are two key geospatial viewer applications that are used extensively within the agency and by the general public: The "What's In My Neighborhood" viewer provides facility and regulatory information for a user-defined area of interest; and the "Environmental Data Access" viewer exposes surface water, ground water, and air quality monitoring information. PCA's most important internal database contains facility information and related monitoring data. Most of these monitored entities have associated geospatial locations and an ArcEngine application allows program custodians to refine the spatial location information. This point-based editing application may have broad application in other agencies and could be made available as an enterprise resource. PCA shares geospatial information via an FTP site and many public data sets are distributed via the LMIC geospatial data clearinghouse.

3.1.14 Legislative Coordinating Commission

The LCC uses GIS to reapportion legislative districts every 10 years following each US census. Legislative bills are researched and maps are created whenever an examination of geographic data pertains to a proposed bill. For instance, maps of arsenic poisoning and elevated lead blood levels were overlaid with socio-economic data to better understand impacts of recent legislation on PCA's permitting process.

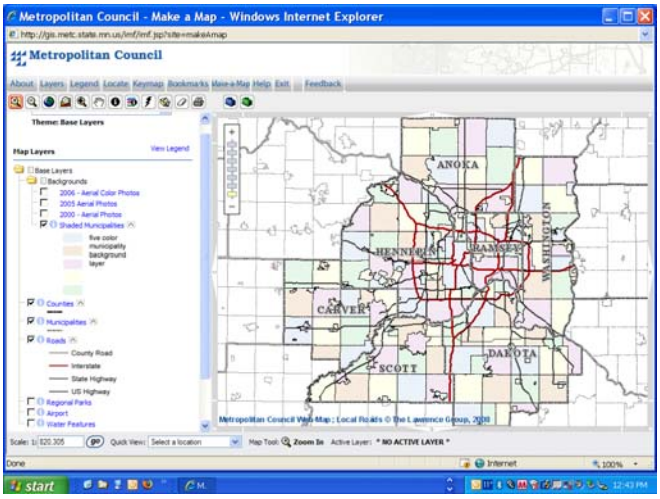


Who Represents Me?

The GIS manager and a staff of 2.5 FTE provide all GIS and overall IT services for the LCC as well as GIS support for the entire Minnesota State Legislature. Two ESRI licenses are used for map production. Maptitude software is used for redistricting. Open Source tools are used to house the agency's spatial databases (i.e. PostGIS), and the MapServer software hosts web applications.

3.1.15 Metropolitan Council

The Metropolitan Council, a regional planning agency that includes the 7 Minneapolis-Saint Paul Metropolitan counties is considered a state agency for this GIS transformation project and has significant and numerous business drivers that require GIS technology. A number of transit and para-transit processes require GIS, including: planning, modeling, routing, scheduling, marketing, operations and police dispatching. Regional growth and land use management, research, planning, monitoring and forecasting are facilitated by GIS. Environmental protection geospatial support



includes surface water monitoring and modeling, aviation planning and mitigation, and assessment of lake conditions using orthophotography. Sewage conveyance and wastewater treatment facilities are planned, built, managed, and monitored using GIS capabilities. Low-income housing, social services, and foreclosure prevention also benefit from the application of GIS technology.

Metropolitan Council, a mature adopter, has a several GIS staff centralized within its Information Services unit. Metropolitan Council staff also supports MetroGIS, which promotes and facilitates geospatial data sharing/standards and develops web applications in the metro area as a collaboration among GIS interests in the region. The Council provides coordination resources through a full-time GIS Coordinator and an additional 1.5 FTE of technical support to MetroGIS. In turn MetroGIS supplies much of the GIS data needed by the Council. The Metropolitan Council has well over 100 GIS users of various expertise levels who use geospatial data and applications to produce maps, graphs, tables, images, and analysis to support the Council's operations and planning functions. Met Council coordinates and collaborates with local metro governments to acquire accurate geospatial data as efficiently as possible. This data is standardized and made available to local governments as well as "up-stream" consumers, such as state government. A variety of ESRI, Google, Microsoft and Open Source software tools are used by the Metropolitan Council. Siemens Automatic Vehicle Location/GPS technology is used on all MetroTransit busses to provide location information once per minute. Hastus scheduling software is used to integrate transit route geography and schedule information for analysis and reporting.

3.1.16 Other Small, Late Adopters

The **Department of Corrections** and the **Department of Labor and Industry** have very small or non-existent GIS programs and neither has any dedicated GIS staff or infrastructure. Instead, they rely on other agencies, or outside vendors, to support their geospatial needs, such as map production or spatial analysis. These agencies are constrained by budgets, staff expertise, GIS software licenses, and a lack of access to appropriate data. Training and implementation assistance for basic map production capabilities were mentioned as necessary prerequisites for establishing GIS programs within these agencies.

Though these agencies have a general of awareness of what GIS is, they have a limited understanding of the full potential of the technology and how it can be used within their business operations. Both agencies see the potential for GIS as a program management and communication tool and expressed a desire to learn more about the benefits and uses of GIS. This type of agency is particularly encouraged by the focus on an enterprise-wide approach that will help make GIS more accessible.

3.2 The Cost of GIS to Government

A principal driver for an enterprise approach to GIS is the scale of the investment that the State has made in GIS technology and its rapidly growing costs. Because agency GIS activities often are spread across many bureaus and programs and generally are not broken out as explicit cost centers, identifying the full GIS "cost to government" in Minnesota is elusive. However, it is evident from the data compiled from agency sources that the reported annual cost of GIS to the State approaches $13 million per year, not including capital investments that have already been

made. This figure represents a conservative estimate focused on the direct costs of GIS and the full costs are likely significantly higher when indirect costs are factored.

Table 1 compiles estimates of current GIS expenditures as reported by State agencies. The table was assembled from agency responses to standardized questions about budgeted expenses for geospatial technology, GIS staff, and costs associated with supporting GIS capabilities. Although standard questions were asked of agencies, agencies were given some discretion in how these estimates were assembled. The table includes agency assumptions that underpinned aspects of their estimating exercise in the "Comments" column. The following describes the key, agency supplied columns from the cost estimating spreadsheet:

- **GIS Headcount (FTE):** Identified all full-time GIS professionals as well as program personnel that use GIS for 25%, or greater of their time.
- **Loaded Staff Costs:** Salaries and benefit costs for the GIS FTE's that were identified in the "GIS Headcount" column.
- **Non-Staff GIS Costs:** Represents the cost for GIS hardware, software, maintenance as well as project, travel and consulting budgets.
- **Overhead Costs:** Identified indirect expenses for items such as rent, utilities, administration and information technology necessary to support the GIS FTE's.

Although this table does not represent the results of a comprehensive expenditure audit, it provides a "best available" baseline estimate of GIS costs for the State and is the first such compilation performed for the State.

Estimated GIS Cost-to-Government for Minnesota

		Staff Costs		Non-Staff Costs			
GIS Activity Category	Agency	GIS Headcount (FTE)	Loaded Staff Costs	Non-Staff GIS Costs	Overhead Costs (e.g. rent, etc.)	TOTAL GIS COSTS	Comments
Mature Adopter	Natural Resources	29.75	$2,379,286	$435,207	$116,464	**$2,930,957**	Source: Tim Loesch. Not all units reported. Two FTE's add based on GIS Mgr. knowledge of the business unit and costs for those personnel were based on average FTE costs of the other units reporting.
Mature Adopter	Administration/LMIC	12.00	$1,053,000	$137,000	$216,000	**$1,406,000**	Budget includes both base ($804,000) and fee-for service budgets. About 6 FTEs are supported by the base budget.
Mature Adopter	Met Council**	26.00	$2,275,000	$300,000	$240,000	**$2,815,000**	Source: Rick Gelbmann. FTE is composed of 16 full-time and 30 part-time at 33% performing GIS work.
Mature Adopter	Pollution Control Agency	12.00	$1,080,000	$150,000	$140,000	**$1,370,000**	Source: Tad Schindler. Loaded staff calculated @ $90,000 /person.
Mature Adopter	Transportation	13.00	$975,000	$259,000	$15,600	**$1,249,600**	Source: Dan Ross, Supervisor EGIS Services. Includes staff, licensing, PT contracts, and 1.6% overhead needed to support GIS at MnDOT
Mature Adopter	Agriculture	5.50	$386,000	$60,000	$40,700	**$486,700**	Sources: Mike Dolbow, GIS Coordinator; Larry Palmer, CIO
Mature Adopter	Board of Water and Soil Resources	2.25	$165,000	$30,000	$3,300	**$198,300**	Source: Tim Ogg. GIS headcount is spread across 3 people.
Specialized Adopter	Legislative Coordinating Commission	1.50	$129,000	$50,000	$75,000	**$254,000**	Lee Meilleur: staff costs = (1.5/2.5) * $215k to calculate GIS staff cost out of total office IT staff cost.
Specialized Adopter	Health	4.00	$422,036	$52,500	$77,232	**$551,768**	Source: Wendy Nelson
Specialized Adopter	Employee and Economic Development	2.00	$180,000	$17,000		**$197,000**	Source:Sherry Falb-Joslin. Loaded staff cost includes overhead items such as rent.
Specialized Adopter	Education	1.25	$112,772	$12,500	n/a	**$125,272**	Source: John Paulson. "Fully burdened staff costs" are $90,217.57 /FTE and include administrative overhead.
Specialized Adopter	Revenue	1.00	$87,739	$33,000	$8,774	**$120,739**	Source: Kent Treichel. Overhead estimated at 10% of staff costs.
Late/Emerging Adopter	Human Services	2.00	$160,000	$7,000	$16,000	**$167,000**	Source: Nancy Ducette. Overhead estimated at 10% of staff costs.
Late/Emerging Adopter	Public Safety	3.00	$255,000	$215,000	$25,500	**$495,500**	Non-staff GIS costs column "includes a recent $200,000 one time purchase for hand held GPS data collection devices." Source: Steve Retzlaff, OTSS w/in DPS.
Late/Emerging Adopter	Commerce	0.015	$1,308	$0	**$293**	**$1,601**	Staff calculated at 32 hrs; Overhead calculated as IT support at 5 hrs; Agency has let software maintenance lapse on 2 ArcView licenses.
No program	Labor and Industry	0.00	$0	$0	$0	**$0**	Source: Cindy Valentine, CIO
No program	Office of Enterprise Technology	0.00	$0	$0	$0	**$0**	No ongoing activity.
No program	Corrections	0.00	$0	$0	$0	**$0**	No ongoing activity.
	Total	**115.27**	**$9,661,141**	**$1,758,207**	**$974,863**	**$12,369,437**	

** Please note, while the MetCouncil is not formally a state agency, it receives state funding and it's GIS activities are closely coordinated with the state.

3.3 Overall Assessment of Minnesota State Government GIS

Geospatial technologies and GIS have been in use in Minnesota state government since the late 1970s, when Minnesota became one of the early pioneers and leaders in deploying this technology. Today, as with most state governments across the nation, GIS activity is centered in agency-based programs that span the full spectrum of geospatial maturity. Several state agencies have made significant, sustained investments in geospatial infrastructure and possess well-developed departmental enterprise systems. Other agencies fund and implement GIS at the program or divisional level with varying degrees of resource and expertise sharing between the divisions. Finally, a smaller number of state agencies, which currently have little or no in-house geospatial capability, are actively investigating projects and initiatives that will build GIS capacity. State agencies make some attempts to remain loosely coordinated through vehicles such as the State Agency GIS Workgroup (SAGIS) which has open membership for state agency GIS practitioners and meets on a regular basis.

Coordination among these efforts exists, but it is both informal and ad hoc. No agency formally oversees coordination and an overall state government-wide enterprise approach to GIS is lacking. While the Land Management Information Center (LMIC) has taken on some of these functions, its mandate and reach are limited. For instance, LMIC has helped orchestrate statewide data development initiatives to acquire orthoimagery data and it maintains an infrastructure that delivers web services and public data. In addition, LMIC provides fee-for-service consulting and project services to other state agencies on a cost recovery basis. Finally, LMIC provides staff support to the Minnesota Governor's Council on Geographic Information (MGCGI), formed in 1991 to help establish and promote coordinated geospatial policies, standards, education and data stewardship.

Minnesota state government GIS program coordinators recognize the importance of the extensive GIS activity occurring outside of state government and the importance of coordinating with those efforts. For example, the Twin Cities Metropolitan Council provides a regional focus and has strong relationships with many of the local governments within the metro area. Simarly, many state agency GIS programs have a demonstrated need for data, such as parcels, that are created and maintained by county governments. The University of Minnesota also has a rich GIS program and has been a leading organization in the development of the open source GIS movement. All of these types of organizations have deep ties and work extensively with various Minnesota state agencies.

Minnesota state government deploys a wide variety of geospatial technologies. While the industry leader ESRI predominates, there are also significant uses of open source tools such as MapServer[6], which was developed at the University of Minnesota. In addition, some agencies deploy solutions from MapInfo and Intergraph. Agencies deploy a wide range of customized applications as both desktop and web solutions and there is an increasing move to using GIS on mobile devices in the field and integrating GIS with global positioning systems (GPS).

Overall, while there is a recognized need to continue to develop agency-based solutions that are focused on agency business processes, there is an increasing recognition that a more coordinated program that spans all agencies would compliment and enhance those efforts. Such a

[6] See: http://mapserver.gis.umn.edu/ for further details

coordinated program should be able to achieve operational efficiencies and budget savings while nurturing agencies that are newly adopting these technologies. And thus, such a program has a large potential for improving the overall geospatial technology capacity of state government.

4 Opportunities and Benefits

Taken together, the profile of state agency use of GIS reflects well on Minnesota. Where GIS has been implemented most comprehensively and with adequate funding, agencies have been able to provide services more efficiently, effectively and responsively. In many instances, they have been able to provide services that could not have been provided any other way. The GIS Programs at the DNR and Transportation provide rich examples of agencies that have benefited from their investments in GIS. But it is evident that the benefits are not equally available to all agencies. Across state government there is the full range of "GIS Haves" and "Have Nots." Transforming GIS from an agency or program-oriented technology to an enterprise technology can provide enormous value to the state – enhancing the benefits already provided by the "Haves" and bringing the benefits of GIS to the "Have Nots." The most tangible benefits involve maximizing the value of the large investments that the state makes in GIS, but the full catalog of benefits is extensive.

4.1 Reducing the Cost of GIS

Controlling costs is one of the principal drivers for an enterprise approach to GIS. An analysis of agency GIS programs reveals that the existing investments are large and that geospatial activity at the agency level continues to grow rapidly. Driven by consumer-oriented location technologies, such as GPS navigation for cars and boats and web-based direction finding from MapQuest, Google and Yahoo!, a growing awareness of the benefits of GIS has resulted in a demand for GIS within agencies that are only beginning to develop their capabilities, such as Human Services and Public Safety.

It can be expected that GIS costs will continue to grow as GIS continues to become more widely adopted as a fundamental business tool. Even assuming a 10% annual increase, unchecked, costs could approach $30 million per year by 2018. An enterprise approach to deploying geospatial technologies should reduce the rate of increase of GIS costs by half through strategically deployed enterprise services, reduced redundancies and other operational efficiencies. As many of the examples below imply, as the state builds common geospatial infrastructure, the barriers to entry – including cost - for new geospatial participants are drastically lowered. As the state more fully develops its infrastructure, new agencies will not face the costs of building their own infrastructures, rather they will absorb the far lower costs of "plugging in" to, and leveraging existing resources.

To illustrate the possibilities, the following agencies have, are planning, or desire "geospatial viewers" to visualize their program data. Rather than investing in the same solution within each of these agencies, a single enterprise application could be deployed to display standard "Minnesota Base Data" overlaid with agency specific data, while still allowing agency specific branding. The following instances illustrate the opportunity.

- The **Board of Water and Soil Resources** has existing plans for a geospatial data viewing application.

- **Education** has future plans for an internal geospatial data viewer and a Public School/District finder/viewer.

- **Health** desires a viewer to provide performance data about nursing homes and a viewer to disseminate data about on-going crises.

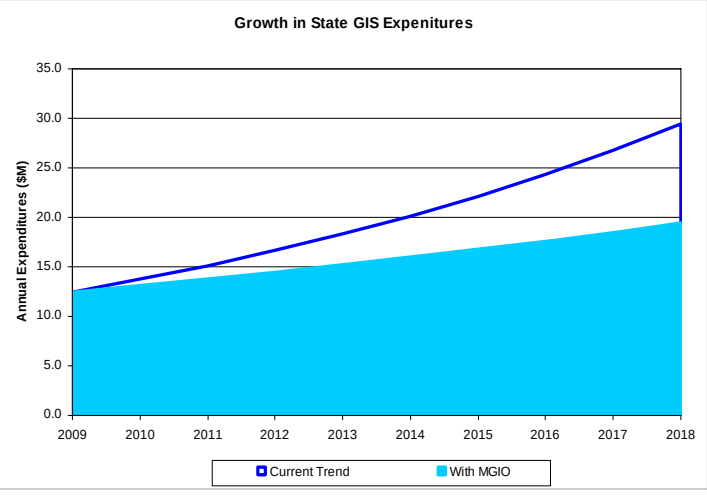
- **Labor and Industry** could improve internal processes with a spatial data viewer that provides base map data for research workplaces, job sites, and home locations.

Reducing the overall costs of GIS is not likely to be an achievable goal in an environment where geospatial technology is becoming increasingly widespread and essential. Nevertheless, an enterprise approach can certainly help Minnesota *control* the costs of GIS and would provide a substantial return on investment by significantly avoiding future costs.

Due to the widespread and diffuse use of GIS across many units of government, modeling future GIS costs for all of state government is a challenging and elusive task. In fact, the GIS cost to government analysis completed as part of this project (see section 3.2) is one of very few assessments of this type. The absence of raw data requires GIS cost modeling to rely on a set of reasonable assumptions. The core assumption of the model presented below is that GIS use and expenditures will continue to grow for the foreseeable future. The growth comes in two types. First, agencies that have made existing investments will continue to reinvest in the technology as their capabilities grow, they become more reliant on the technology, and as the technology penetrates into new bureaus and divisions. Second, there is enormous potential for growth in agencies that have not yet made significant investments, such as both Human Services and Public Safety.

Even in tight fiscal times, some level of additional investment is expected as some larger, multi-year initiatives will be under way and because strategic GIS investments can promote efficiencies that save money (e.g. optimized vehicle routing). In addition, when fiscal conditions become less constrained there may be pent up demand and the potential for accelerated investments in those years.

Figure 2 illustrates how a state government-wide enterprise approach to GIS can reduce costs. This model assumes state government GIS spending to be $12.5 million in 2009, which matches the conservative estimate generated in the cost to government analysis in section 3.2. It is reasonably estimated that future GIS cost growth will average 7% - 10% annually. This is a reasonable and conservative estimate given that Daratech, as reported by GIS Café, estimated that GIS "growth in the public sector averaged 15% per year for 2004 – 2006"[7].



The graph shows the results of the model using the higher 10% annual growth rate and assumes that an enterprise GIS approach will slow growth to 5% annually after the implementation of the

[7] See: http://www10.giscafe.com/nbc/articles/view_weekly.php?section=Magazine&articleid=301162 for the full text of the GIS Café article from September 4, 2006.

MGIO. Based on this model, in 2018 the state would potentially avoid up to $10.1 million in costs for that fiscal year. The raw cumulative avoided cost would be approximately $42 million over ten years. If it is assumed that the full funding increase of $2.2 million per year that is recommended later in this report to build-out the MGIO was provided, the cost increase of implementing the enterprise GIS program over 10 years would be $22 million. Thus, there would be approximately $20 million of cumulative cost avoidance[8] after the implementation of the MGIO. Even assuming an expected growth rate of 7%, the model yields a positive return on the $2.2 million of annual funding increase necessary to *fully* fund the MGIO. Under a 7% GIS cost growth scenario, the enterprise approach could be expected to yield a net benefit of $4.1 million over the ten year period (i.e. $26.1 million of cost avoidance for a $22 million investment).

4.2 Improved Coordination

Almost all state agencies using GIS report extensive intergovernmental interactions and data sharing requirements. Many agencies actively engage county governments to obtain locally created GIS data sets. Many of them also interact with Federal government partners on geospatial matters. Finally, most agencies report that they routinely work with and share data with other agencies within state government. Despite this extensive interaction, these activities are fragmented and often seem as chaotic as coordinated, especially to local government partners. Most agencies acknowledge that their coordination activities are not comprehensive because they are unable to dedicate resources specifically for coordination. In short, agencies recognize the value of coordination but are only able to coordinate on an opportunistic and part-time basis. The MGIO would provide the single point of contact and the full-time coordinating capability that the state needs.

4.3 Reduced Duplication

There currently are at least 15 distinct GIS programs within state agencies. This is a natural result of how GIS has evolved and how GIS has been funded – often for specific projects. They vary in size and complexity, but every one of them bears the costs of staff, technology, and overhead. In more than a few cases, these programs are inadequately staffed and funded, which severely limits their value. Although consolidating these into a single GIS service provider is not advisable, GIS software now allows for server and web-based implementations that can meet agency needs using a common infrastructure based on accepted standards. Providing GIS services through a smaller number of well integrated "Shared Service Centers" (SSC)[9] would allow for a significant reduction in the number of small free-standing GIS programs while improving the level of service at the same time.

[8] Please note that none of the figures in this analysis have been discounted for net present value and thus the benefits would be somewhat smaller if adjusted into present value.

[9] Please note that the term "Shared Service Center" is synonymous with the term "Center of Excellence" that was used previously in several documents that were prepared as part of this project.

4.4 More Efficient Data Storage and Management

Many agencies store copies of the same data on their own servers, including very large data sets such as aerial imagery.[10] While physical disk space is relatively inexpensive, data collection and management costs could be reduced by maintaining common data within a coordinated geospatial data library.

4.5 More Effective Software Licensing

Historically, GIS software has been purchased by individual agencies, sometimes by several individual different program groups within agencies. Although they receive a government discounted price, the state neither receives the benefits associated with volume nor from shared use of common licenses. Newer software licensing models, including pooled "floating seat" licenses and enterprise license agreements (ELA), if implemented properly, provide opportunities to effectively share licenses across agencies while decreasing the overall number of licenses and increasing the utilization of existing licenses.

Almost all of the 16 agencies interviewed use ESRI software. A LMIC survey of the use and importance of ESRI software determined that more than $550,000 was spent in FY2008 on ESRI software maintenance and new licenses. Analysis of likely benefits resulting from successfully negotiating an ELA with ESRI indicate that the rapid growth in license costs can be stabilized and costs per user could be reduced by a minimum of 20% per user. Even without an ELA, an enterprise approach based on inter-departmental license pooling would reduce the overall license count and create the ability to re-constitute the mix of licenses by potentially retiring unused desktop licenses in lieu of server licenses.

4.6 Shared Web Applications and Services

Deploying GIS capabilities through browser-based applications provided by web servers is an important and increasing trend. For small agencies or recent adopters of GIS, the most cost-effective GIS deployment strategy may be web-based applications. However, the capital costs and expertise necessary to effectively deploy web applications can be large. These agencies should be able to avoid these problems since existing capability – and potentially, even excess capacity – already exists within several state agencies.

The following agencies maintain GIS application server environments requiring hardware, software licenses, system administration, and performance monitoring:

- **Agriculture.** Hosts 12-24 web internal/external applications.
- **Board of Water and Soil Resources.** Supports and maintains eLink, a landowner data editing tool used to plot best practices implementation areas.
- **Education.** Is building a GIS infrastructure to host a few applications that support the Food and Nutrition Service.

[10] Agencies reporting that they store one or more copies of statewide imagery include Natural Resources, Transportation, Agriculture, BWSR and Administration (Land Management Information Center). Others are known to store copies as well.

- **Natural Resources.** Maintains publicly accessible GIS applications including: Airphoto Browser, AniMap (animal habitats), Recreation Compass (place finder), and Landview (open source GIS viewer suitable for mobile computing).

- **Pollution Control Agency.** Hosts two very popular public facing web applications: "What's in my Neighborhood" and "Environmental Data Access"

- **Transportation.** Maintains about 15 web-based applications. These applications are moving to ArcGIS server as soon as possible.

- **Land Management Information Center.** Maintains a data center with a variety of ESRI and open source applications, a statewide orthoimagery web service, and the Minnesota Geospatial Data Clearinghouse.

4.7 Coordinated Data Acquisition, Collection and Compilation

Several agencies are already collecting data from county governments, even the same data. This duplication could be eliminated by coordinating these efforts and making the data available to all state agencies. The following examples illustrate the opportunity.

- The **Metropolitan Council's** MetroGIS program maintains data sharing agreements with the seven metro counties for collection and distribution of county parcel data.

- **Natural Resources and Transportation** are pursuing county data sharing agreements and data collection for data sets such as parcels. To date, data from approximately 30% of the state's counties has been assembled by DNR. This program could provide a statewide framework for parcel data collection.

- **Transportation** and the **Land Management Information Center** conducted a statewide parcel map inventory survey in 2007 to maintain updated information about the state's county-based cadastre systems. This inventory will provide data that will help reduce Transportation's data collection costs.

4.8 Common Data Distribution Portal

Several agencies maintain services that provide GIS data available to the general public. The number of services could be reduced by creating a limited number of comprehensive libraries that contain the state's GIS holdings that are not restricted from public access. The following agencies all maintain public geospatial download capabilities.

- **Health.** Distributes drinking and groundwater protection data from a publicly available web site.

- **Land Management Information Center.** Coordinates the Minnesota Geographic Data Clearinghouse. The clearinghouse provides access to a wide variety data and metadata from state agency, federal, and other sources.

- **Legislative Coordinating Commission.** Hosts a public download site for distribution of legislative district boundaries.

- **Metropolitan Council.** Maintains the publicly available DataFinder repository to distribute over 200 data layers.

- **Natural Resources.** The Data Deli provides access to most of DNR's data holdings and some spatial data from other state agencies.

- **Transportation.** Provides access to current multi-model data through a use of web map services.

4.9 Strategic Data Investments

Agencies generally make their GIS investment decisions on an individual basis. Although the primary drivers for such decisions may be the agency's own business requirements, over time agencies have built similar systems to address similar business requirements. There can be significant savings derived by having agencies jointly invest in common geospatial data development needs.

For example, several agencies are investigating, or have built geospatial applications to support similar field inspection activities. Using the field inspection application example, two different agencies' requirements may overlap by 60%. As such, it may be more cost effective to pursue a joint project that employs configurability or a service-oriented architecture that can meet both the common and unique needs of the agencies than it would be to pursue two separate projects. In addition, when approaches such as configurability and service-oriented architectures are pursued, there are additional opportunities for these applications to serve as enterprise frameworks that other agencies can benefit from if, and when they encounter similar business requirements. Examples of geospatial areas that were of interest to multiple departments include:

- Field and inspection applications
- Statewide addressing/geocoding
- Land records management
- Asset management
- Emergency response
- Automated vehicle location and fleet management
- Data development programs (e.g. statewide high resolution elevation data)
- Stimulating local government geospatial spending through matching funds

Multiple agencies are expanding the use and deployment of **mobile GPS/GIS** capabilities for data collection and field applications. Each is investing in research, procurement and application development. Multiple standards and best practices will reduce enterprise efficiencies inhibit integration.

- The **Board of Water and Soil Resources** field staff and summer interns collect wetland information.

- **Agriculture** uses GPS/GIS enabled mobile computing for facility inspection that is integrated with enterprise business systems. MDA is a potential mobile computing shared service center.

- **Transportation** maintains a 30 station, statewide geodetic control network providing real-time error correction and sees mobile GPS/GIS is the agency's largest growth area over the next several years.

- **Natural Resources** uses GPS to aid the mapping of Minnesota Lakes to support fish and wildlife management. Natural Resources has developed a extension to ArcView to directly transfer data between handheld GPS receivers and various GIS software.

Multiple agencies suggested the strong need for a single **statewide addressing** initiative to develop processes and systems to provide a statewide addressing capability that includes: validation, geocoding, navigation, and routing.

- **Agriculture** purchased TeleAtlas data for geocoding in rural areas. Agriculture would consider contributing to statewide addressing efforts because there is potential for significant return.

- **Commerce** inspects and calibrates thousands of scales and fuel pumps throughout the state. Efficient inspection routing is strongly desired.

- **Corrections** accesses many address-based data sources to aid in fugitive search and apprehension. Supervision of juvenile probation in 55 Minnesota counties requires efficient routes and agent assignment. Geocoding and routing capability are desired for increased agency efficiency.

- **Education** currently maintains an address geocoding capability. The need for accurate geocoding in remote rural areas is acute.

- **Health** needs a standard address format; existing address cleaning techniques do not meet federal mandates.

- **Labor and Industry** issues more than 300 electrical inspection refunds yearly for inspections performed outside the state's jurisdiction. Address validation tools would help resolve these errors.

- **Revenue**, a licensed user of The Lawrence Group (TLG) and TeleAtlas road centerline data, supports the geocoding of all businesses and individuals that report tax information. DOR maintains advanced geocoding tools that are used by LMIC for bulk-geocoding.

- **Transportation** maintains a web-based geocoding service based on MnDOT centerline data.

- The **Metropolitan Council** is planning a unit level address collection application for use by counties without GIS capability. They are also working on a regional geocoding service.

- Several other agencies – including **DEED**, **Human Services**, and **Public Safety -** expressed the need for better statewide address information and related geocoding capabilities.

Most agencies have a need for **emergency operations** that need, or would benefit from GIS data and technology in response to emerging events. Agency jurisdictions overlap, yet response is currently not integrated and some activities, such as map production and data sharing are uncoordinated and may contribute to inconsistent results. Some emergency response examples include:

- **Agriculture** performs response and cleanup of regulated chemical spills.

- **DEED** assesses the impact on employers and workers by conducting employment density and commute shed analyses in case of a bridge collapse or other natural disasters.

- **Health** has numerous emergency response requirements for ad hoc mapping and cloud release modeling.

- **Labor and Industry** responds to natural disasters to determine the amount of structural damage and determine habitability.

- **Natural Resources** occasionally produces spot aerial imagery in response to natural disasters.

- **Transportation** is required to assist state agencies and local governments in the event of natural and technological disasters/emergencies. Transportation coordinates emergency response among the various transit modes (road, rail, air, and waterway).

- **Public Safety** needs access to the best and most current geospatial data to support its multiple emergency response organizations.

4.10 Better Trained Staff

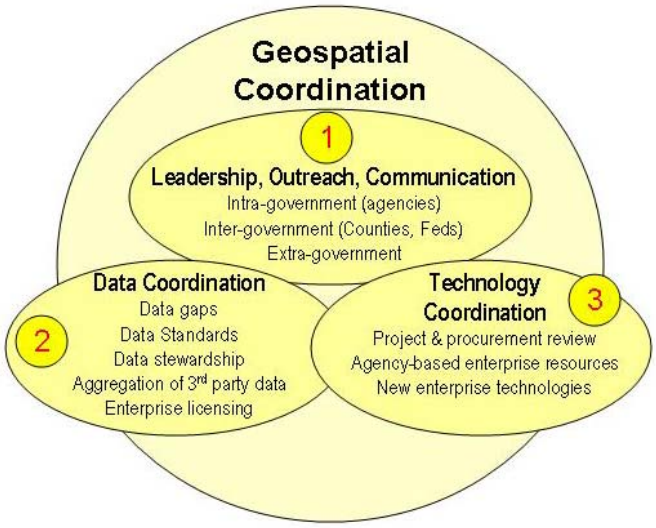
All agencies occasionally require expertise and services that are not available within the agency (e.g. consulting expertise, training and staff augmentation). Coordinating access to these specialized resources across agencies could **reduce overall costs** and provide for enterprise-wide **consistency** and levels of training.

- Smaller agencies like **Commerce** have no dedicated GIS staff and little exposure to best practices. Post-training support was identified as crucial to effective use of GIS as a communication tool.

- Large agencies like the **Agriculture** use outside consultants for on-going training and application development needs.

5 Activities: Coordination

Based upon the analysis of GIS uses and requirements documented by this study, it is recommended that a Minnesota Geospatial Information Office be established that would be responsible for eight activities organized into three program areas. Of the eight activities recommended for the MGIO, the three within the "geospatial coordination" program area are distinctly oriented towards coordination. These three activities will provide the leadership and guidance needed to develop, promote and support strategic solutions to meeting the geospatial technology needs of state agencies, their partners and their customers. These three activities are:



- Leadership, Outreach and Communication
- Data Coordination
- Technology Coordination

5.1 Leadership, Outreach & Communication

As the value of GIS becomes increasingly apparent to state agencies seeking more effective and responsive ways to pursue their missions, they often recognize that successfully implementing GIS requires major investments in data, technology, and staff. Even mature programs depend on other organizations for much of the data they utilize. Emerging programs are totally dependent on data from other sources and, more often than not, on processing or services that may be provided by other organizations.

Active coordination is needed to ensure that data and infrastructure can be shared and appropriate standards are identified or developed, and then implemented. However, no strong mandates drive individual agencies to coordinate their efforts and they reasonably give coordination activities a lower priority than their internal agency mandates. This can remain an instinct in a tight fiscal environment, when coordination becomes even more important to successfully implementing GIS.

A state MGIO would fill the gap between agency-specific missions and the need for coordination, providing leadership for state agencies and active outreach to the state's partners and customers. Primary benefits would include leveraged investments that benefit all state agencies, reduced duplication, and stronger adherence to standards. Numerous other benefits such as increased public access to information would also result from a more coherent and strategic approach to investing in, and deploying GIS within state government. In order to

maximize the benefits of coordination, the MGIO would undertake three forms GIS coordination, which are more fully described below:

- **Intra-governmental.** Coordination between state agencies
- **Inter-governmental.** Coordination between the state and other levels of government
- **Extra-governmental.** Coordination between the state and non-government institutions

5.1.1 Intra-Governmental Coordination

These coordination activities focus entirely within state government, with the goal of achieving the full benefits of treating GIS within state government as an enterprise resource. To realize the full benefits of an enterprise approach to GIS, the state needs to actively promote and orchestrate agency-to-agency communication and collaboration. Such coordination would yield several broad benefits:

- Shared funding of significant investments (e.g. statewide orthophotos)
- Development of communal resources available to all agencies (e.g. web services)
- Lower barriers to entry, and assistance to agencies commencing GIS for the first time
- Removal of unnecessary redundancy
- Increased awareness of GIS initiatives and programs within state government.

Specific intra-governmental coordination activities include:

A. Strategic plan guidance and implementation
The MGIO would work with stakeholders to develop, guide and implement a strategic plan for making GIS resources and services available throughout state government. Updating a state government GIS strategic plan on an annual, or bi-annual basis would remain a priority for the MGIO. The MGIO would work with state agencies to encourage the development of departmental geospatial strategic plans. Once plans have been developed, the MGIO would guide the development of implementation strategies and participate in plan implementation and the monitoring of results.

B. Policy, legislative and budget coordination
The MGIO would work with agencies to identify common requirements and opportunities for collaborative projects and funding. This would include identifying mutual requirements for legislation that would clarify GIS responsibilities and/or provide funding for statewide GIS initiatives such as orthoimagery re-flights or statewide addressing. The MGIO would take the lead in presenting and managing legislative and budget initiatives through the legislative process.

C. Communication with agency GIS leads
Geospatial coordination is a two-way street. While the MGIO will provide resources and energy to catalyze increased levels of communication and coordination, the MGIO needs an

identified universe of agency GIS leads. Most agencies that have been performing GIS for an extended period have well identified GIS leadership within their own organizations. However, in other agencies GIS activity is performed on a more ad hoc basis, limited to specific projects or program areas. Early on, the MGIO should work with agencies to identify a clear "agency GIS point of contact." Subsequently, the MGIO should foster regular communication with agency leads to communicate new statewide developments and to better understand agency activity.

D. Maintenance of GIS portfolio and promulgation of agency best practices
The MGIO would be responsible for effectively communicating with agencies to help establish and maintain a statewide, cross-agency portfolio of GIS activity. Using this portfolio, the MGIO would be able to identify and disseminate state agency *geospatial best practices* that can guide other agencies pursuing similar projects. An example of a best practice that may have wide applicability to a variety of agencies would be "data stewardship" practices for GIS layers. This activity is closely aligned with other efforts that are described below in Section 7.2.

E. Identification of opportunities for collaboration and leveraging resources
By tracking geospatial activities across the enterprise and maintaining a portfolio of geospatial activity, the MGIO would be able to identify where opportunities exist for departments to pursue joint projects that both meet agency needs and help build enterprise resources. The MGIO could help guide agencies newly involved with GIS technology towards departments that have geospatial resources or experiences to share.

F. Support for advisory groups
The MGIO would provide staff support to its advisory groups -- the existing Governor's Council on Geographic Information or its successors. Staff support may include scheduling and coordinating meetings, taking meeting minutes and taking on other tasks identified by the advisory groups.

G. Non-geospatial information technology coordination and communication
Although the MGIO would be involved in extensive, cross-departmental communications about technical matters, discussions may not be limited to geospatial issues. Because GIS cuts across many disciplines and is applied to many business problems, the MGIO would have opportunities to better understand agency perspectives on a variety of technologies and applications. While the MGIO cannot be expected to address all of these issues, it can act as a conduit about issues and opportunities to other organizations such as OET.

5.1.2 Inter-Governmental Coordination

These coordination activities focus on relationships between the state and other governmental entities – local, regional and national. The state already has extensive interactions with other governmental partners within the state as well as with neighboring states and the Canadian government. However, much of this interaction occurs on an agency-by-agency basis – even at times through multiple contacts within a single agency. While departmental level communications will need to be maintained for certain activities - such as collecting local government data sets – the MGIO can provide leadership in "doing it once for the enterprise." Some partners, such as the Federal Geographic Data Committee (FGDC), prefer working

through a primary "coordination entity" for each state to improve the federal government's coordination practices. The MGIO should be formally recognized as the geospatial coordination entity for Minnesota. Specific inter-governmental coordination activities include:

A. Communication and outreach to local governments
The MGIO would actively reach out to local governments – especially counties and regional agencies -- that have implemented GIS to help assemble a statewide portfolio of local GIS activity. Ideally, representatives of the MGIO would communicate with every county in the state on a regular basis and encourage a culture of inter-governmental data sharing.

B. Coordinate with federal GIS programs
The MGIO would actively monitor and participate in the federal government's GIS coordination efforts, especially those coordinated through the Federal Geographic Data Committee (FGDC).

C. Represent Minnesota within national organizations
The MGIO would formally represent Minnesota within the National States Geographic Information Council (NSGIC), which represents the interests of all states and advocates on their behalf to federal agencies. At a minimum, this involves attending two national meetings.

D. Communicate with neighboring states and Canada
The MGIO would actively communicate with neighboring states and the Canadian government to monitor and understand their efforts and to facilitate data sharing. This is especially important in order to provide GIS support for emergency preparedness and response. This also may identify opportunities for multi-state collaboration in projects for which cost efficiencies and economies of scale exist.

5.1.3 Extra-governmental Coordination

In addition to coordinating with other governmental stakeholders there are clear needs to coordinate with academic and private and non-profit sector GIS stakeholders. The MGIO's extra-governmental coordination activities will include working with utilities, academia, business and non-profit organizations.

A. Utilities
Utilities are major users of GIS to support their infrastructure management programs. The MGIO would pursue opportunities to develop agreements with utilities to exchange or share data and to contribute to investments that meet their shared interests. Utility data is especially important for GIS applications that support emergency preparedness and response, though much of their data is considered proprietary.

B. Academia
The University of Minnesota and MnSCU have developed a number of undergraduate, graduate and professional programs designed to train students to use GIS as well as programs that are more explicitly related to Information Technology. The MGIO would provide a mechanism for developing formal and informal relationships with these programs to provide

training, technical guidance and project support functions that the state may not provide on its own.

C. Businesses
The MGIO would identify private sector GIS service providers qualified to offer GIS services or support to state government and also work with them to promote the use of state GIS standards, particularly in work they do for local governments.

D. Non-Profit Organizations
The MGIO would communicate with non-profit entities to identify ways by which the state's GIS data and infrastructure can provide support for the work they are engaged in that promote public policy objectives.

5.2 Data Coordination

Geospatial data represent the largest investments that state government has made in GIS infrastructure. Thus, it becomes paramount that existing data investments are widely available to all state government users and that future investments are well coordinated between agencies. Formal geospatial data coordination would help address many existing challenges and would provide several benefits that include:

- Facilitating common access to the GIS data assets of the enterprise
- Facilitating increased levels of standardization and quality for newly created data
- Catalyzing the development of new data – for example statewide addressing – to fill existing data gaps and to support agency business requirements
- Clarifying data stewardship and user expectations for data reliability and the frequency of data update
- Streamlining the process for collecting, aggregating and making data available from commercial and third party sources (e.g. parcels collected from counties)

Broad participation in a coordinated data management process that would implement data standards and contribute to the construction of a widely used statewide geospatial data library would greatly aid the transformation of GIS in Minnesota. The following activities should be pursued to achieve this goal:

5.2.1 Improve Data Standardization

The MGIO should convene a working group of agency GIS coordinators to oversee the creation, implementation and evolution of appropriate data standards. Minnesota has adopted several relevant standards, but the increased level of geospatial activity and increased levels of intra-governmental and inter-governmental collaboration make standards increasingly important. Whenever possible, existing national and international standards, such as the FGDC's Geographic Information Framework Data Standards[11], should be investigated and adapted to fit

[11] See: http://www.fgdc.gov/standards/projects/FGDC-standards-projects/framework-data-standard/framework-data-standard-part5

Minnesota conditions. Ultimately, there is a need for standards that covers the following elements:

A. Data Library Model
Identifies the state data library layers and physical schemas, defines the library acceptance criteria, and determines the interaction mechanisms between federated library nodes.

B. Data Content
Defines format, structure, and access options to enable the widest use of the data in the library.

C. Data Quality
Determines accuracy, update frequency, and completeness benchmarks for constructing the highest quality data.

D. Metadata
Provides the best set of documentation to describe data characteristics and to inform decisions about appropriate use of the data.

E. Security
Describes access control parameters and protection methods for sensitive data.

F. Stewardship
Defines the custodial roles (e.g. management of data quality), responsibilities (e.g. assignment of change authority), and needs (e.g. timely access to current data to support agency mandates).

Once Minnesota data standards are established, the MGIO would monitor their use and develop incentives for compliance. For example, data must meet standards before they can be included in the state data library, or any entity receiving state funding for data development must adhere to standards.

5.2.2 Data Policy Development

The MGIO would be involved in developing and clarifying geospatial data policies on behalf of the enterprise. Examples of areas where such policies are required include:

- Interpretation of Minnesota's public records law and how they pertain to the state's own data as well as data that may be collected and aggregated from partners.

- Formalizing a process to identify data sets that contain private data or pose public safety and security risks. A well-defined data security policy would identify how data sensitivity is determined and would promote common policies across all state agencies. This would define privacy limits and promote sharing of non-sensitive data.

5.2.3 Coordinate Enterprise Data Programs

The MGIO would facilitate project design, and provide coordination and advocacy for multi-agency funded initiatives to meet common statewide needs that are beyond the purview of any single agency. Program types include:

A. Meeting Statewide Addressing Need

During interviews and at workshops the need for accurate and current statewide addressing, and an attendant geocoding web service, was identified by virtually all state agencies. Thus, it is recommended that a program be initiated to work with local and county governments to develop a process for creating and maintaining a statewide address data resource that contains the point location of all addresses in Minnesota.

B. Filling Statewide Data Gaps

Not all statewide data needed by state government currently exists. Over time, these gaps can be filled by undertaking new data creation initiatives to meet common needs across multiple agencies. Examples of existing data gaps include statewide high-resolution elevation data, common transportation network, and current statewide landuse/land cover data. The MGIO would help identify these gaps, advocate for support of new initiatives and work with agencies to design programs for developing new data.

C. Managing Recurring Data Programs

Once statewide data programs are established – for example, orthoimagery and addressing - they would need ongoing support for regular updating and coordination of technical program to complete the updates.

D. Executing Enterprise Data Licenses

Execute favorable state enterprise licensing for data products that are used by multiple agencies (e.g. commercial road centerline, demographic or business location data sets).

5.2.4 Coordinate State Agency Data Custodial Functions

Success of a state data library relies on the development of an empowered community of data custodians. Frequent interaction among custodians would ensure a uniform approach to the management of data that would ultimately reside in the statewide geospatial data library. The MGIO would have the responsibility to educate, inform, and promote interaction between all custodians and data end users. As described above, the MGIO can promulgate a clear set of stewardship guidelines and standards across state government. Other activities might include advocating for legislation to identify custodial responsibilities for data sets. Specific custodial coordination functions include:

A. Identifying Custodians

When a layer is identified for inclusion into the state data library, attendant data custodial responsibilities should be assigned, documented and tracked.

B. Supporting Agency Data Custodians

In some cases, agency data custodians may require assistance from the MGIO to bring data up to state standards in order to prepare them for inclusion into the state data library. The MGIO would support agency custodians in making these data preparations and would work

with custodians to facilitate the initial development of loading procedures for each layer in the statewide geospatial data library.

C. Maintaining Library Metadata Index

Ensure that all layers in the library have metadata that meets the metadata standard and is properly loaded into the library metadata index. The metadata from agency data libraries that may be part of an overall federated statewide data library must also be fully integrated into metadata index.

D. Ensuring Data Custodial Services

Provide the leadership for identifying, and potentially assuming data custodial responsibilities for data sets which may not have a formal, agency custodian (e.g. municipal boundaries, critical infrastructure). As required, the coordination entity may need to take on, or arrange to contract for, the custodial responsibilities for these "communal data sets."

5.2.5 Coordinating Data Partnerships

Building upon the coordination and outreach efforts to local and county governments described above, there would be a specific need for coordinating inter-governmental data sharing and data aggregation initiatives to build and maintain statewide data layers assembled from locally maintained data such as parcels. These include:

A. Increase Data Management Awareness

Educate local and county governments about the process of implementing state standards, the data aggregation process, and how to access the web services and data available in the statewide geospatial data library.

B. Establish Local Data Sharing Agreements

Establish data sharing agreements with as many local and county governments as possible. Such data sharing agreements should represent the interests of the entire enterprise of state government thereby eliminating or reducing the need for multiple agency agreements with a single county. Several agencies, including DNR and Mn/DOT, have pursued this activity for their own purposes and many more are interested in the resulting data. Clearly, this major effort should be completed once on behalf of the enterprise.

C. Assist Local and County Data Custodians

During the process of establishing data sharing agreements, the MGIO would identify local data custodians, who may require much of the same type of assistance as state agency coordinators before local data can be published as part of the statewide geospatial data library.

D. Collect Data From Partners

Provide the lead for the physical collection of local/county data sets, such as parcels. Develop and manage the model, workflow processes and procedures for the aggregation of locally collected data in preparation of import to the state data library. The actual execution of data aggregation routines would be accomplished by the "data services team" as described below (see Section 6.1).

5.3 Technology Coordination

One of Minnesota's primary GIS strengths is the strong departmental GIS efforts that have "grown up" over the past three decades in agencies such as Mn/DOT, DNR and PCA. These efforts represent a major knowledge base and infrastructure that can potentially be leveraged beyond agency boundaries to benefit the entire enterprise of state government. With many large agencies, such as Human Services and Public Safety only starting their GIS efforts more recently, there is great potential for new adopters to learn from the technology leaders and to share baseline GIS infrastructure.

Often several agencies are exploring or investing in similar technology, such as mobile computing and GPS. Where agencies make investments in identical, or similar, technology without coordinating with one another, redundant or incompatible investments may result, they cannot learn from common pilot programs, and training costs increase. There is an opportunity to reduce duplicate efforts and for agencies to benefit from investments made and experience gained by other agencies.

Other business processes, such as software procurement and data licensing, are done individually by all agencies. Organizational efficiencies can be gained by coordination of these activities by a single entity, such as the MGIO,

The MGIO's unique perspective can provide a holistic view of GIS related projects across multiple agencies and can be instrumental in helping to make this happen by performing and/or expediting *technology coordination* activities, which include the following.

5.3.1 GIS Project Reporting

Sharing knowledge about departmental projects across the enterprise would help identify opportunities for cross-departmental synergy as well as existing use cases and best practices. To maximize this potential, new projects should be recorded within a "GIS portfolio database" at their inception, and not at their conclusion. In addition to identifying opportunities for collaboration, this kind of routine project reporting would help provide early warnings for redundant initiatives. In addition, as the state strives for efficient deployment of geospatial technology, the project reporting process would help the state visualize and manage the full and growing portfolio of geospatial activity and track the overall costs to government. The project reporting aspect of technology coordination is closely aligned with other program elements that open the intra-departmental communications channels (see Section 5.1 above) and create tools for sharing information within the portfolio database across agencies (see Section 7.2 below).

5.3.2 GIS Procurement Review

To improve the effectiveness of State investments in geospatial technology the MGIO should be involved in a review of geospatial procurements that exceed a particular threshold (e.g. $50,000). Such a process would track the technologies that departments are investing in, identify opportunities for potential enterprise licensing while also providing the opportunity to identify existing enterprise or departmental capacity that might be used instead of a new procurement. As with the project review process, this type of review would not imply an approval process. Rather, it would be a reporting mechanism that provides the opportunity for the state to better

understand its geospatial expenditures and track its portfolio of GIS equipment, software and data.

5.3.3 Integration with Enterprise Systems

Increasingly, many commercial, enterprise systems include "GIS modules" that provide the ability to geospatially enable those systems. Two current Minnesota examples of such systems are *DisasterLAN* which is being deployed in the state's Emergency Operations Center (EOC) and *Archibus* which is being deployed by the Department of Administrations as part of their Drive to Excellence Property Management project. Such systems have specific requirements for GIS data and connectivity in order for those modules to properly function. Given these scenarios, the MGIO entity could provide GIS support to agencies pursuing the deployment of these types of software systems by:

- Clarifying the GIS data and connectivity required for integration
- Communicating with vendors about geospatial issues
- Assisting agencies in developing RFP/specifications for enterprise systems that define GIS integration requirements (i.e., GIS integration should be considered early in the process, not after a system is already selected)

5.3.4 Identify and Assist in Implementing Shared Service Centers

As described above, many departments have extremely mature GIS operations and well-developed capabilities to service a diverse range of programs. In some cases, these departments have the capacity to act as "enterprise resources" that provide capability/service to other departments. Such an approach would increase enterprise efficiency leveraging existing resources and expertise. Examples of existing agency capabilities that may be ready to be scaled to function as "enterprise shared service centers" include:

- DNR's "Data Deli" and LMIC's Geographic Data Clearinghouse for public dissemination of geospatial data
- Mn/DOT's ArcGIS Server application hosting infrastructure
- DNR's Open Source web service hosting infrastructure
- LMIC's image hosting and image service infrastructure

While the technology and approaches exist to scale these types of efforts across the enterprise, there is not currently a mechanism to provide the additional staffing, or other resources, necessary for a department to provide enterprise-wide capabilities. Ultimately, agency personnel have a primary responsibility to their own organizations. The MGIO would be able to work with agency managers to develop appropriate tactics for enabling agencies that can serve as shared service centers to have the resources necessary to interact with and support the requirements of other agencies. Options might include compensatory funding, formal interagency resource sharing agreements, or having MGIO staff embedded within agency SSC's to provide an "enterprise outlook."

Additional administrative planning for deploying enterprise shared service centers will need to tackle:

- Requirements to establish Service Level Agreements (SLAs) that will define the performance and availability expectations for users

- Working with agencies on appropriate budgeting and accounting procedures to properly account for their investments in shared services, data and infrastructure

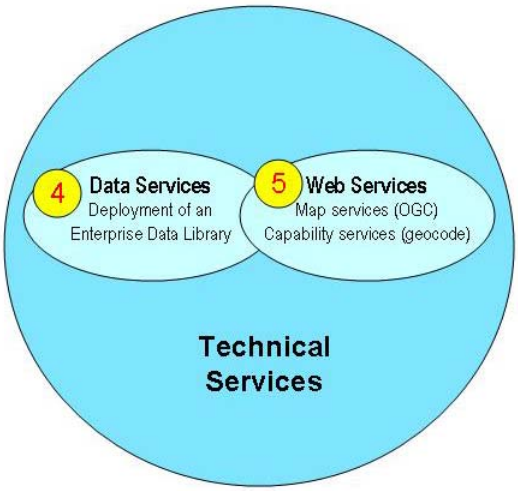
Once the appropriate mechanisms for deploying enterprise SSC's are established, the MGIO would help agencies deploy the enterprise resources, advertise their availability and foster their use within the state government user community.

5.3.5 Identify Enterprise Approaches for New Investments

Many new geospatial *technologies* are emerging or being adopted, such as mobile device GIS applications and automated vehicle location (AVL) systems. Individual agencies now investigate and/or deploy these new technologies independently. The MGIO, partially through the procurement review process describe above, would work with agencies to identify opportunities to deploy these new technologies as enterprise initiatives at the outset. This includes identifying opportunities to pool agency resources to meet common and enterprise needs.

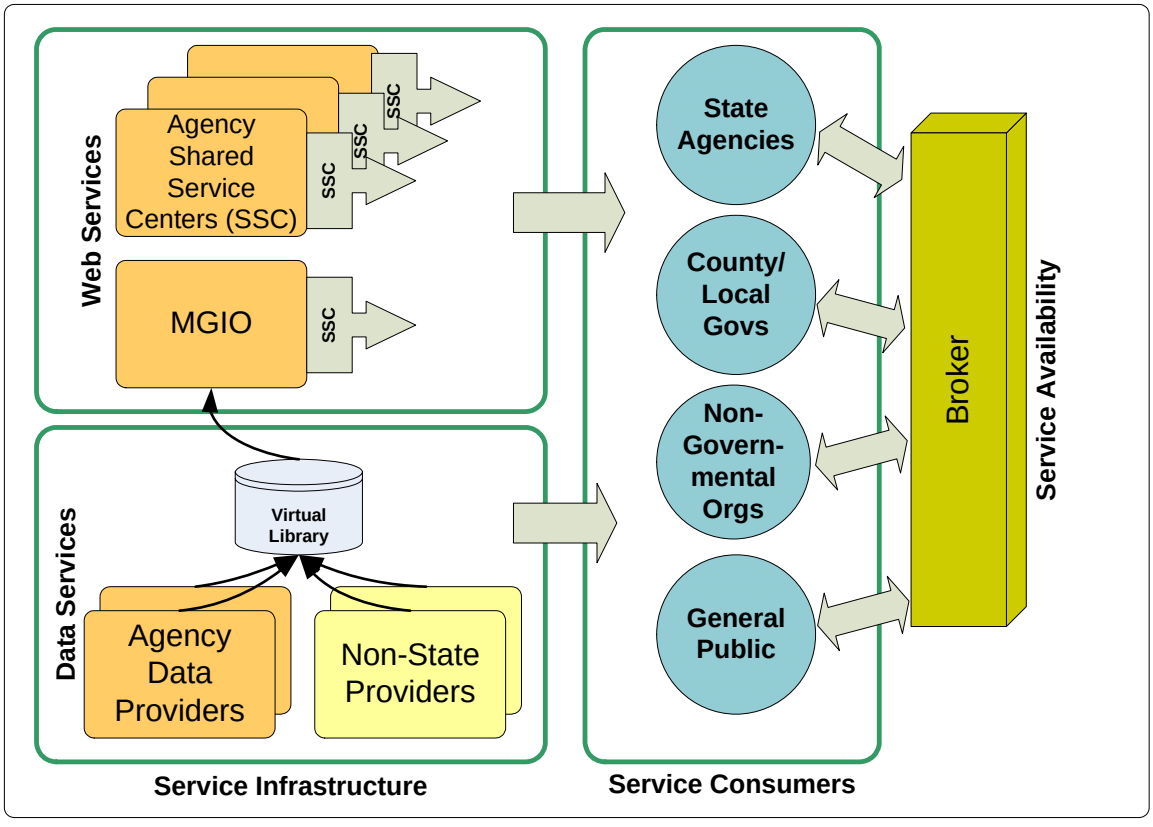
In addition to new technologies, there may be common needs for new *applications* that can support multiple departments. Applications such as facility/asset management and vehicle routing optimization to conserve fuel and promote green government are examples that interest several departments. While the procurement review process should help to identify these opportunities, the MGIO should also work with agencies to support project design and execution so that these types of projects can result in enterprise-wide resources and infrastructure.

6 Activities: Technical Services



In addition to the coordination elements, a transformed, enterprise oriented GIS for Minnesota will require a **technical infrastructure** that provides the data, tools, staff and knowledge to develop, implement and support the deployment of communal GIS technology that provides support to the entire enterprise of state government.

In addition to resources provided by the MGIO directly, data and web services may be provided by Shared Service Centers (SSC) managed by state agencies and other partners. To facilitate this, the MGIO would provide, or coordinate a "broker" function that would publish information on new services and how to access them as they become available and monitor service availability and performance. The figure below illustrates the overall conceptual architecture for a Minnesota state government enterprise GIS, composed of data services, web services and a broker that facilitates access to the services.



Conceptual Architecture for Minnesota Enterprise GIS

6.1 Data Services

With many spatial data providers and an increasing number of spatial data consumers, there is a growing need for reliable methods to search for and access to the best available state data. Standardized, reliable, and efficient access to data is necessary for the development of an enterprise infrastructure. Sources of data can be combined from multiple agency collections into one, or more, logical data libraries. These libraries, described by frequently updated metadata indexes, can provide widely known and accessible interfaces that provide data access to the most current agency and statewide data. Well organized data services will increase overall awareness of the existing data and ensure the likelihood that data is accurate and kept current.

One of the core roles of the MGIO would be ensuring that there is a smooth, and when required, secure flow of data between state government agencies and also between the state government enterprise and other public and private sector partners. Minnesota's data assets represent the State's largest GIS investments and ensuring that all parts of state government have access to these data will help the State derive the largest returns on its data investments. To accomplish this, the MGIO would have a central coordinating role in identifying, inventorying, documenting and when necessary, collecting and aggregating the state's data so that they are readily accessible to all that need them. This would involve the following activities:

6.1.1 Inventorying Data

Minnesota requires the creation and maintenance of a comprehensive index of all state government GIS data. In many cases, departments with mature GIS operations (e.g. DNR, Mn/DOT) will already have indices of their own holdings and these can be consolidated into the statewide index. In other cases, the MGIO may need to work with departments with less mature GIS operations to develop these indices and include them in the statewide listing. Once assembled, appropriate mechanisms for keeping the index current will need to be established.

6.1.2 Documenting Data

In addition to assembling an index of all available data, the MGIO should work with agencies to ensure that all data holdings are properly documented with metadata. Although many agency data sets already contain metadata, other agencies will need support in creating metadata. LMIC has been a strong advocate for documenting geospatial data using the Minnesota Geospatial Metadata Guideline (MGMG), which complies with the Federal Geographic Data Committee (FGDC) metadata standard. MGMG was adopted in 1998 as one of the State's first data standards.[12] LMIC also has provided training, documentation tools, and support for metadata development. A key early task for the MGIO would be to update the Minnesota metadata standard to comply with proposed FGDC revisions and enhance support for a standard metadata environment across state government. The metadata environment should support both the metadata tagging of data elements as well as the ability to query and search a metadata index that may be an element of the data inventory described above. As appropriate, metadata development tools, such as those at the DNR, could be selected as enterprise resources that are made available to all of state government.

[12] For details about this standard and resources to support it, see http://www.lmic.state.mn.us/chouse/meta.html.

6.1.3 Establishing Geospatial Data Library

In addition to being able to discover data and understand its characteristics through the data inventory and metadata activities described above, the MGIO should facilitate the development of a "statewide geospatial data library" that would enable agencies to gain access to the data they need, and that may be created and maintained by other agencies. Establishing an effective statewide library would be a large undertaking and an ongoing effort that would likely consume a large amount of the MGIO's early data focus. Many alternatives exist for constructing such a library and the MGIO would need to work with a team of technical advisors from state agencies, and potentially other important partners such as MetroGIS, to finalize a technical approach and final architecture. Early on, the MGIO should be focused on constructing this resource. Later on, it would be responsible for managing the resource in association with data contributors.

The key technical issues and alternatives revolve around whether to pursue a **centralized** or **federated** approach, or whether a **hybrid** alternative would work best.

A. Centralized Library

While a centralized approach with all data assets housed in one physical location is conceptually simpler, such an infrastructure can be redundant to what several agencies already have in place. In addition, a fair amount of active effort will need to be devoted to ensuring that the centralized resource contains all of the latest data from contributing agencies. A benefit to the centralized approach is that it provides an on-line backup of agency data holdings and provides a disaster recovery asset. This approach also provides the ability for mature agencies to house local replicas of the centralized data library. This would further the backup and disaster recovery benefits and it may also provide performance benefits for local users within those agencies.

B. Federated Library

While modern technology supports federated approaches better than ever, the fact remains that the overall performance of federated approaches is limited to the slowest server that is being accessed. Under a federated approach an agency may need to access several servers and/or web services to gain access to all required data and this could inhibit performance. Equally, not all agencies will be in a position to host/publish their data assets to the enterprise as this requires specialized hardware, software and personnel. Unless all agencies have the appropriate technology and capabilities a comprehensive federated approach is not possible.

C. Hybrid Library

Under a hybrid approach, agencies that can host/publish their data sets could do so, and a centralized resource could be established to house the data assets of agencies that do not have hosting/publishing capabilities. Similarly, the centralized resource could house "communal" data sets needed by many agencies such as orthoimagery, census boundaries and commercially licensed data such as street centerlines. Since a hybrid approach requires the creation of a centralized resource, this obviates the "redundant infrastructure" critique of the centralized approach to some degree.

Ultimately, this resource will need to be carefully designed and constructed in coordination with agency data custodians. Most likely it would be deployed incrementally and in phases that may embody elements of all three approaches.

Under all circumstances, ushering in some type of data library solution, that accounts for all data holdings, and that in combination with the *data inventory* and *metadata* activities allows all state government agencies to *both* **discover** and efficiently **access** geospatial data should be an integral component of the MGIO's mission.

Once the library is established, the MGIO should maintain a technical assistance capacity for the creation of Extract, Transform, and Load (ETL) procedure and other formatting techniques for populating the of statewide geospatial data library from agency data sets. When possible, automated techniques such as geospatial data replication should be employed.

6.1.4 Communal Data Holdings

Regardless of the data library approach that is taken, the MGIO would need to be involved in identifying, assembling and making accessible several classes of data that are not necessarily owned by any single agency but that are required/desired by many agencies. This work will be closely aligned with the data coordination activities described above in Section 5.2. While the data coordination activities will focus on ushering these data into existence and formalizing licensing and use agreements, the technical activities described below involve managing these data and making them available to users through a server infrastructure. These data sets include:

A. Enterprise Data
These include layers, such as aerial orthoimagery, that may be co-funded by multiple organizations and that are used by almost all GIS users. Other examples may include layers such as municipal boundaries for which a formal custodian does not exist and where the MGIO may provide or facilitate data maintenance.

B. Licensed Data
These data include layers such as commercial street centerline or business location data. The MGIO may facilitate obtaining enterprise licenses for these data and serving the data may involve some use restrictions (e.g., commercial data may not be available for public use and/or download).

C. Aggregated Third-party Data
Most commonly, third-party data would be aggregated from county and local governments. Parcel data provides a good example of third-party for which there is large state agency demand. Once the data have been acquired, they would need to be processed into a standardized format and/or normalized into a common data model and managed on servers. In addition to the technical aspects of this effort, the MGIO would need to develop appropriate relationships and agreements with county data providers. Because of disparate data distribution practices at the county level, it is unrealistic to expect that all counties will participate at the outset, but over time the MGIO should develop appropriate incentives to foster further participation.

6.1.5 Data Access

Assembling all of the state's geospatial data holdings into a physical and/or virtual data library is a critical first step. Once the data are inventoried and assembled, appropriate access to the data needs to be established for a variety of uses by a diverse range of users. As with the data library,

the MGIO would need to work with an agency technical advisory team to establish a framework for providing appropriate access. The following describes the different types of access that would be required:

A. Data Synchronization

The ability to update and replicate data holdings into a centralized or hybrid data library, as well as the ability update and replicate data into locally hosted databases. This ability should enable data custodians to control the timing of data updates.

B. Network-based Data Access

The ability to access data holdings using the state's high speed network and geospatial data management software (e.g. ESRI's ArcSDE). Such direct access should provide the most flexible and highest-speed means of accessing data from desktop GIS software.

C. Web Mapping Services

The data library should provide access to consumable web mapping services for both web applications and desktop GIS software. Most likely, access would be provided using the variety of specifications and standards published by the Open Geospatial Consortium (OGC). This capability is further described in Section 6.2.

D. Data Download

The data library should support the ability for state agencies, partners and the public to download data holdings that they need. The specific download capabilities that will be offered, and the tools to support those capabilities, will be designed and constructed over time. Examples of desirable capabilities include but are not limited to:

- **User specified extents.** Allowing users to limit their data download to predefined areas, such as counties or municipalities, or to interactively identify a bounding box for data downloads.

- **User specified formats.** Allowing users to choose among several common formats for receiving their data downloads. Formats may include: ESRI (e.g. SHP, geodatabase, etc.), OGC (e.g. GML, KML, simple feature, etc.), or DXF (e.g. a CAD interchange format).

E. Data Viewers

In some cases users may not actually require access to the data themselves, but access to "pictures" of the data. To satisfy these needs, a suite of browser-based GIS Viewers may be created that allow the public and novice users to gain simple, visual access to data.

The table below introduces likely access types that should be supported, organized by user type.

User Type	Data Synchro-nization	Network Data Access	Web Mapping Services	Data Download	Data Viewers
State agencies	X	X	X	X	X
Data partners	X		X	X	X
General public			X	X	X

6.1.6 Data Security

Many of the activities described above imply distinct levels of access for different classes of user. As such, an integral component of any data library solution is an appropriate role-based security mechanism. In addition to limiting access to capabilities, such as "network data access" there may need to be role-based access restrictions for individual data sets. For example, Human Services and Public Safety often develop or maintain data containing sensitive information that cannot be shared outside of the agency. The data library must be designed so that those agencies can use the data library with the confidence that their data is secured and that access is appropriately controlled. The MGIO will need to design role-based security that reflects the legal framework established by the Minnesota Data Practices Act, the Federal Freedom of Information Act, and other laws that either limit or require access. In addition, the security policies and protocols must be consistent with ongoing OET efforts to establish enterprise-wide identity management.

6.2 Shared Web Services

GIS web services can be broadly defined as relatively small network based applications that provide geospatial data, maps and discrete GIS functionality (e.g., geocoding) based on simple, standards-based application programming interfaces (APIs). Web services can be consumed by web sites, enterprise applications as well as by desktop GIS software. Web services are becoming an increasingly common element of statewide geospatial programs and several state agencies are applying this approach now.

Web services are a relatively simple way for larger agencies to build their GIS infrastructure and make GIS capability, such as address geocoding, available for users within the agency as well as other users outside the agency. All agencies can combine web services from multiple providers to create GIS applications that have access to the most accurate data and the most advanced geoprocessing capability.

The implementation and maintenance of a broader program of coordinated web services accessible to all state agencies and, potentially the general public, presents a significant opportunity for GIS transformation. Web services offer the potential to provide GIS users across the state with the ability to easily access common geospatial data and basic GIS functionality with minimal amounts of hardware and software. This would have a broad impact on the efficiency of GIS operations and would substantially increase the quality, reliability, and consistency of GIS data presentation.

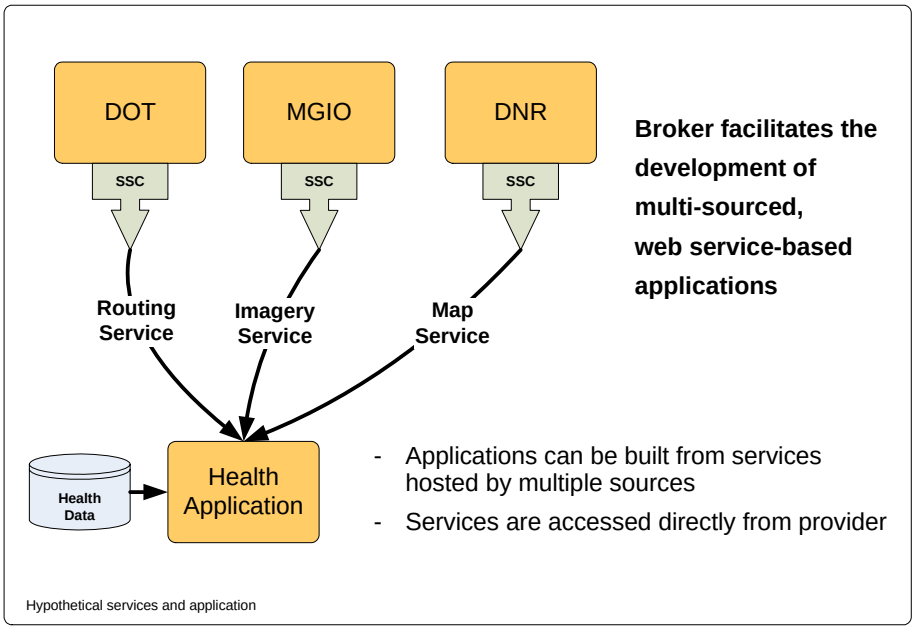
Building a web services program presents not only a technical challenge, but it would also require substantial administrative coordination and management. While initial investments will be needed to establish the necessary infrastructure, over time many efficiencies will be gained through a highly re-usable, non-redundant mechanism for accessing GIS data and functionality. The MGIO should oversee a web services program that involves the following activities:

6.2.1 Technical Architecture and Web Service Design

The success of web services is rooted on the quality of the data presented, the reliability of the services, and the simplicity of their use. Setting, or adopting existing standards for services

interfaces, service catalog access, and service performance levels are key early activities that are necessary for a coordinated enterprise-wide system. An incremental implementation strategy will need to be developed which should enable early deployment of simple high-priority services, encourage the addition of new capability, and allow for continuous improvement. Standards setting and technical architecting will need to be a collaborative effort between the MGIO and the agency user community, especially more mature agencies that have already invested in web services.

As with the data library, key initial decisions revolve around whether there will be a single, centralized provider of services, or whether services may emanate from multiple SSC points within the enterprise (e.g. MGIO, Mn/DOT, DNR, etc.). As illustrated here, it is feasible to pursue an architecture where many independently managed services can be brought together in a single application.



In all cases there is a distinct need for ongoing coordination with service consumers (e.g. end-users) and potential service providers which may include non-state partners such as MetroGIS, and potentially even commercial service providers (e.g. for weather data). Planning and design efforts should focus on:

- Adopting/setting appropriate web service standards (e.g. for geospatial, the numerous existing Open Geospatial Consortium standards[13], as well as for web services in general, such as SOAP, WSDL, REST, etc.)
- Prioritizing required services
- Avoiding unnecessary redundancy in service deployment
- Delivering high levels of performance and availability, including strategic redundancy for fail-over and disaster recovery

A web service design process should determine the functional capabilities of the individual services that are to be developed. Potential services identified through the MGIO planning effort include:

A. Map and Feature Services

In general, map and feature services are accessed through requests for layers for a specific area (e.g. identified through a bounding box). Map services provide an image (e.g. JPG,

[13] http://www.opengeospatial.org/standards

PNG) depicting the requested layers. Feature services deliver the geometry of those layers, typically in a simple, standard format (e.g. GML).

- **Minnesota Base Map.** Would provide a map service that could be consumed by GIS viewers and desktop GIS applications such as desktop ArcGIS and DNR's Landview. Having one common base map that includes parcels, roads, hydrography, shaded relief as well as administrative boundaries would eliminate the necessity of creating new base maps for each new application, or ad hoc map. A common map service would provide cartographic and geospatial data consistency for all map presentations. Map services can be optimized for presentation at various scales, and can also include scale traps so that some layers are not drawn at scales where they would not look good. Today, several agencies already provide map services and these have the potential to serve as a baseline for a more comprehensive base mapping web service solution.

- **Orthoimagery.** An imagery service would provide access to the latest orthoimagery, as well as historic othoimages and would greatly reduce the need for local storage and server capacity. An orthoimage web service, using the OGC WMS specification, is currently deployed by the Land Management Information Center (LMIC) and is widely used. In addition to providing access to statewide imagery, the imagery service should be capable of providing access to higher resolution imagery acquired by local governments for more limited geographic extents.

B. Geospatial Capability Services

In general, capability services are accessed through requests, and return *data* to the requesting application. For example, a geocoding service would make a request by providing an address, and the service would deliver back to the application the "data" containing the latitude/longitude coordinate pair of the address. The following are services that agencies reported they needed.

- **Geocoding.** An address or PLSS coordinates are provided to the geocoding service which returns a geographic location (Latitude/Longitude).

- **Address Verification.** An address is submitted, compared to list of valid addresses, and an address status is returned.

- **Mailing Labels.** A set of parcels ids is provided and a set of addresses, potentially formatted as PDF mailing labels, is returned.

- **Routing and Scheduling.** A series of feature locations is provided and the most efficient route to visit all locations is returned.

- **Reverse Geocoding.** Location coordinates are submitted and the nearest address is returned.

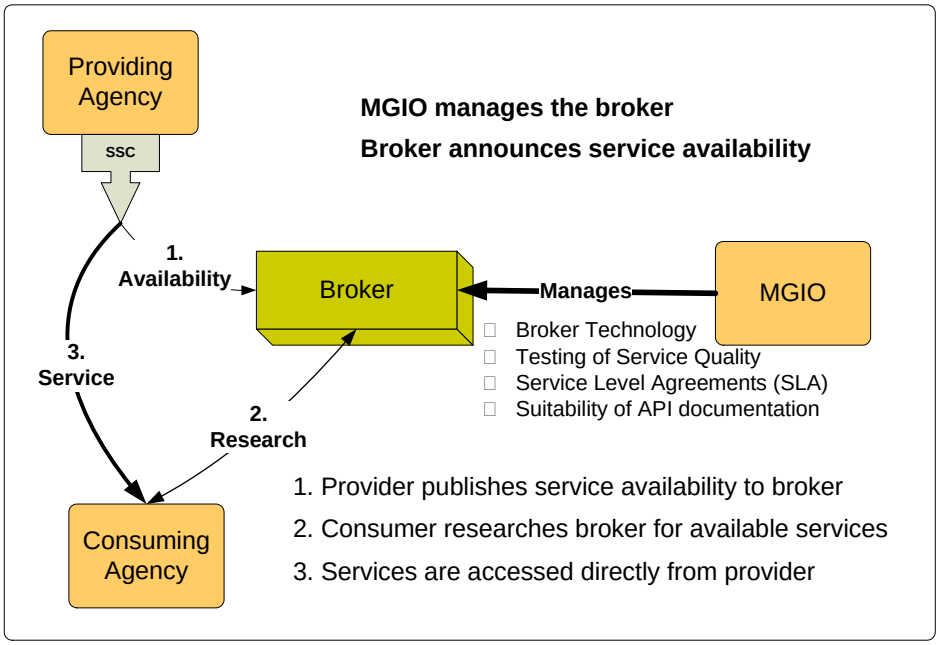
- **Point-in-polygon.** A point location and a polygon (i.e., layer name, feature-ID) are submitted and a returned status indicates if the point is inside the polygon.

6.2.2 Web Service Catalog and Broker Management

Given that web services may not all emanate from a single source, and in fact may come from several state and non-state sources there can be challenges in both finding and understanding how to access the services. These challenges can be overcome by managing a catalog of available web services. The MGIO can manage a coordinated effort that will employ a combination of manual and automated processes to build, maintain, and publish the catalog. The MGIO would serve as a "broker" and work with partner agencies and other service providers to collect information about currently available services. These would be registered in an on-line catalog that can be referenced by application developers and map authors to provide information about how to both find and use the services. LMIC already has begun to develop a catalog of services that would support the broker function, called the MN GeoService Finder, which currently lists close to thirty services that are available for any agency's use.[14]

An on-line web service demonstration should be developed to illustrate how existing services could be used by client applications. This type of interactive tool could serve as a support mechanism that provides an overview of how web services work and could serve as an entry point to the catalog of available services.

On an on-going basis, the MGIO will maintain the catalog, acting as a broker that will manage the service publishing process. Management will involve testing, accepting, performance rating, registering, and announcing services that are ready and acceptable for state government use. An element of the service broker function is to monitor the performance of services that are hosted by state government to ensure that they are performing up to service level agreements. As illustrated in the broker diagram, the broker announces service availability and authenticates service quality, however, the services are accessed by consumers directly from the providers.



The broker function also will involve working with service developers to identify problems with services, to manage issues reported by the user community and to provide input for new features and upgrades.

[14] The MN GeoService Finder site can be accessed at http://www.lmic.state.mn.us/GeoServiceFinder/.

6.2.3 Coordinating Data Access

As identified in Section 6.1, there needs to be close coordination between the web services team and the data services team. Ultimately, web services need to be relied on to deliver the best and most current data. As such, they should access the current contents of the data library or a replica of the library.

6.2.4 Web Service Development

The MGIO should maintain a capacity to collect requirements, build, test, and deploy web services. It is possible that this capacity will be derived, or supplemented by other state agencies, other levels of government, academia, the private sector, or other partners.

6.2.5 Web Service Administration

Once constructed, the web services infrastructure would require system and application administration. Portions of this work – for example, hardware administration within a data center - may be outsourced to OET. Administrative functions also include identifying potential models for funding web service operations, maintenance and potential expansion. The administrative functions can inform capacity planning based on utilization monitoring. This type of information can help determine whether cost recovery models, such as assessments and/or user fees, are feasible and appropriate and what the fees might be.

6.2.6 Managing Service Level Agreements (SLA)

When agencies commit to using web services, especially for mission critical applications, it is essential that they receive a commitment for the performance and reliability they can expect. Such commitments should take the form of Service Level Agreements (SLA) between the organizations that host services and those that consume them. Some service providers may not be prepared to adhere to SLAs and their services should be identified as such. However, services that are deployed by the MGIO, or endorsed by the service brokering function should provide this information so that potential consumers can make informed choices about how to architect their solutions. Such SLAs will be increasingly important in an environment where access to services is funded through assessments, charges or and/or user fees). Periodic review of the current SLAs and testing of the web services should be performed to ensure that SLA metrics are being met.

7 Activities: Support & Guidance

The MGIO should have an important role in assisting state government agencies to become and continue to be effective users of GIS technology. This would be especially valuable to organizations who are GIS newcomers, but even departments with mature GIS operations would benefit through reduced training costs, better trained partners, and the availability of special expertise to support short-term needs or technically demanding projects.

As with any far reaching technology, it is difficult for an organization new to GIS to develop the expertise necessary to effectively introduce and incorporate GIS into the organizational structure, even when the benefits of doing so are recognized. Because GIS has the potential to affect so many aspects of that structure, it can be overwhelming, leading to an "I don't know where to start" feeling. At the same time, several Minnesota departments have a long history of utilizing GIS and they have much to contribute via a mentoring mechanism.

7.1 Training

All GIS users in all agencies require training on new technology. Most agencies outsource training to third party vendors. A significant opportunity for saving could be realized by combining training requests form individual agencies into a single coordinated program. Consistent levels of training and cost savings can be realized through the creation of a coordinated training and user support program.

The ability to develop a suitable foundation in the use of GIS through appropriate training is central to all state agencies' effective and efficient application of GIS to everyday business tasks. There are various levels of GIS users across state government, including:

- **Casual users** who have an occasional need to view and query maps
- **Analysts** who use GIS to manipulate data and produce reports or maps
- **Power users** who use GIS on a daily basis to perform their jobs;
- **Database administrators** who are responsible for the creation and maintenance of GIS data
- **Developers** who create custom GIS applications for desktop or web environments.

Teaching someone how to use a piece of software is not enough. An understanding of data and the application of GIS to an agency's specific business tasks and workflows is also critical in becoming an effective user of GIS technology.

The MGIO could support state enterprise GIS training requirements in two key ways: coordination and instruction.

7.1.1 Training Coordination

The MGIO could serve as a one-stop shop for identifying training needs and the means to meet those needs. Specific tasks will include:

A. Training plan
The training required for a user to get up-to-speed with GIS or with a specific aspect of GIS varies depending on the level of user, as described above. The MGIO could help to develop a training guide that outlines appropriate training for different types of users. This would be especially useful to those organizations that are in the early stages of implementing GIS.

B. Training directory
An online directory of GIS training opportunities readily available from training vendors as well as through local colleges and universities would simplify the task of discovering training options. This resource would also include a directory of vendors who provide training services and might be engaged for custom training. If this directory could be updated directly by the organizations providing the training, the responsibility for keeping the directory current would not fall on the MGIO itself. The advertising that such a directory would provide serves as an incentive for those organizations to keep the information updated. An option for students to rate classes would provide a motivation for vendors to provide the best possible training. A Wiki-type of environment would also allow users to add other resources such as online training options, books, useful tutorials, etc.

C. Pooling and training discounts
Many vendors offer reduced per student tuition for classes that meet a minimum required size. It often is difficult for a single agency or department to meet the required number of students. The MGIO could coordinate across multiple organizations to determine interest in specific classes in order to meet the requirements for discounted training rate.

D. Track training needs
The MGIO could conduct an annual survey of training needs across state government to identify areas where large-group classes should be pursued or custom training could be developed to meet similar needs for multiple organizations.

E. Application-specific training template
All agencies would benefit from application-focused training tailored to the organization's own data sets and specific business needs. While each agency is unique, the MGIO could develop an outline or template detailing how to develop a custom class. The class could be created by agency staff or by a training vendor.

F. Establishment of alternate delivery methods
Some users may not be able to attend classroom-based training. Also, some training needs may be met by less than a full day of instruction. Alternative training delivery methods, including video-conferencing and web-based virtual classrooms, can be effective for addressing these needs, especially where regional office staff are a long distance from formal

training opportunities. The MGIO could help vet these types of offerings and could assist in finding or providing facilities for non-classroom training.

7.1.2 Provide Basic GIS Training

There is no requirement that the MGIO becomes a "training organization" in light of other cost-effective options for receiving current and quality instruction. However, all new GIS users will require a basic introduction to the concepts of GIS and a tour of the state's existing, available data. Providing this type of basic training offers the opportunity to introduce the MGIO to new users and build relationships, while reinforcing the idea of the MGIO as an important resource for facilitating GIS within state government.

In addition, the MGIO's complementary data coordination and data services roles (see Sections 5.2 and 6.1) dovetail well with the genuine need for training about available state GIS data and their uses. Data training is a second class that could be provided by MGIO staff, perhaps supplemented by presentations from agency data custodians and the attendee agencies concerning additional agency-specific data issues and limitations.

7.2 Technical Guidance

A common frustration expressed by organizations that are in the early stages of implementing GIS is that they do not know where or how to start. Organizations with more developed implementations can encounter the same frustration, for example when implementing newer technology or migrating to new versions of hardware, software or databases.

In addition, there is much to learn from mature GIS organizations that have already sorted through a variety of common issues that may be encountered when establishing GIS throughout an agency or department. Individual users often have an expertise in a particular software or aspect of a software program, or a skill in a particular type of process such as database design or project management.

The long history and deep institutional knowledge of GIS possessed by several agencies that have been engaged and committed to GIS for decades represents an enormous resource for the state government enterprise. The MGIO can play a key role in helping to leverage that resource by identifying knowledge resources and coordinating the sharing of that expertise.

Specific ways in which the MGIO could provide and/or facilitate technical guidance include:

A. Resource directory

An online directory of people who are willing to share their specific expertise or skill in a coaching role would be a valuable tool to all state GIS users. The directory could also include other resources, such as an index of user groups and best practices, and could perhaps be combined with the training directory, as described elsewhere. The MGIO could create and host such a directory and allow individuals to update their information directly.

B. Mentoring coordination

The MGIO could help foster more formal arrangements between organizations to create a mentoring relationship. The role of the MGIO in this case would be to act as "matchmaker"

to help the entity desiring help find the best match from available mentors. Recognizing that these types of relationships impose costs on the agencies providing expertise, the MGIO could also help document the net benefits to the enterprise and advocate for sensible cross-agency resource sharing.

C. Development of best practices documents

The development of a "mentor directory" will identify individuals who are best suited to create best practice documents for a variety of topics, including project design, project management, data maintenance, mobile applications, implementing web technologies, etc. The MGIO could help develop a template for best practice documents to help facilitate the creation of additional documents by agencies. Once created, such documents would be indexed and published via the resource directory described above.

D. User group coordination

User groups organized around specific technologies (e.g. open source technology), level of user sophistication, or application type can provide a valuable forum for providing support and learning opportunities to all members of the group. While the MGIO may participate in various user groups, it would remain important for these groups to be organized and led by *users* and not the MGIO. For example the existing informal State Agency GIS user group (SAGIS) should remain under its current leadership and organization. That said, the MGIO can support user groups like SAGIS by disseminating information about them, providing facilities for such groups to meet, and actively encouraging the creation of additional groups.

E. Technical support hotline

A user who is frustrated with a technology is less likely to use that technology. One way to address this frustration is for the MGIO to provide immediate phone support to state GIS users. Such a hotline would provide a first point of contact for common problems and if the hotline cannot address a question they can provide reference to resources that may be able to provide further assistance (e.g. a software vendor's technical support). Providing a hotline sets an expectation that the hotline will be available and that there will be immediate, competent help. The MGIO could dedicate staff to a hotline or contract this service to a vendor. As described below, see Section 7.3-D, such "first point of support" capabilities can be part of enterprise license agreements for GIS software.

Ultimately, for the MGIO to provide effective technical guidance there must be a commitment by participating organizations to work cooperatively for the benefit of others, and for the enterprise. This will not happen without cabinet-wide organizational support for the coaching and mentoring elements of this program and potentially some form of compensation for the loss of staff time to the more mature "provider" agencies.

7.3 Consulting and Project Support

While LMIC has historically provided extensive project production capabilities on a fee-for-service basis, it is recommended that these activities be transformed and potentially reduced, over time. It is most important that the MGIO receive adequate resources so that many project support activities can be provided to agencies that require them without cost. Rather than maintaining an in-house "service bureau" that would produce projects, this team would be largely viewed as in-house "project design consultancy" that would provide *support* services to

agencies without charging fees. Given the large number of new departmental GIS efforts, there is currently a great need for support in designing GIS projects and data products and in weighing technical alternatives.

Under most circumstances, the MGIO will be viewed as a resource that can help get agency projects *started* in a smart fashion. However, for the most part the MGIO will not be viewed as means of producing those projects. Instead, in most cases project production will be handled by the numerous available resources in the academic and private sector communities. Exceptions that might continue to be pursued on a fee for service basis may include agency projects that are particularly germane to enterprise initiatives as well as providing assistance to agencies that are performing quality assurance/quality control (QA/QC) on work that is contracted to the private sector. Under this new model, the majority of MGIO consulting and project support would not replace development work within agencies, or by their contractors. Rather, the MGIO would be focused on providing assistance to get agencies started and to provide ongoing advice.

In addition, at times the MGIO itself may pursue GIS projects on behalf of the enterprise, for example, the planning, coordination, management and quality-control for projects to create new statewide aerial imagery or statewide addressing. Also, this capacity would enable the MGIO to provide support for special projects that might emanate from the Governor's Office (which does not have its own GIS capacity). Thus, the same GIS analyst and project management staff skills necessary to provide inter-agency support are also available to help manage such efforts.

The following describes several project support and consulting activities that should be provided by the MGIO:

7.3.1 Project Design

Agencies starting out with GIS may have limited abilities to fully understand GIS capabilities and alternatives and to think creatively with the technology. The MGIO's project design capacity would be a resource that these types of agencies could tap to discuss their requirements and to understand what might be possible. The capacity would also help agency personnel to begin designing and budgeting projects to efficiently meet their needs.

7.3.2 Database Design

Since data products are costly to create and also often outlive the projects that create them, it is critical that they be well designed. The MGIO project support team should be in a position to provide advice and assistance in efficient and effective data design to agencies that are pursuing data development initiatives. Database design issues where guidance may be provided include:

- Geospatial data structuring (e.g. feature classes, topologies, etc.)
- Adherence to existing standards
- Approaches for managing attribute data, including linkages to external, transactional database systems
- Data optimization (e.g. spatial and non-spatial indexing strategies)

- Review of proposed designs that come from agencies, or contractors working on behalf of agencies

It is important to note that database design for large and complex systems or data sets can be a time consuming and involved process. The MGIO should be expected to provide guidance and input, it should not be expected to produce final, detailed designs for significant databases.

7.3.3 Procurement

Given that the MGIO would have very limited ability to produce projects on behalf of agencies, project support activities should assist agencies in finding appropriate partners for getting project work done. Potential partners include the strong geospatial programs in several Minnesota higher education institutions as well as private sector consultants. Procurement support should include activities such as:

- RFP design and development
- Geospatial product and project specification
- Development of functional requirements
- Contractor selection criteria development
- Identification and evaluation of commercial, off-the-shelf (COTS) solutions

7.3.4 Geospatial Master Contracts

In addition to providing procurement support, the MGIO should take the lead in establishing enterprise-wide master contracts for common geospatial products and services. Such contracts would provide expedited means of procuring geospatial products and services and would save significant agency administrative time involved in running large numbers of individual procurements for similar products/services. In addition, the MGIO should work with agency GIS personnel to understand what kinds of contracts are required and are most desirable and then work with the Department of Administration to issue procurements to put these contracts in place. As appropriate, the state could consider executing these contracts in such a manner that other levels of government (e.g. counties) could buy off of these contracts as is done in other states. This would provide benefits by leveraging the state's purchasing power to benefit non-state GIS stakeholders. Examples potential master contracts to pursue include:

- **Master Services Contract for geospatial services.** Such contracts provide a list of pre-qualified vendors that can propose on individual opportunities emanating from agencies. Under this type of contract pre-qualified vendors compete against one another based on scopes of service. Minnesota currently maintains such a contract for GIS services.
- **MGIO Task Order Contract for geospatial services.** Such a contract would involve a formal indefinite delivery/indefinite quantity (ID/IQ) relationship with one, or more geospatial service providers. Under such a contract, individual agencies could issue direct task orders to get work done by the winning firm(s) thereby streamlining the

process of initiating work. Funding for the work would come from agencies but be channeled through a master contract with the MGIO.

- **Master Purchase Agreement for geospatial software**. Such a contract would establish a relationship with leading geospatial software providers whereby the state could purchase products directly, and with favorable discount pricing.

- **Enterprise License Agreement (ELA) for geospatial software.** Such a contract would provide unlimited access to both desktop and server GIS software across the enterprise for a fixed annual fee, for a specific term (e.g. 3 years). Companies such as ESRI have been actively promoting these types of contracts to state government and the MGIO should evaluate whether this is desirable for Minnesota. In many ways, the ELA is an alternative to the Master Purchase Agreement described above. If an ELA were to be pursued, the MGIO would play an important role in implementing it across the enterprise including contract negotiation, allocating licenses and providing the required primary software support.

7.3.5 Project Management

As described above, the MGIO project support team should be composed of GIS analysts and project managers that have the skills to provide project support to agencies. These same skills would enable the MGIO project support team to take on and oversee new initiatives that are pursued by the MGIO itself, whether one-time special projects, or long term initiatives such as pursuing statewide addressing. These direct project management responsibilities would be balanced with inter-agency support activities depending on the volume of MGIO initiated projects. Initially, it is expected that the large majority of project support activities would be aimed helping other agencies that are getting started with their geospatial programs.

8 Staffing Requirements for a Successful MGIO

Successfully implementing and supporting an enterprise approach to GIS will require an adequately staffed and funded office, organized to support all eight of the recommended MGIO functions. To benefit from its existing informal coordination role and its capabilities, it is recommended that the staff and budget of the Land Management Information Center be considered to be the nucleus of the MGIO. However, with a new and expanded portfolio of activities, LMIC's staffing would need to be enhanced and, in some cases, reconfigured to perform the duties recommended for the MGIO. This section identifies the staff and general job descriptions required for a successful MGIO.

8.1 Staffing Needed for Coordination

A program leader, titled Geographic Information Officer, and a team of five (5) full-time equivalents (FTE) is recommended to fulfill the leadership and coordination activities described above, for a total of six (6) FTEs supplemented by an additional FTE for administrative support. There should be a dedicated, full-time employee for each of the three program elements – governmental coordination/outreach, data coordination, and technology coordination - that have been identified above. Ideally, there would be multiple people involved in fulfilling the far-reaching data coordination program element. In addition, it is anticipated that the MGIO Director would play a significant role in overall geospatial coordination and would be viewed as a leader of the state government GIS community. The following provides an overview of the job titles, skills and activities required for coordination, outreach and communication.

MGIO Program Director/Geographic Information Officer (GIO)

- Experienced manager
- State government experience
- GIS technology and management experience
- Strong, versatile communication skills

Government and Agency GIS Coordinator

- State government experience, ideally as an agency GIS practitioner
- Experience working with Federal and/or county governments
- Hands-on GIS technology skills
- Strong writing and verbal communication skills

Data Coordinator

- Strong hands-on GIS technology skills
- Experience with geospatial data automation and/or the management of GIS data automation projects
- Familiarity with photogrammetric processes and techniques
- Strong writing and verbal communication skills

Technology and Project Coordinator

- Strong hands-on GIS technology skills
- Experience with GIS application development and/or the management of GIS application development projects
- Familiarity with programming and data serving environments
- Database management system experience
- Strong writing and verbal communication skills

8.2 Staffing Needed for Technical Services

A team of up to four (4) FTEs is recommended to fulfill the technical infrastructure activities of the MGIO. At a minimum, there should be a dedicated, full-time employee for each of the two recommended program elements – data services and web services - plus a full-time Network/System Administrator. The following provides an overview of the job titles, skills and activities that are required to support the technical infrastructure.

Geospatial Database Administrator (DBA)

- Professional experience as a professional DBA and/or geospatial DBA
- Strong database management skills (e.g., SQL Server, Oracle, PostgreSQL, etc.) including database design and modeling, scripting as well as extraction, transformation, loading (ETL) routines.
- Strong experience with geospatial extensions to database management systems (e.g. ArcSDE, PostGIS, etc.)
- Experience with geospatial standards

Geospatial Web Service Master/Developer

- Professional experience as a web master and in administering web services
- Strong underlying web server skills (e.g. web server administration, web programming)
- Strong experience with geospatial and map services including ESRI (e.g. ArcIMS, ArcGIS Server) and Open Source (e.g. International Map Server, GeoServer) platforms
- Strong web programming and scripting skills (e.g. .NET, C#, python, JavaScript, etc.)
- Familiarity with Open Geospatial Consortium standards and specification (e.g. WMS, WFS, KML, GML, etc.)

Network/System Administrator

- Professional experience as a Microsoft system and network administrator
- Experience managing environments that include GIS software
- Hardware maintenance and management
- Microsoft operating system administration
- Familiarity with Unix and Open Source environments

8.3 Staffing Needed for Technical Support & Guidance

A team of up to five (5) FTEs is recommended to fulfill the MGIO's technical support and guidance activities. If full funding is not provided, three (3) may be adequate if the others can be funded out of project revenues, if it is determined that a fee-for-service operation should be maintained. Under all circumstances, there would be a dedicated, full-time employee to cover both the training and guidance program elements and another FTE to cover the project support program element. The project support coordinator would be supported by at least one GIS Project Manager/Analyst. Under some scenarios, there may be additional GIS Project Manager/Analyst FTEs to support the MGIO's own project initiatives as well as project support to other agencies. The following provides an overview of the job titles, skills and activities that are required for providing project support, training and guidance.

Training & Mentoring Coordinator

- Professional experience involving GIS training and/or coordination
- State government experience, ideally as an agency GIS practitioner
- Strong hands-on GIS technology skills
- Strong writing and verbal communication skills

Project Support Coordinator

- Professional experience in GIS project management
- State government experience, ideally as an agency GIS practitioner or manager
- Personnel management experience
- Strong hands-on GIS technology skills
- Strong writing and verbal communication skills

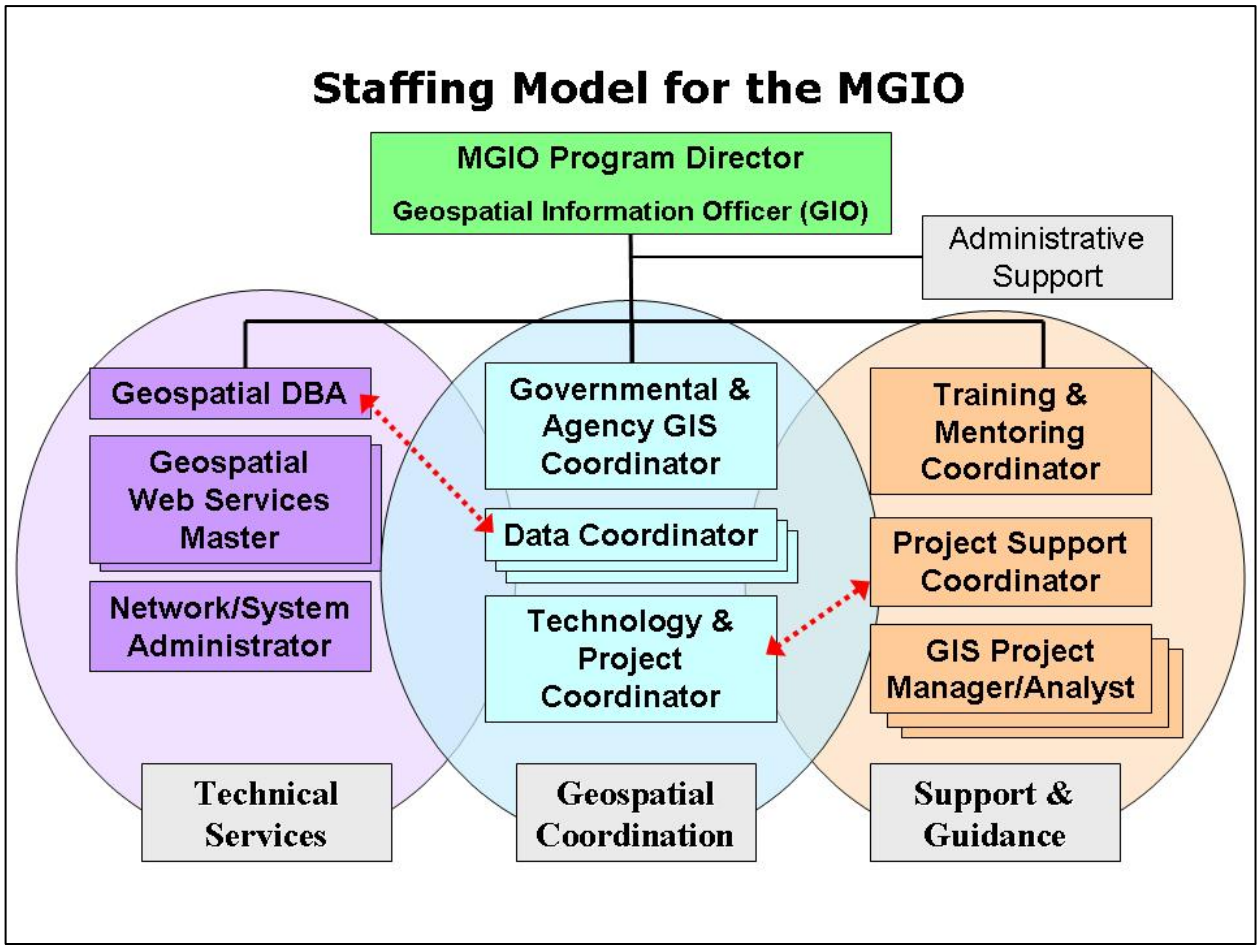
GIS Project Manager/Analysts

- Professional experience in GIS project management
- Strong hands-on GIS technology skills
- Strong verbal communication skills

8.4 A Staffing Model for the MGIO

The following presents an overall staffing model for the MGIO, assuming all of the positions are located within the Geospatial Information Office. This model attempts to rationalize the job titles and functions described above into a cohesive, organized team. The model does not specify the precise number of people comprising this team at the outset, as there may be several people with the same job title for a few of the positions, as suggested in the Staffing Model diagram.

The recommended full staffing level for the MGIO is 16 positions, with six (6) devoted to Coordination, four (4) for Technical Services, five (5) for Technical Support & Guidance, plus a full-time administrative support position. Scaling back from that level will require strategic choices regarding the relative importance of each of the functions. In order for the MGIO to have a realistic opportunity to successfully address all of the recommended functions, a single person for each of the 11 titles illustrated above should be considered a *minimal* staffing requirement. In Section 11, several scenarios for building this team are outlined, and these reflect varying levels of capacity based on different funding scenarios.



9 Risks and Implementation Barriers

Fully implementing the recommended Enterprise GIS Program represents a major organizational transformation that has attendant risks. Nevertheless, the most important risks and barriers to implementation are identifiable and can be managed if understood at the outset. The following are important risks and barriers that must be considered, and mitigated:

A. Missing the unique timing offered by the Drive to Excellence initiative. The use of geospatial technology in Minnesota is broad-based and substantially mature. Smaller agencies are looking for direction and leadership as they implement GIS into their everyday business workflows. Larger agencies are examining their role in the larger state agency community. The timing of the Drive to Excellence program is ideal and substantial effort has identified a workable program that has a broad base of support among stakeholders. There is a sincere desire for transformation within the enterprise. If this opportunity is missed, larger agencies are likely to focus on further developing their existing GIS silos and smaller agencies will continue to struggle in their attempts to implement meaningful GIS programs.

B. Losing senior executive support for the proposed transformation. Although this program emanates from Governor Pawlenty's Drive to Excellence initiative and has substantial senior level executive staff support and visibility, this support can easily be squandered if the current "window of opportunity" is missed or if the transformation to an enterprise-oriented view of GIS led by an MGIO is poorly implemented. It is especially important to maintain support of senior executives from essential participating agencies, such as DNR and Mn/DOT, but losing support of senior management in any agency can threaten the success of this transformation. Agency CIOs and GIS coordinators have been actively involved in this study and support its conclusions, but continued senior executive support remains essential to the transformation's success. These CIO's and GIS coordinators are well positioned to ensure that there is senior level knowledge and support of the initiative within their agencies. Such communications will help mitigate the risk of not having senior executives aware of, and supportive of the initiative.

Essential to the Enterprise GIS vision is the notion of cross agency geospatial resource sharing in the form of Shared Service Centers (SSC). Under this model, some additional departmental costs to scale up to provide services to other agencies may be required to realize broader benefits across the enterprise of state government. In order for this level of resource sharing to take place, executive level knowledge and support will be essential. This may include Commissioner support as well as gubernatorial support in the form of directives to impacted members of the cabinet. Without this level of support there are significant risks that some up-front costs will not be budgeted and that necessary organizational changes will not occur. Simply put, departments – especially those that are in a position to *offer* shared resources - may not choose to participate unless compelled.

C. Loss of agency GIS program support for the proposed transformation. Regardless of executive support for the transformed enterprise GIS program, grass roots support is needed at the agency level. In other words, there is a requirement that the most significant GIS players in the state actively and willingly agree that this program is worth pursuing. Toward that end, this planning project has been conducted in a transparent and participatory fashion

and there has been extensive effort aimed at having the existing GIS community help shape the program. There is a strong need for the people performing and managing the GIS work in these agencies to help advocate for support from their own senior executive management.

Agencies with GIS capability such as, Agriculture, Transportation, Natural Resources, the Pollution Control Agency and LMIC, already provide some services to other agencies. Under the proposed program, current *ad hoc* relationships and understandings will evolve into formal agreements. "Provider" agencies will need to remain engaged and support both the new coordinating entity and the smaller "consumer" agencies.

D. Perceptions of insufficient transformation. In addition to leveraging existing capacities of strong agency GIS programs, another key element of this program is the establishment of the MGIO to replace the existing Land Management Information Center (LMIC). By design, this new office is envisioned to have a significantly enhanced and different mission and focus than LMIC. While LMIC has served the GIS community well over a long period of time and there are many good historical reasons to retain the LMIC brand, many GIS stakeholders strongly believe that radical, not incremental transformation is required. To be blunt, significantly more than a name change and the rearranging of job titles is required.

The recommended enterprise GIS program represents the potential for this type of drastic transformation. It is imperative that this program be implemented in such a way that the new team possess the right mix of skills and experience to be successful and to add value to the new mission. Absent this level of transformation and the infusion of some new skills there is a risk that the stakeholder community will perceive this as a superficial change with inadequate capacity to carry out the new mission. The current LMIC staff skill sets will need to be evaluated in light of the different MGIO responsibilities with the potential of some changes or adjustments being needed. Without strong belief in the *level of transformation*, agencies may be less inclined to support and advocate for the initiative.

E. Inadequate funding. As with many transformation initiatives, some upfront resources are required for longer term efficiencies and benefits. Obtaining this near term funding support is crucial so that the transformation can take hold and so that the MGIO can assert appropriate leadership while demonstrating real value to the state government GIS community. Without funding beyond LMIC's current budget to carry out the new mission, there are risks that the new organization will be ineffective and the potential for fundamental transformation will not be realized. Fully understanding that the national and international economic situation will impact the state's ability to make significant investments, the modest investments called for in this program should yield meaningful short-term benefits and long term efficiencies.

F. Insufficient resources for cross-agency support and Shared Service Centers. One of the most delicate elements of the proposed program is cross agency resource sharing and the deployment of agency shared service centers (SSC) that can meet needs that go beyond the hosting agency. While excess hardware and software capacity may exist, it can be more difficult to free up the staff time that is necessary to communicate with, and act on behalf of agency partners. As such, the enterprise coordination program will require some level of resources, or other support that can be provided to agencies that host SSCs. Whether these

resources come in the form of funding, or staff assistance from the MGIO that may be embedded within the hosting agency, it is essential that they be available. Otherwise, there are significant risks that "user agencies" will not have their requirements met by the SSC. Equally, without such resources the host agencies may be less willing to open their infrastructure up to the enterprise.

G. Inadequate performance of shared services and resources. Minnesota has an established culture of resource sharing. As the use of GIS matures, critical business processes will consume data and services from *other* state agencies. It is imperative that shared resources have the ability to meet the consumer's performance and reliability requirements or else they will not be used. Service Level Agreements can define the service performance criteria and will help ensure that shared services are constructed with reliability, redundancy and high performance in mind.

10 Implementation Strategy

The Enterprise GIS Program described above is comprehensive and specific, but Minnesota has many options for implementing it. Although the fundamental changes in organization and governance structure need to take place rapidly, the implementation should be sequenced to reflect strategic priorities. In a fiscally constrained environment, some less critical program elements may need to be carried out later and through successive phases. The following describes a general implementation approach that presents overarching principles as well as guidance on phasing, transition, and initial prioritization of program elements.

10.1 Implementation Principles

Several principles have been considered in formulating the recommended implementation strategy for transforming GIS in Minnesota state government:

A. The MGIO should be viewed as a facilitation and coordination engine and not as a production engine. It is important that the MGIO is not perceived as a major, new bureaucracy. On the contrary, the MGIO should be viewed as a **focused team** with a goal to facilitate and coordinate efforts across the enterprise of state government. The MGIO would be involved in construction and maintenance of some pieces of geospatial technology and data infrastructure and would have some production capacity to deliver projects. However, most of its effort would be aimed at *working with* the state agencies that possess the main GIS production capacity of state government.

B. Minnesota's "transformed" enterprise GIS program should fully leverage existing agency geospatial investments and the collaborative spirit that exists among state GIS professionals. Over the past three decades, Minnesota has made extensive investments in GIS technology at the departmental level and the overall GIS community has demonstrated an inclusive and collaborative attitude. These core strengths of the geospatial landscape need to be capitalized on as state government GIS is transformed.

C. The implementation should proceed over time and through multiple phases. The recommended GIS transformation represents significant and extensive change and it needs to be undertaken in a well planned and orderly fashion that proceeds over time and through phases. Some phases will involve organizational transformation, while others will involve the planning and construction of new infrastructure. Finally, once the initial transformations are completed there will need to be a transition into ongoing management of the new organization and infrastructure. While the implementation will proceed over time, and in order of priority, it is also important to recognize that the program is a comprehensive set of eight program elements that must all be pursued within a reasonable timeframe to fully realize the transformation potential. It is expected that the full program should be achievable over the course of the next two biennial budget cycles (i.e. within the next four years).

D. State government budgets will be tight for the foreseeable future. With the weak condition of the economy in late 2008 and early 2009, it is fair to assume that state budgets

will remain extremely tight for the next 2-3 years.[15] While this program recommends some new spending, every effort has been made to limit these requests and properly size them in light of expected benefits, which include some cost reductions but which will be most apparent in avoided future costs as geospatial technologies become increasingly essential to the efficient and effective delivery of government services.

10.2 Program Priorities

Once consensus was achieved about the eight program elements[16] that comprise the recommended enterprise GIS program, it was recognized that fiscal constraints were likely to limit how many of the eight program elements could be pursued simultaneously at the outset. To guide the implementation strategy, a prioritization exercise was conducted during October, 2008 to help identify the relative importance of the eight program elements. This exercise involved surveying the state agencies interviewed during this project. Fifteen of them completed the survey, with one authoritative response per agency, generally from its Chief Information Officer. Each agency was asked to rank the eight program elements in order of priority using two different ranking methods. Each agency's ranking was weighted equally.

The first ranking method involved asking each individual agency to score each program element on a scale of 1 (most important) to 10 (least important). Multiple program elements could be assigned the same score. Rankings were then averaged so that each program element was assigned a composite score between 1 and 10, with lower numbers reflecting the highest priority program elements. Grouping of priority were found at <4, 4-5, and >5 and are illustrated below.

Rank	Group	Program Element	Priority Points (1 - 10 scoring)
1	A	Data Coordination	3.20
2	A	Leadership, Outreach & Communication	3.60
2	A	Web Services	3.60
4	B	Data Services	4.00
5	B	Technology Coordination	4.13
6	C	Technical Guidance	5.53
7	C	Training	5.73
8	C	Project Consulting	5.93

The second method involved asking agencies to allocate 100 points among the eight program elements. Points could be allocated in any fashion the agency determined was appropriate. Responses were averaged for each program element, with higher scores reflecting the highest

[15] On December 4, 2008, the Department of Finance projected a budget shortfall of more than $5 billion by the end of the next biennium.

[16] Consensus was gained through a process of sequentially presenting and refining the draft program elements to various project participants. This was done both for the Drive to Excellence GIS Project Steering Committee and also for the Governor's Council on GIS's Strategic Planning Committee. In addition, the State Government GIS Stakeholders Workshop that was conducted as part of this project presented the eight program elements and obtained feedback and refinement guidance from over 60 members of the broader state government geospatial stakeholder community. That workshop also validated general consensus around these eight program elements.

priority program elements. Groupings of priority were found at >14, 10-14, and <10 and are illustrated below using color.

Rank	Group	Program Element	Priority Points (of 100)
1	A	Leadership, Outreach & Communication	18.33
2	A	Data Coordination	15.80
3	A	Web Services	14.00
4	B	Data Services	13.20
5	B	Technology Coordination	12.07
6	C	Training	9.27
7	C	Technical Guidance	8.87
8	C	Project Consulting	8.47
		TOTAL Points	100.00

Ultimately, both scoring systems yielded extremely similar results with the "top 3" and "bottom 3" priorities being the same. To test if there were significant differences in how agencies perceived priorities based on the level of their GIS involvement and the maturity of their GIS operations, the 15 agencies were divided into two groupings of "more advanced" and "less advanced" in the following manner:

More Advanced	Less Advanced
Dept. of Administration (LMIC)	Dept. of Education
Dept. of Natural Resources	Dept. of Economic and Employment Development
Dept. of Transportation	Dept. of Public Safety
Dept. of Agriculture	Dept. of Commerce
Pollution Control Agency	Dept. of Human Services
Dept. of Health	Dept. of Revenue
Metropolitan Council	Office of Enterprise Technology
	Dept. of Labor & Industry

The prioritization ranking was then repeated for each of these two groups. When this was done there were only minor variations in the prioritization. Out of the four additional ranking scenarios, there were only two examples where a program element fell out of the original "top 3" or "bottom 3" determined by the ranking of all agencies. For instance, the training program element was ranked fifth (tied with technology coordination) using the point allocation ranking for "less advanced" agencies and was elevated out of the "bottom 3" and into the middle tier. This assessment provided an increased level of confidence that the enterprise-wide priorities reflected in the tables above accurately reflect the composite needs of all agencies.

The priorities derived from this exercise helped inform both the transition strategy and the alternative implementation scenarios that are presented below. These scenarios emphasize the "top 3" priorities identified by stakeholders.

- Leadership, Outreach & Communication
- Data Coordination
- Web Services

10.3 Transition Issues

Implementing an Enterprise GIS program will not happen overnight and will require attention to a number of important issues as the State undergoes a transformation from program or agency-focused GIS approaches to a statewide enterprise-focused approach. Getting from "Here" to "There" is important, but the transition will not necessarily be easy. Eight key components of the transition need to be considered.

A. Establishing the new organization and addressing space and equipment implications. It is anticipated that a new Minnesota Office of Geographic Information (MGIO) will be created, as recommended by the Drive to Excellence Subcabinet. The new MGIO would be housed within the Department of Administration (DOA) and would replace the existing Land Management Information Center (LMIC), which also is housed within DOA. The first element of the transition strategy concerns whether the MGIO would be physically relocated, or whether it would occupy LMIC's existing space. Similar determinations need to be made regarding the office and computer equipment that the new organization will require and whether LMIC's equipment will be re-purposed for the MGIO.

B. Aligning with parallel effort to create a new geospatial governance structure. In parallel with the GIS functional transformation effort, the Minnesota Governor's Council on Geographic Information (MGCGI) Strategic Planning Committee has been pursuing a plan for organizational transformation. This includes re-examining the role of the MGCGI, and creating appropriate authority and accountability mechanisms. Key among the MGCGI's recommendations is that the State's Chief Information Officer formally delegate the authority for geospatial coordination to the MGIO. This recommendation has been endorsed by the Drive to Excellence Subcabinet. The delegation of authority and the creation of new/reformulated oversight bodies would need to occur during the transition phase of this initiative.

C. Managing authority that is delegated from the CIO. While the legislation creating the Chief Information Officer position expressly allowed for the delegation of authority, the delegation of an expansive set of authorities to an agency other than OET has not been previously tested. The new MGIO would need to work in close coordination with the CIO to develop norms for ongoing communication and to anticipate if, when and under what circumstances actual authority may need to be exerted.

D. Staffing the new organization. With the MGIO being created to replace LMIC there are key questions about *how* the new organization would be led and staffed. Because the MGIO would have responsibilities beyond those currently assigned to LMIC and some new skills may be required to meet those responsibilities, staffing decisions for the MGIO will need to be made thoughtfully. The transition strategy will need to balance the human element of providing job continuity for current LMIC employees with the business requirement of assembling the strongest possible team to fulfill the MGIO's new and different mandate. As has been noted elsewhere, it is essential that the MGIO be viewed as more than just a name change for LMIC, but that the transformation also brings new skills and capabilities.

E. Commencing formal geospatial coordination activities. As reflected in the program design, fundamental aspects of the MGIO's role are intergovernmental and intra-

governmental coordination and these activities need to commence immediately. The MGIO will need to first assert its leadership in geospatial coordination among state agencies. Activities may include, but are not limited to:

- One-on-one meetings with all state agency GIS programs to introduce the new organization and to seek their input on making the program effective.
- Establishing inter-agency work groups to address priority issues and initiatives (e.g. statewide geospatial data library planning).
- Opening and sustaining strong intra-governmental communication channels including utilizing newer web 2.0 technologies to foster communication.

Next, the MGIO needs to assert its leadership in representing state government to the broader Minnesota GIS stakeholder community. These activities should not be limited to simply providing education on the MGIO's new role, but may also include:

- One-on-one meetings with key geospatial stakeholders
- Participation in regional GIS user groups
- Formal presentations to statewide geospatial and county government organizations.

Once outreach and initial contacts have been made and there is wide understanding of the MGIO and its role, then the organization would move on to pursuing its core data and technological coordination functions.

F. Planning of geospatial infrastructure development. Two of the program elements (see Sections 6.1 and 6.2 above) involve the construction of technical infrastructure to provide shared GIS **data library** capabilities and **web services** across the enterprise. There are several options for deploying each of these pieces of infrastructure and during this planning project many agencies expressed a strong interest in being actively involved in planning for these capabilities. Once established, the MGIO should proceed to create inter-agency work groups to advise on decisions and design that are necessary precursors to developing the infrastructure. Following the design phase, these work groups should serve important advisory and testing roles during the development of the infrastructure.

G. Detailed implementation planning for high priority program elements. The prioritization exercise described above identified the following **three** program elements as "highest priority" and these should be focused on in the near term:

- Leadership, outreach & communication
- Data coordination
- Web services

Once the MGIO is established, the management team should prepare detailed work plans for deploying appropriate staff and monetary resources towards these priority program elements over the next 12 to 18 months.

H. Preliminary implementation planning for lower priority program elements. While three activities have been identified as higher priorities than the other five, these "lower priority" activities are important to the success of the enterprise GIS strategy.

- Data services
- Technology coordination
- Training
- Technical guidance
- Project consulting

Because these are important to the overall strategy, planning for them must take place during the transition from LMIC to the MGIO so that they can be addressed when resources become available. Ultimately, two of the budget scenarios described below are designed so that all eight program elements can be supported to some degree by the end of the second year of the transition.

11 Implementation Budget

In order for the Enterprise GIS strategy to succeed, it is essential that the funding for the MGIO matches its roles and responsibilities. The availability of an office with an existing base budget, LMIC, as a foundation for the MGIO provides a portion of the resources required to support the expanded MGIO mission. States that have had success establishing similar offices and that are considered national leaders, such as Michigan, fund their GIS offices at annual levels that exceed $3 million a year. While that may not be the path that Minnesota chooses to follow, several options are presented here that reflect the priorities described in the previous sections.

11.1 Budget Elements

In developing the budget recommendation four separate line items were used. The following describes the line items found in the budget tables that accompany the implementation strategies described in this section.

A. Base budget. The baseline budget is taken directly from LMIC's current FY08 appropriation. This figure currently covers all of LMIC's operating requirements except for those that are paid for through LMIC's service bureau and retained earnings account. This figure currently covers approximately 6 of LMIC's FTE and it assumed that this funding will be available for the new MGIO.

B. New funding request for operating budget to expand MGIO staff. One of the key recommendations in crafting the transformed GIS program was properly directing and resourcing geospatial coordination activities. Rather than doing coordination as a "part-time job" the new MGIO needs to vigorously pursue the coordination mission with adequate resources to succeed in harvesting the benefits that are described above. As has been described above, a team of sixteen (16) is recommended to carry out these functions. Funding under this line item would pay for new staff beyond LMIC's current non-service bureau headcount.

C. New funding request for expanded operating budget. New staffing is not enough to make the MGIO fully operational and effective. It remains important that some funding be available to support partnerships and liaison activities with other GIS stakeholders. Specific examples of other operating expenditure include travel to interface with GIS stakeholders throughout the state; participation in national conferences to liaise with other states; memberships in geospatial organizations; and strategic investments in technology and other equipment.

D. Data development funding. In addition to its statewide coordination role, it is critical that the MGIO have some resources to invest in the statewide spatial data infrastructure. The state maintains very valuable data assets that need periodic reinvestment to ensure that they are current. There also is a need to fill some systematic gaps in the data available for Minnesota. Examples of existing weaknesses identified through this project include:

- **Statewide addressing.** There was near unanimous departmental agreement that an accurate and reliable statewide database of all addresses in Minnesota is highly desirable, and many agencies have actively researched how to create such a resource.

Since new addresses are created every day, one of the key elements of such a resource would be a program that not only develops a comprehensive addressing database but also contains workflows designed to keep these data regularly updated. Once constructed, this type of address database would be exposed through a "geocoding" web service that would enable any address – whether a crime incident location, a regulated day care facility, or the location of an environmental permit – to be mapped.

- **Statewide high resolution elevation.** There also is broad interest in improving the geographic coverage and quality of the state's elevation data. Currently, the best statewide resource has a resolution capable of supporting 10 foot contours while 2 foot contours are required for many public safety and environmental applications(e.g. flood response and planning). The needed 2-foot contour data have been developed for some areas of the state using LIDAR technology, but an $8 to $10 million investment is needed to complete coverage for the entire state.

Both examples are large, expensive efforts that are required by all agencies but are unlikely to be funded by any single department. The MGIO has great potential to usher these types of statewide projects into being and to leverage state funding with other sources that have similar interests in the data (e.g. county governments). Also, while many of the benefits of the MGIO will be in the form of improved coordination and user support, the MGIO must further demonstrate its value in tangible terms by spearheading new projects that are in great demand across agencies and would provide the state with critically important data sets.

E. Project services revenue (labeled "Other revenue" in the budget tables)**.** As described earlier, LMIC maintains an in-house service bureau that provides consulting services to public sector agencies. This service bureau is run on a cost recovery basis and, and while it requires some management oversight from LMIC, it is required to set rates annually so that they only cover its operating costs. As validated by the prioritization exercise, this capacity is important but it is not viewed as one of the higher priority aspects of the mission of the new MGIO. While this capability may initially be transitioned from LMIC to the MGIO, the MGIO will need to decide whether, and how to carry this program forward as a standalone enterprise. There are three primary options for doing this:

1. The activity is carried out by distinct "service bureau" personnel who sit next to the MGIO personnel who will carry out the core mission,

2. The activity is carried out by "blended" personnel who perform some "service bureau" activities as well as core MGIO activities,

3. The service bureau activity should be sunsetted.

If the service bureau is reduced in size, or not carried forward, agencies will continue to have several options for completing fee-for-service projects, including engaging the academic and private sectors. It is critical to understand that since service bureau revenues directly pay for the staff that carries out the projects, these funds should not be viewed as an alternative to an increase in the MGIO's base operating budget for staff. The MGIO requires new staff that can be *focused* on the new mission, not on executing fee-for-service work.

11.2 Recommended Funding

The following table presents the recommended funding level to fully carry out the MGIO's mission spanning all eight program elements as described in sections 5, 6, and 7. The table includes a column for the number of FTE that are expected to be covered by each line item that fund staff.

Num	Item	Amount	FTE
1	Base budget (existing LMIC appropriation):**	$804,000	6
2	New operating budget to fully staff the MGIO:	$800,000	10
3	New operating budget	$200,000	
4	New data development and maintenance funding:	$1,250,000	
Sub-tot	**TOTAL Annual Appropriation:**	**$3,054,000**	16
5	**OTHER revenue (based on 2009 estimates):**	$700,000	

** Includes both staff and operations

The table below presents the estimated allocation of the 16 FTE across the eight program elements. The color coding represents the prioritization tiers that were determined through the prioritization survey described above.

Priority Tier	Program Element	MGIO FTE
1	Leadership, Outreach & Communication	3*
1	Data Coordination	3
1	Web Services	2.5**
2	Data Services	1.5**
2	Technology Coordination	1
3	Training	1
3	Technical Guidance	1
3	Project Consulting	3
	TOTAL	**16**

* Administrative support is allocated under the Leadership, Outreach & Communication program element.

** Network/system administrator effort is divided between web services and data services program element.

11.3 Reduced Budget Scenarios

The opportunity to accrue significant statewide benefits by dramatically transforming GIS to an enterprise activity justifies a major investment. However, because prospects for significant new funding during the current fiscal climate are small, strategic adaptations to the full recommended funding level are presented in several budget alternatives shown below. In all cases, the scenarios assume the existing LMIC budget to be a baseline and then new resources are added to enable the MGIO to carry out an expanded mission. If the full recommended funding cannot be provided for the FY2010-FY2011 biennium, it is assumed that higher levels of funding will be pursued for the subsequent biennium, thereby stretching out the timeline for fully implementing the program.

11.3.1 Scenario 1: Scaled back effort to address all priority program elements

This scenario recognizes that full funding may not be possible in the current fiscal climate and thus the recommended funding levels for both MGIO operations, including staff, and data investment have been scaled back approximately 25 percent. As the table below illustrates, under this scenario, MGIO staffing for operations would be at 11 FTE.

Num	Item	Amount	FTE
1	Base budget (existing LMIC appropriation):**	$804,000	6
2	New operating budget to fully staff the MGIO:	$500,000	5
3	New operating budget	$150,000	
4	New data development and maintenance funding:	$1,000,000	
Sub-tot	**TOTAL Annual Appropriation:**	**$2,454,000**	11
5	**OTHER revenue (based on 2009 estimates):**	$700,000	

** Includes both staff and operations

The table below presents the estimated allocation of the 11 FTEs across the eight program elements.

Priority Tier	Program Element	MGIO FTE
1	Leadership, Outreach & Communication	2.5*
1	Data Coordination	2.5
1	Web Services	1
2	Data Services	1
2	Technology Coordination	1
3	Training	1
3	Technical Guidance	1
3	Project Consulting	1
	TOTAL	**11**

* Administrative support is allocated under the Leadership, Outreach & Communication program element.

What is lost: The major reductions in activity under this scenario would be in the lower priority "project consulting" program element. Ultimately, there would be less support to outside agencies commencing their GIS efforts and there would be a smaller capacity to manage in-house projects. In addition, this scenario would likely mean that the MGIO foregoes an in-house system/network administrator and instead those technical duties would be carried out by a combination of other in-house personnel (e.g. the geospatial DBA and web service master) and the Department of Administration's (DOA) IT staff. Finally, the reduced data development and maintenance funding would imply a lower level of data activity and there is a concomitant reduction in data coordination and data services personnel.

11.3.2 Scenario 2: Fund highest priority elements, significant funding reduction for data development

This scenario represents a deeper scaling back of the MGIO's ability to cover all eight program elements. With an FTE total of nine (9), effort is focused on the highest priority program

elements with a reduced capacity to cover the lower priority program elements. This level of operating budget increase represents the minimal staffing needed to achieve the kind of transformative change that this program represents.

If new appropriations are not possible through the legislative budget process, serious consideration should be given to other mechanisms to raise these funds. For example, agencies that use geospatial technology could provide the $400,000 worth of funding through a system of assessments and/or chargebacks. However, it must be noted that any system of assessments or chargebacks would pose challenges and be controversial from an agency perspective. For instance, even if agencies supported the notion – and it is not clear that they would – they would need to be given ample time, and perhaps resources, to budget for the fees. As a result, if this path was pursued, then it would need to be done cautiously and while learning from the experiences of other agencies that have taken this tact (e.g. OET).

This scenario retains a modest budget for data development and maintenance. The kinds of data development that are envisioned – for example, statewide addressing or high resolution elevation – are considered to be extremely valuable by most agencies. Making a communal investment in data through the MGIO would help emphasize the communal benefits that this approach offers.

Num	Item	Amount	FTE
1	Base budget (existing LMIC appropriation):**	$804,000	6
2	New operating budget to fully staff the MGIO:	$300,000	3
3	New operating budget	$100,000	
4	New data development and maintenance funding:	$250,000	
Sub-tot	**TOTAL Annual Appropriation:**	**$1,454,000**	9
5	**OTHER revenue (based on 2009 estimates):**	$700,000	

** Includes both staff and operations

The table below presents the estimated allocation of the nine FTE across the eight program elements.

Priority Tier	Program Element	MGIO FTE
1	Leadership, Outreach & Communication	2
1	Data Coordination	2
1	Web Services	1
2	Data Services	1
2	Technology Coordination	1
3	Training	0.5
3	Technical Guidance	0.5
3	Project Consulting	1
	TOTAL	**9**

What is lost: The most significant additional reductions in activity under this scenario would be in the data arena. With a greatly reduced data investment, there will be a reduced need for personnel to manage data projects. This scenario involves losing a dedicated administrative support person. As with the loss of an in-house system/network administrator, the MGIO would

need to rely on existing DOA administrative support. Finally, this scenario has the MGIO providing a smaller level of training and technical guidance support. Ultimately, with less resources available, the lower priority program elements will not be fully staffed and the level of service and capability that they supply will be greatly reduced, and/or their full implementation will be delayed until the next biennium.

11.3.3 Scenario 3: Fund highest priority elements, no funding for data development

As described for scenario 2, it will be impossible for the MGIO to deliver truly transformative change without an increase in headcount of at least three people. Thus, this scenario maintains the same headcount of nine as scenario 2, and instead the budget reductions are created by eliminating the data development allocation and reducing the non-staff operating budget.

Num	Item	Amount	FTE
1	Base budget (existing LMIC appropriation):**	$804,000	6
2	New operating budget to fully staff the MGIO:	$300,000	3
3	New operating budget	$50,000	
4	New data development and maintenance funding:	$0	
Sub-tot	**TOTAL Annual Appropriation:**	**$1,154,000**	9
5	**OTHER revenue (based on 2009 estimates):**	$700,000	

** Includes both staff and operations

The table below presents the estimated allocation of the nine FTE across the eight program elements.

Priority Tier	Program Element	MGIO FTE
1	Leadership, Outreach & Communication	2
1	Data Coordination	2
1	Web Services	1
2	Data Services	1
2	Technology Coordination	1
3	Training	0.5
3	Technical Guidance	0.5
3	Project Consulting	1
	TOTAL	**9**

What is lost: The entire data development budget is removed and this will greatly diminish the ability of the MGIO to deliver or maintain needed data. While the MGIO will continue to have the ability to add value through data coordination, it will not have the ability to invest in data improvements on behalf of the enterprise. In addition, the reduction in operating budget will force tradeoffs in the travel required to effect coordination and in strategic investment in geospatial technology/equipment.

11.4 The No New Funding Scenario

Under a worst case scenario, only LMIC's current, FY2008 budget would be available to the MGIO. This would provide only skeletal staffing of six full-time equivalents to carry out the eight program elements and no funding for data development. While having a new, better defined coordination mission may help to some degree, without new resources the new organization will be severely hampered and will face the same challenges that LMIC currently faces; and, LMIC's staffing level has proven inadequate to address those challenges. Further, this scenario would amplify the risk that the GIS stakeholder community does not view this as *transformational* change but as *superficial* change, with the MGIO representing only a series of name and title changes.

Ultimately, this is not a desireable option and would severely limit the benefits resulting from an enterprise initiative. To produce real, positive transformational change, the new MGIO must be equipped to handle the new mission with an appropriate level of resources.

To illustrate this point, the tables below attempt to spread the existing resources across the eight program elements.

Num	Item	Amount	FTE
1	Base budget (existing LMIC appropriation):**	$804,000	6
2	New operating budget to fully staff the MGIO:	$0	0
3	New operating budget	$0	
4	New data development and maintenance funding:	$0	
Sub-tot	**TOTAL Annual Appropriation:**	**$804,000**	6
4	**OTHER revenue (based on 2009 estimates):**	$700,000	

** Includes both staff and operations

The table below presents the estimated allocation of the six FTE across the eight program elements.

Priority Tier	Program Element	MGIO FTE
1	Leadership, Outreach & Communication	1.5
1	Data Coordination	1
1	Web Services	1
2	Data Services	1
2	Technology Coordination	0.5
3	Training	0.33
3	Technical Guidance	0.33
3	Project Consulting	0.33
	TOTAL	**6**

What would be lost: Amongst the largest impacts of this scenario is that the new GIO, the director of the MGIO office, would need to play an active, hands-on role in leading at least one of the program elements in addition to his, or her overall management and leadership responsibilities. This increase in the GIO's operational responsibility will likely impact the ability to proactively lead the state government GIS community. This will be exacerbated with

an absence of administrative and network/systems support staff. In addition, this scenario would provide only *minimal* effort to the four lowest priority program elements, with a single person covering training, technical guidance and project consulting, and only ½ FTE covering technology coordination.

11.5 Implementation Timeline

The implementation timeline presented below corresponds to the full-funding recommendation for the MGIO. It covers the period from July, 2009 through June, 2011 and reflects the first two years of implementing the transformed enterprise GIS program, through the end of the 2010-2011 biennium. It assumes that the compelling case for the transformation justifies a full funding scenario that will support implementation of all eight program elements within the next biennium.

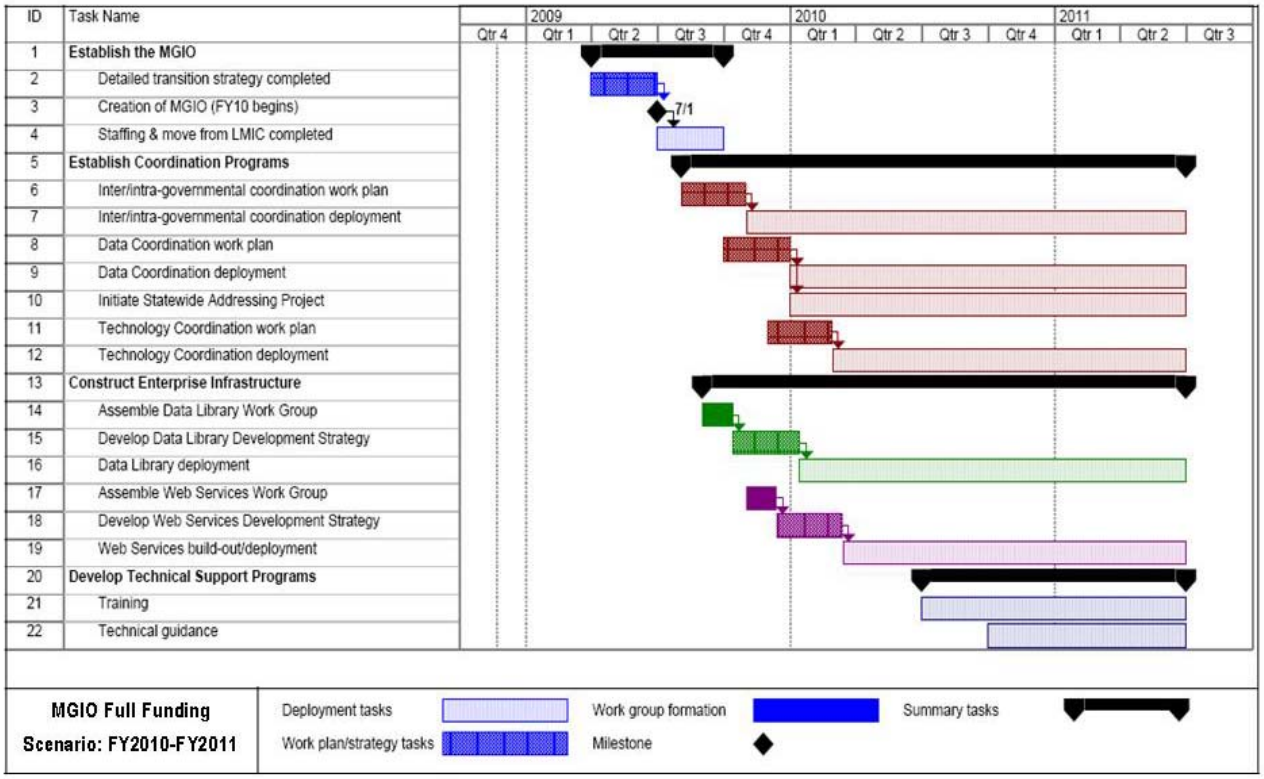
No detailed timeline has been developed for the reduced funding options, but even those that would support implementation of all eight activities would require extending the implementation timeline beyond the next biennium. If additional funding is provided in the 2012-2013 biennium, full implementation is achievable within a four-year period.

The implementation timeline is intentionally general, since it is assumed that the new MGIO leadership and staff will need to make adjustments as they ramp up to carry out the individual program elements. The timeline incorporates two important strategic elements, described below.

- **Initiatives should be preceded by a planning phase.** Given that the MGIO will be a new organization, potentially with new staff, it is recommended that the new team review this plan and then carry out additional and more detailed planning on how to achieve the goals of each of the eight program elements. For some program elements, this should be done via in-house teams with strong involvement from the GIO. For other initiatives – particularly those that involve or influence agency partners, such as the data library – planning should involve inter-agency work groups that will be responsible for defining a program that meets enterprise needs while considering agency constraints.
- **Start of initiatives should be staggered, but implementation can proceed in parallel.** It is assumed that the MGIO will have sufficient staffing to carry out several initiatives in parallel. Still, it is recommended that the initiation of programs be staggered by a period of 1-3 months. This will provide two benefits. First, it is anticipated that the GIO will need to be intimately involved in the planning of each of the program elements and the staggered start of initiatives will help ensure that there is time and focus for him, or her to maintain that level involvement. Second, it is anticipated that there will be important lessons learned during the planning for each program element. Thus, staggering the start of initiatives will allow the lessons learned by early efforts to be carried into the next initiative.

11.5.1 Timeline for Scenario 1: Recommended funding

The timeline below shows implementation covering the next biennium, as well as a transition planning period that would commence at the tail-end of FY-2009. The timeline illustrates that with full funding, it will be feasible to have planning completed and deployment underway for all eight program elements within the first 1.5 years of the new biennium.



11.5.2 Timeline Implication of Reduced Funding Scenarios

All the alternative funding scenarios involve a reduction of overall resources both for staff and data development. With partial funding for both MGIO operations and data, the planning and deployment phases will need to be extended across a longer period of time and into the next biennium. With fewer personnel, the planning phases will take more time and the deployment phases will extend later. Under the lowest funding level scenarios, some activities – for instance, statewide addressing data development - may need to be deferred until the next biennium and the availability of new funding.

11.6 Other States Budget Comparison

In an effort to provide some context for the recommended MGIO budget and program recommendations, enterprise GIS programs from other states were researched, evaluated and summarized. The results are presented in the table below, which compares GIS programs from other comparable states, including their functions, staffing and budgets. States were chosen based on their demonstrated commitment to GIS coordination and who possessed mandates and activities that were comparable to those recommended for the MGIO. While a broad range of budget and staffing situations are represented, each state has a statewide GIS coordination office that facilitates communication and cooperation between state agencies, counties, and local governments.

The information in the table was initially gathered directly from other states through verbal or written correspondence; subsequently, each state validated this condensed, tabular format. Although the research conducted has been distilled into a simplified format for the purposes of comparison, the reality is that no two states are alike and behind each "row" there are a variety of staffing and funding nuances and complexities. The "comments" field provides relevant qualifiers and additional detail addressing some of these complexities. A key to the responses is shown below.

Column	Description
Lead Agency	State agency within which GIS Coordination resides; "Information Technology" used to denote the CIO's office.
NSGIC 9-Criteria Score (out of 45)	As self-evaluated and reported in NSGIC annual survey. Higher numbers indicate most "effective" programs.
Coordination	Y/N, agency is leader in intra-governmental coordination between state agencies, other levels of government (regional, local), and non-government institutions.
Data Management	Y/N, agency facilitates access to data assets, provides standards, catalyzes development of new data sets
Web Services	Y/N, agency provides web services to be consumed by websites or desktop GIS software
Data Acquisition & Distribution	Y/N, agency assists in acquiring and aggregating relevant data sets and making available to GIS users statewide
Training	Y/N, agency assists state agencies and others to become effective users of GIS technology
Enterprise Licensing	Y/N, agency has pursued enterprise-wide licensing. Yes, indicates an ELA with ESRI, unless otherwise noted in the comments field.
FTEs	Full-time employees devoted to supporting GIS program
Annual Base Funding	Includes all legislatively appropriated funds plus regularly recurring funding sources (such as capital budget).
Additional Funding	Includes all additional funding sources such as "fee for service", grants, chargebacks to other agencies.
Total Budget	Total budget is sum of Base Funding and Additional Funding
Comments	Relevant qualifrs or explanations

General			Activities						Resources				
State	Lead Agency	NSGIC 9-Criteria Score (out of 45)	Coordination	Data Management	Web Services	Data Acquisition & Distribution	Training	Enterprise Licensing	FTEs	Annual Base Funding[1]	Additional Funding[2]	Total Budget[3]	Comments
MA	Environmental & Energy Affairs	37	X	X	X	X	X	X	14+	$1M	$350K	$1.35M	• Base budget funded • Enterprise licensing agreement with NAVTEQ for geocoding files • Chargeback to agencies for software costs
MI	Information Technology	43	X	X	X	X	X		40	$3M	$3M	$6M	• GIS consolidated within IT
NY	Cyber Security & Critical Infrastructure Coordination	42	X	X		X			20	$2.75M	$1M	$3.75M	• Additional funding is mainly "partner funding" for photogrammetry program "buy-ups" by county/local governments. • Coordination headcount is approximately 10, as it varies with time and across personnel.
NC	Natural Resources & Environmental Protection	42	X		X	X		X	20	$164K	$1.5M	$1.52M	• Coordination program funded out of overhead from receipt based budget and federal grants • State appropriation funds 2 staff positions to support NC OneMap initiative
UT	Information Technology	44	X	X	X	X	X		17	$1.2M	$800K	$2M	• Facilitates coordination for all Utah GIS users • Provides consulting to federal, state, and local governments and other organizations
WI	Split between: State Cartographer & Information Technology	37	X	X	X	X	X		7.5	$725K	$0	$725K	• Budget and headcount include both offices of GIO and State Cartographer • Fee for service consulting planned but not yet implemented; Rates will cover costs but not generate additional revenue • GIO and State Agency Geographic Coordination Team (SAGIC) responsible for coordination
DC	Information Technology	35	X	X	X	X	X	X	18	$2M	$200K	$2.2M	• Base funding does not include capital money • Fee for service consulting fluctuates according to demand
OH	Information Technology	44	X	X	X	X	X		4.5	$580K	$250K	$830K	• Coordination fully funded through general funds, capital budget, and federal grants
OR	Information Technology	46	X	X	X	X			4	$1M	$625K	$1.6M	• Base funding $2M (biennium) funds 4 staff plus $500K of data development, some application development • Negotiating ELA but does not currently exist • Grants are in form of partnership funds; range from $500K to $750K per year • No use of fee for service model currently; attempted in 1990s and failed

[1] Includes all legislatively appropriated funds plus regularly recurring funding sources (such as capital budget).

[2] Includes all additional funding sources such as "fee for service", grants, chargebacks to other agencies.

[3] Total budget is sum of Base Funding and Additional Funding

12 Summary & Conclusions

The Drive to Excellence process initiated by Governor Pawlenty aims to identify government functions that can be delivered more effectively by taking a state government-wide, enterprise perspective. As this study thoroughly documents, GIS is a perfect candidate for this type of silo-to-enterprise transformation for the following reasons:

- GIS technology is widespread and heavily integrated into the day-to-day business activities of at least 17 state agencies
- There is significant growth in agency utilization of these technologies
- Historical, non-enterprise approaches have resulted in overlapping GIS efforts between some agencies
- There are widespread opportunities for technical infrastructure sharing between agencies
- There is widespread goodwill and a collaborative attitude between GIS practitioners across agencies
- Short term expenditures will yield significant, longer term efficiencies and will greatly contain the future, overall GIS expenditures of state government

Based upon these conditions, it is recommended that an adequately funded Minnesota Geospatial Information Office be created to guide the state's silo-to-enterprise transformation of GIS. The new MGIO would have the formal authority to coordinate, manage, and support GIS technology within state government. The MGIO would be led by a Chief Geospatial Information Officer, working in close association with the state CIO. These recommendations are supported by agency managers and GIS users who have contributed to this study through a variety of workshops, surveys, interviews and other means.

Fully implementing the MGIO would involve transforming the existing Land Management Information Center into an operation that is fully focused on the new coordination and enterprise GIS mission outlined in this plan. The recommended funding for this program assumes LMIC's current base budget will be enhanced with $1 million in additional funding to add the staff necessary to support the MGIO's expanded role. An additional $1.25 million in annual data investment is also recommended to support the development of common data needed by all state agencies. In return for this investment, a net benefit of more than $20 million is projected over a ten year period. Recognizing the fiscal realities heading into the 2010-2011 biennium, this report also recommends several more modest implementation scenarios at lower funding levels.

This document presents a practical plan for achieving significant benefits through the transformation of GIS into an enterprise resource. While the budgetary challenges the State faces are unprecedented, it is important that the opportunities revealed during this analysis and the recommendations presented in this document be followed with an appropriate commitment to implementation. A large cross section of GIS practitioners from across the state, have invested time and energy in this process with the belief that this type of GIS transformation will address existing problems and help restore Minnesota to national GIS leadership. Expectations are high. The path forward has been identified. It is now time to move forward.