ND State Water Commission

IT Strategic Plan

2011-2013 Biennium

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ND State Water Commission IT Strategic Plan (2011-2013)

IT Architecture Review

The State Water Commission (SWC) is responsible for the management and regulation of the water resources in the State of North Dakota. The mission of the agency and the State Engineer . .

> *. . . is to improve the quality of life and strengthen the economy of North Dakota by managing the water resources of the state for the benefit of its people . . .*

The SWC utilizes information technology to support almost all facets of the business operations surrounding water resource management. Agency IT requirements are generally driven by the scientific applications used for water resource analysis. Advanced data analysis, research, data modeling, and engineering applications are routinely combined with customized applications that are developed internally. Because of the wide range and diversity of applications used, the IT infrastructure must be open and extensible. An open framework supports a wide range of diverse applications, which makes it possible to easily scale and evolve the IT infrastructure to accommodate changes in current initiatives as well as any new initiatives.

Currently, the SWC has implemented a collection of services and solutions that are based on a range of open source and commercial application development solutions. The core of the SWC's infrastructure is based upon 4D's data management / application environment. 4D provides a unique application development environment integrated with a robust data management engine. In an effort to address the spatial aspects of the water resource systems that are managed by the SWC, significant effort has been made over the past six years to integrate GIS and related mapping services. Most of these services are based upon open source solutions, which provide extensible resources that can be easily integrated with other tools available within the scientific and engineering disciplines.

The SWC maintains the following line of business applications:

Well Inventory – provides data management functions for the collection and analysis of the data supporting the management of North Dakota's ground and surface water systems. There are currently more than 33,000 sites for which data has been collected throughout North Dakota. This system includes subsurface information for more than 24,000 of these sites with nearly 3.5 million water level observations and nearly 64,000 water chemistry samples. This system also houses the domestic log reports filed by private well drillers for more than 58,000 sites throughout North Dakota.

Water Permits –provides management functions for North Dakota's water appropriations. It includes all of the necessary legal information related to requested and approved water appropriations as well as related historic water use reporting. This system also includes management functions for all temporary water permits that are processed in North Dakota.

Retention Structures –provides management and reporting capabilities for all of the major water retention structures in North Dakota. This includes Dams, Dikes, Diversion Structures, Dugouts, and other types of retentions structures. This system also includes an inventory of the majority of legal drains in North Dakota. In addition to the structures and drains, management functions related to construction permits in North Dakota as they pertain to the construction of water retention structures are also included.

Precipitation Stations –provides management for the network of private observers that report precipitation information throughout North Dakota. This network is maintained by the Atmospheric Resource division of the SWC and represents one of the largest and most comprehensive observer networks in the US. This system includes station information, daily precipitation values, and observed occurrence of hail events.

Flight Operations –provides support for the cloud seeding operations performed by the Atmospheric Resources Division. This includes flight tracking, inventory tracking for designated chemicals, and other related functions that pertain to the field operations that are conducted June through September.

Survey System – provides internal management for North Dakota's survey benchmarks. In addition, it provides a self-service utility for the Survey community to access North Dakota's survey repository, GLO's, and relevant benchmark data.

While 4D is a cross-platform system and will run on either Macintosh or Windows platforms, the implementation of 4D and the backend open source systems are uniquely designed to work with the Unix environment provided on the Macintosh platform. The Unix platform provides greater utility to integrate a variety of tools that are available for water resource management.

All of the business applications in use at the SWC were designed, developed, and maintained by internal staff. Most of the development at the SWC revolves around scientific application requirements. As a result, it is very difficult to assign these types of tasks to traditional IT programmers. The SWC currently maintains two staff positions within the IT section to develop and support the agency application base. One position is classified as a Hydrologist, and the individual within this position has training in hydrology and meteorology. The second position carries the Information Technology Administrator classification, and the individual within this position has training in geology, geohydrology, and geography. In addition to the core application services, other staff members in the agency also contribute to the development of some of the more focused tools that surround the primary business applications. While these positions do not contribute any time to the core business applications that are in service, the tools that they provide do augment the business applications to address analysis needs unique to specific water resource management functions.

IT Asset Management

The State Water Commission (SWC) currently maintains IT infrastructure to support 86 FTE's. This infrastructure includes the necessary technology to serve the desktop needs as well as the server, storage, and back-office needs for most of the SWC business functions. In addition to the standard office automation peripherals such as printers and photocopiers, the SWC also maintains large format plotters and printers as well as large format scanners to address agency business requirements.

The SWC currently supports all development, maintenance, and procurement functions with internal staff. The SWC maintains 4 FTE's for purposes of supporting the IT infrastructure and related data management and data development functions required by the agency. While all four positions provide some support for the agency data management infrastructure, only one FTE is dedicated to provide help desk and related maintenance, procurement and desktop deployment functions. The other 3 FTE's provide some indirect support, but for the most part are focused on data management, data development, and program development related functions in direct support of the agency data management requirements.

In order to provide the necessary tool base to address the various aspects of the agency business model, it is necessary to maintain an IT infrastructure that is relatively current. This includes maintenance, management, and replacement of much of the IT infrastructure on an on-going basis. The current IT asset management plan in place at the SWC varies depending upon the type of IT equipment. In order to maintain the IT infrastructure so that it all works together and continues to meet the on-going needs of the agency, replacement schedules have been developed for much of the technology deployed at the SWC. Different replacement schedules have been developed for the different classes of equipment to provide more efficient utilization of the limited resources. Each of the major categories will be discussed separately.

Desktops

For the past 20 years, the SWC has maintained a mixed platform shop with both Windows and Macintosh users, and a small number of Linux workstations. In 2006, Apple introduced its first Intel based Mac, and in 2007, Apple migrated its entire product line to the Intel architecture. This provided an opportunity to standardize the SWC desktop hardware on a single architecture that would support all of the different OS requirements for agency users. This hardware independence has improved the efficiency of desktop deployment and replacement. Because the Apple Macintosh computer will run MacOSX, Windows, and Linux natively, the SWC can now purchase hardware without regard to the OS requirements of individual users. More importantly, as we migrate the existing hardware within the agency, there are no longer any hardware barriers to prevent the utilization of the technology anywhere within the agency.

Currently, the SWC has standardized on the Macintosh Desktop computer with Apple's Mac OSX as the base operating system. Through virtualization any other OS can be run with minimal performance penalties. Windows and Linux distributions can be created and then deployed simply by dragging disk images across the network.

The SWC has a range of desktop system requirements, which includes everything from an office automation workstation deployment to very high-end computational modeling workstations. The standard 4 year replacement cycle advocated by EA

does not work well for the more advanced scientific requirements where end-user needs are better served with a much more aggressive replacement cycle. However, at the other end, user demands at the office automation stations are generally much lower and can be upgraded less frequently. As a result, the SWC has adopted an upgrade policy where the advanced high-end workstations are generally replaced every 2 to 3 years. The displaced machine is then migrated down within the user hierarchy to users with lower requirements. The net effect is that the desktop fleet in general adheres to a 4-year replacement cycle.

In addition to the standard desktop users, the SWC has many users that require mobile computing. While in the past the SWC provided shared laptops to address mobile user requirements, better mobile technology combined with better tools to integrate laptops within the desktop environment has changed the approach toward mobile technology. Currently, the SWC maintains a small pool of laptops that are available to the occasional mobile user. The SWC has also replaced standard desktop configurations with laptops and docking stations for routine mobile users.

The SWC currently maintains 79 desktop computers. The agency also supports 7 laptop computers that are used as the primary machine for staff with mobile requirements. In addition, 5 laptop computers are maintained for purposes of addressing the mobile requirement for the remainder of the staff with occasional mobile requirements. Over the next two years, it is anticipated that an additional 6 to 10 desktops will be converted to combination laptop / docking stations.

Monitors

Desktop monitors in use by the SWC have evolved over the years from a CRT based technology to flat panel technology. Currently, there are only a couple of CRT monitors in service at the SWC. The SWC has adopted a replacement strategy for monitors more closely tied to the life-cycle of the monitors. Based upon the life-cycles that were experienced with the CRT technology, monitors are targeted for replacement between 5 and 6 years. The introduction of flat panels has not changed this strategy. In addition, the SWC has standardized most desktops on Apple's iMac platform that includes a built-in monitor. Therefore, these will logically be replaced with the computer.

Printers / Copiers / Plotters / Scanners

Historically, the SWC maintained an array of network business printers, photocopiers, high-end color printers, large format plotters, and a few inkjet color printers. Printing technology has evolved significantly over the past decade, and the SWC has consolidated the majority of the agency print services around two high-speed digital photocopiers. The agency still maintains one high-end color laser printer that was purchased in 2006. In addition, there are still three workgroup printers that are available in key areas for purposes of addressing specific print functions that can't be addressed through the digital photocopiers.

With the integration of high-speed print services, the digital photocopiers replaced the functionality of more than 8 printers that were on the network prior to their introduction. However, at the time that the current photocopier/digital printers were purchased, adding color was still very cost prohibitive. As these copiers reach end-of-life, their replacements will include color capabilities with more advanced functionality, and the long-term strategy for the agency will be to eliminate the stand-alone color printers. As a result, the SWC's printer resources will likely consist

of 2 multi-function digital photocopiers with maybe one or two single function workgroup printer in key areas. Replacement cycles on these will be dictated by equipment duty-cycles, which based upon the current digital copier technology appears to be between 6 and 8 years.

In addition to the general-purpose business printing requirements, the SWC will continue to require large format printing capabilities. These are currently being met with a large format HP DesignJet printer. The replacement cycle for this device will be dictated by the life-cycle of the printer which is somewhat governed by it's use. Based upon current usage, it would be reasonable to assume that the replacement cycle for this device will continue to range from 6 to 8 years.

Over the past three years, the SWC has been moving much of the agency paper records into digital form for purposes of access, preservation, and long-term archival. As a result, agency document workflow has changed somewhat to accommodate capture and digital conversion of existing paper records and incoming paper records. This has necessitated an increase in scanning capabilities to include desktop scanning solutions for several users. Providing desktop scanning solutions is the only real effective way to address digitizing the documents within the current workflow environment. The SWC has added 8 desktop scanners with duplex and OCR capabilities, and it is anticipated that an additional 8 to 12 scanners will be added over the next biennium. The life-cycle of these scanners will likely be dictated by the workload and will vary from station to station depending upon the volume of scanning performed at each station. However, based upon industry claims, it is anticipated that the replacement cycle for the desktop scanners will be between 3 to 4 years.

In addition to the many desktop scanners used in conjunction with records management, the SWC also maintains a large-format scanner for purposes of scanning large maps, plats, and plans. The replacement cycle for the large format scanners will be dictated by life-cycle which appears to be in the range of between 6 and 8 years. Both of the digital photocopiers provide scanning options, but the replacement cycle for these is tied to the replacement cycles for the photocopiers. Currently, the digital photocopiers do not provide integrated OCR capabilities, but it is anticipated that the next generation of this technology will include OCR and this may reduce the need somewhat for scanning technology to be placed on the desktop.

Servers

The SWC maintains the server infrastructure to support the agency data management and application requirements. Unlike the desktops, monitors, and other peripherals, server replacement cycles are more often dictated by application and software resource requirements than by equipment life-cycles. It is not uncommon to upgrade or implement software changes that will vastly change the load and demand placed upon the server. Because server performance and reliability impact the productivity of all SWC employees, replacement cycles are matched to the functions that the server provides. The agency database-application servers require greater performance with greater RAM requirements. These servers are generally replaced more frequently with an average replacement cycle of between 2-3 years. Typically, the displaced servers are then re-conditioned to replace the role of the file server, web server, and SAN meta-data controllers. As a result the replacement cycle on average for all of the servers is between 3 and 4 years.

Storage

In addition to the storage that is attached to each desktop, laptop, and server, the SWC also maintains server based storage used both as primary server storage and backup storage. The storage infrastructure currently in service at the SWC consists of direct attached, NAS, and SAN based storage infrastructure. With the overwhelming growth in storage requirements to address both the digital capture of the historic image resources and on-going management initiatives to collect image data and digital aerial photography, the SWC makes every attempt to balance the storage solution with the needs of the targeted data. The SAN based storage is generally targeted toward daily workflow and direct user storage. The direct attached storage and NAS storage options are generally targeted toward archival processes and agency backup.

The SAN storage is maintained and managed independent of the server infrastructure, and as such, a replacement strategy has been developed that requires replacement of the disk and related subsystems every 6 years. Given the constant increases in storage density, this replacement strategy is expected to provide the necessary replacement of aging infrastructure as well as increased storage capacity to meet on-going increases in storage demands. Much of the direct attached storage and NAS storage is used for data backup and archival, and does not have the same uptime requirements. As a result, it may be possible to push the life-cycle on this class of storage to between 6 and 8 years.

Software

The SWC maintains a policy to keep all software current. Over the years it has been determined that routine incremental upgrades are far less traumatic on the day-to-day business model than larger periodic wholesale updates. Given the mix of software tools that are used within the agency, this includes an array of different schedules and software maintenance issues. For many of the larger applications and software suites the agency is enrolled in annual maintenance to maintain the current state of the software. This includes ESRI's GIS software suite, Microsoft Office, ERDAS, Groundwater Vistas, and AutoCad. In addition, the agency currently enrolls all of the desktop Mac OS software and the Mac OSX Server software in Apple's 3-year maintenance plans. For software without pre-defined maintenance plans, the software is routinely upgraded as upgrades become available. Generally, this ranges from 12-month intervals to 24-month intervals.

Staff Retention and Recruitment

Recruiting and maintaining qualified IT staff is difficult in an environment where you have little control over salary structures. This is even more relevant today when industry demand for IT professionals is increasing. When comparing IT salaries for SWC IT staff with the 2010 edition of Wages for North Dakota Jobs (published by Job Service North Dakota) for similar positions in the Bismarck-Mandan area, the SWC IT salaries are reasonably competitive within the region.

While salary is a very important factor that contributes to effective recruitment and staff retention, it is not the only factor that drives IT professionals. The SWC has been very fortunate to recruit and maintain a very qualified IT staff. This can be attributed to a large degree to the type of infrastructure that is maintained at the SWC and the management structure that has been implemented. The SWC maintains an environment where the individual IT staff have considerable latitude

with direct involvement with the development and deployment of IT solutions end-to-end. This provides the ability for the staff to learn and grow within their position. In the end, this type of latitude provides a better work environment for the IT staff and yields significant benefits to the agency as more innovative solutions are allowed to be developed and implemented.

Operational Infrastructure

In 1999, the SWC developed a needs assessment that addressed the scientific and engineering requirements for the agency as it moved forward. This needs assessment ultimately provided the foundation for the current infrastructure. Within this assessment, the framework that was defined identified significant investments that would be required in the IT infrastructure, if the agency was to continue to meet it's water resource management obligation in the future.

During the 01-03 and the 03-05 biennia, the SWC's IT infrastructure was completely re-engineered to provide a framework for the agency to develop the necessary tool base to meet the challenges that the agency would face over the next two decades and beyond. During the 05-07 biennium, additional components of the infrastructure framework were completed and significant work was completed to integrate and extend much of the IT infrastructure to address many of the key scientific functions required for water resource management. At the end of the 05-07 biennium and during the first half of the 07-09 biennium, the SWC successfully completed the migration of the desktop fleet to a single platform that provides better uniformity and consistency to support the daily work requirements and better support for back-end resources like computational clustering. During the current biennium, management solutions have been effectively deployed to address system imaging and other resources to reduce the administrative overhead associated with deployment, maintenance, and support of the desktop infrastructure.

As the agency moves forward, there are five key areas that will require ongoing attention. These include Data Management, GIS services, Computational Clustering capabilities, Storage Management, and Mobile Computing.

Data Management

Data collection is an integral part of many of the SWC's on-going water resource management operations. Water resource data pertaining to water levels, water chemistry, and well information is collected for purposes of monitoring impacts to North Dakota's ground and surface water resources. This includes on-site data collection by agency field staff and private contractors and continuous collection efforts using electronic methods. The SWC also collects real-time data for radar and flight operations for the North Dakota's weather modification and hail suppression program. GPS technology is used to collect real-time data within many of the flight operations. GPS technology is also used to generate the necessary survey base for construction projects and many other site-specific projects requiring spatial reference information.

The SWC maintains cooperative reporting programs for purposes of collecting water use information, private domestic drilling information, and observed precipitation information. In addition, the SWC is involved with a variety of data collection efforts to obtain site specific information relevant to water permits, dams, drains, wetlands, and other construction projects that pertain to water diversion or retention. The

SWC also routinely collects and processes aerial photography for many areas where there has been significant irrigation development for purposes of monitoring irrigation, evapotranspiration, and other parameters relevant to water resource management.

The SWC has implemented a wide range of technology solutions to accommodate the data collection programs. The SWC uses electronic monitoring tools in many of the data collection programs in an effort to provide more accurate data and to reduce overall cost associated with data collection. In addition, technology has also been implemented where practical in the form of hand-held devices and laptops to facilitate field entry and eliminate re-entry into back office systems.

The data management infrastructure currently maintained by the SWC is based upon a distributed client-server architecture. Given the diverse types of data collected combined with the broad range of analysis requirements, the SWC has expended considerable effort to establish an open and extensible management infrastructure that will support different types of data and the associated collection, management, and analysis efforts. This infrastructure currently supports industry connectivity standards, including ODBC, JDBC, XML, Web Services, Oracle OCI, and many others. At this point, the SWC can push or pull data to almost any commercial software that uses standard communications protocols, and all of the data collected by the SWC is available for public access over the web.

GIS Services

As part of the needs assessment that was developed in 1999, the SWC identified the role that GIS would play in the development of future water management resources. This assessment clearly identified the size and scope of the infrastructure required to provide the necessary GIS resources. Given the size of the user base that would be served at the SWC, it was not cost effective for the SWC to develop core components of this infrastructure internally. Therefore, recommendations were made for ITD to provide these core components of the infrastructure so that they could be extended to a larger user base. The SWC worked closely with ITD to develop the strategic funding requirements necessary to provide the state with a shared GIS infrastructure capable of delivering base GIS services for the state government users. The SWC has also been instrumental in the data development and implementation of the state GIS hub.

While the GIS hub provides core services required for the SWC's GIS initiative, the majority of tools and management functions required for water resource management are designed and built internally in order for these services to support water resource management. While the agency obtained funding to deploy some initial resources using ESRI's base infrastructure, both the ESRI cost model and limitations with ESRI's support model for open industry standards made it difficult to build the necessary infrastructure around the ESRI model. As a result, selected open source alternatives were evaluated and deployed through the 2005-2007 biennium. The open source solutions that were selected were capable of being deployed on existing hardware infrastructure and supported the same industry connectivity standards as the existing SWC data management infrastructure. This provided significant opportunities to develop integrated data management solutions and more comprehensive data analysis solutions that better meet the needs of the SWC. In addition, the open source solutions also provided significant cost savings related to deployment as well as on-going cost savings for maintenance.

The majority of the GIS infrastructure required to provide the necessary services for the SWC is currently in place and is integrated within the current management infrastructure. Moving into the 2009-2011 biennium, the SWC completed many of the analysis tools that will provide the foundation for future water resource management efforts. Most of this tool base will require on-going maintenance and development as we move forward.

Computational Services

Increasing demands for more comprehensive analysis of surface, subsurface, and atmospheric systems has required the agency to develop more sophisticated modeling capabilities. Currently, the agency uses a variety of modeling tools available from the US Geological Survey, US Bureau of Reclamation, the US Army Corps of Engineers, and other sources. These tools are used to provide insight into the environmental and geologic characteristics of these systems so that the agency can develop better understanding of the respective systems.

While many of these tools have been available for some time, the application of these tools has evolved in recent years and utilization of these tools now demand far more resources to achieve useful results. In most cases, the model requirements exceed the computational capabilities available on a single desktop or server. The current server base that has been deployed provides tools capable of addressing the computational requirements for the next generation of ground water, soil profile, surface water, and atmospheric models. Parallel processing technology can also be extended beyond the server core to include the agency desktop workstations. This capability has allowed the agency to leverage not only the server core, but also all of the agency desktops to extend the computational resources as needs grow and evolve. Because of the nature and extensibility of the core IT infrastructure, the SWC has developed and will continue to grow and evolve super-computer class computational resources for little or no cost.

Storage Management

The SWC is responsible for many paper data resources for which there are no duplicates. This includes the General Land Office (GLO) survey plats, Survey Notes, Water Permits, Drillers Logs, Project Records, and many other resources. Historically, these resources existed in paper form and there are no backup copies available, and many have deteriorated with age. In order to preserve and maintain these data resources, the SWC has digitized many of these resources to provide digital copies to be used in-house and to provide a means of storing copies off-site for disaster recovery purposes. In addition, most of these resources have also been made readily available to the general public as well through the Internet.

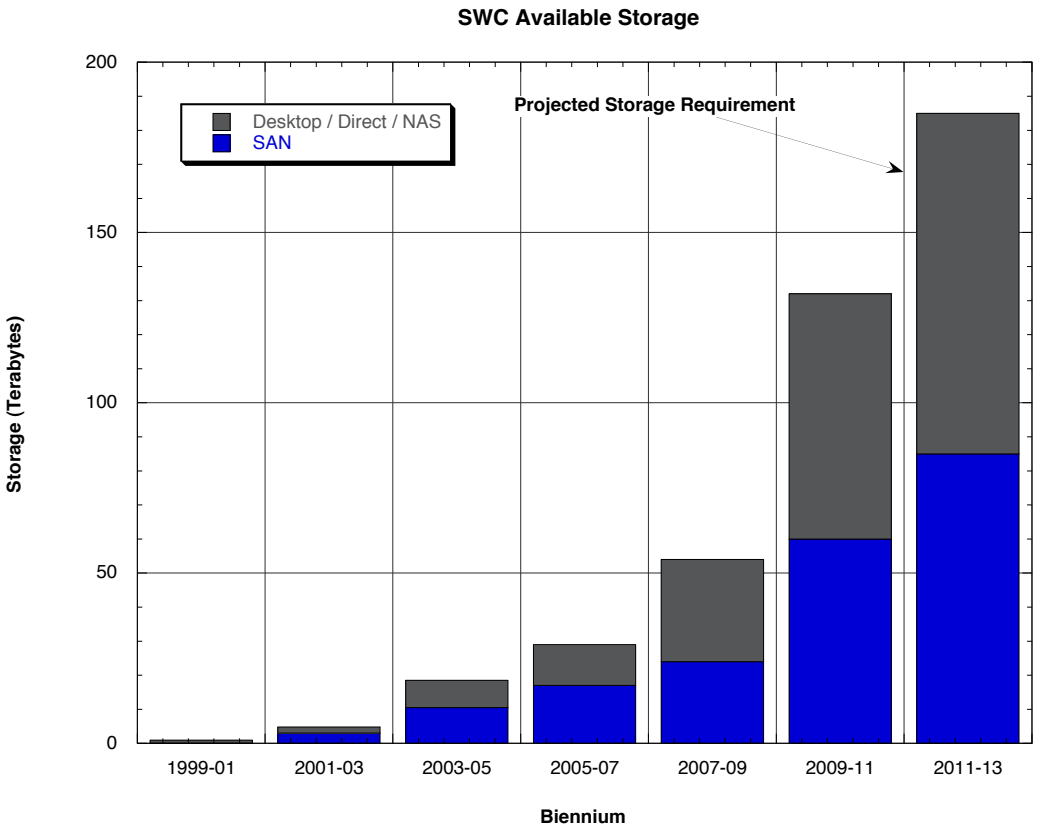
Over the past forty years, the SWC has collected aerial imagery and other remotely sensed data of many areas where irrigation development is growing and in areas where there has been flooding or flooding concerns. This imagery is an invaluable resource for determining and documenting hydrologic conditions relevant to specific events. Historically, this imagery was provided in paper form. However, with improvements in GIS and image technology, this data can now be used within GIS to provide better utilization of the data. The SWC has completed the digitization of the image resources that are available within the agency, and now efforts are focused on the conversion of these resources into spatially enabled products so that they can easily be used within a GIS framework. Most of these types of data are currently collected in digital form and all future data collection for aerial imagery, Lidar, as well

as many other forms of direct and remotely sensed data is collected and disseminated in digital form.

In addition to digitizing many of the historic paper records and the on-going data collection efforts surrounding imagery and Lidar, the SWC has also increased the volume of data that has traditionally been collected for water resource monitoring through the use of continuous recorders and other means. This has resulted in significant increases in the volume of data that is collected and maintained by the SWC. As a result, storage is now the single biggest challenge facing the SWC to provide the necessary data infrastructure capable of meeting the agency's water resource management requirements.

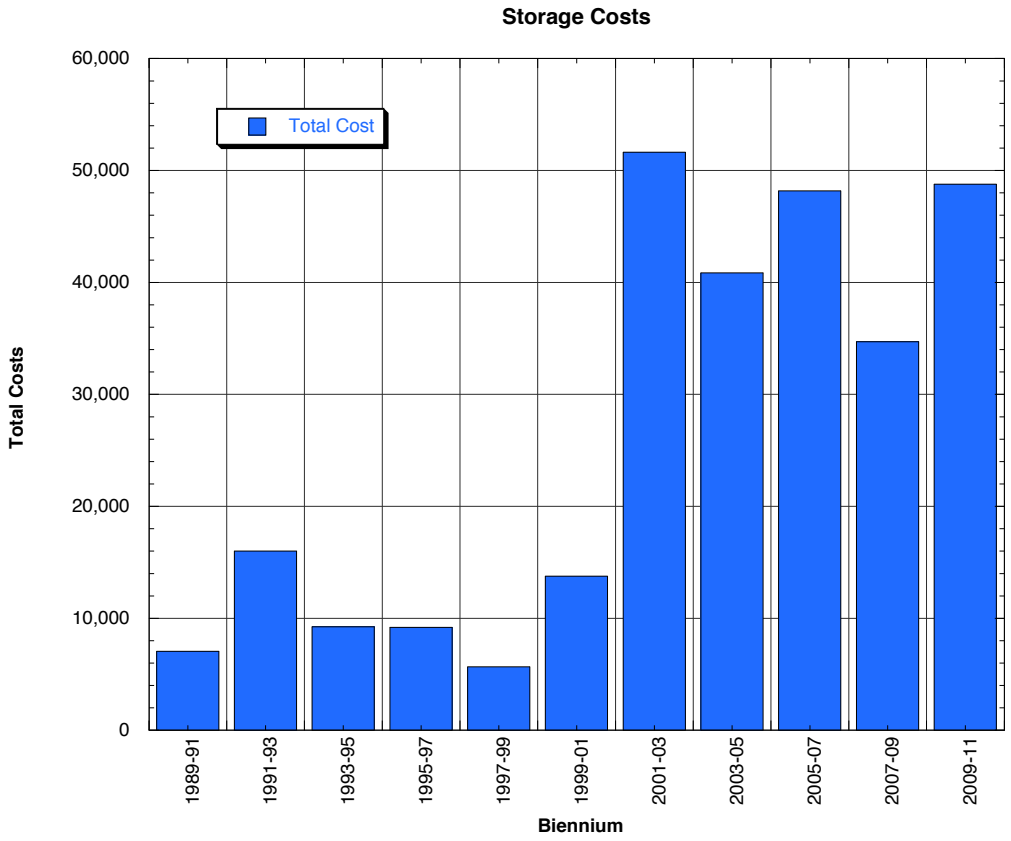
In 2002, the SWC maintained approximately 1 TB of active disk. This included both desktop direct attached storage as well as direct attached storage on the agency servers. In order to accommodate increasing storage requirements, the storage infrastructure for the SWC was completely re-engineered during the 2001-2003 biennium to include a SAN storage solution. It was necessary to provide storage services independent of the server resources so that available storage could easily be increased as needs dictated. By separating storage and servers, the storage services can also be used more efficiently across the entire server base. The storage infrastructure that was implemented has accommodated the storage requirements for the SWC and has provided a means of controlling storage costs to levels that do not dramatically exceed standard desktop storage costs.

Since the introduction of the SAN storage solution in 2001-2003, the SWC has added additional storage to accommodate the storage requirements associated with many of the initiatives outlined earlier. Currently, the SWC maintains SAN storage with an effective capacity of 50 TB. In addition, the agency also maintains more than 60 TB of desktop, direct attached, and NAS storage solutions. Much of the growth through 2009 and 2010 (nearly 60 TB) was a direct result of replacing antiquated tape backup systems incapable of addressing the volume of data that was available on the network. Looking forward, SWC storage requirements have been projected to approach 185 TB over the next three years through the end of the 2011-13 biennium.



With this type of growth in demand for storage, it would be reasonable to assume a similar increase in storage costs. However, agency expenditures for storage do not demonstrate the same dramatic increases, as the following graph clearly demonstrates. Generally, storage costs for the SWC remained fairly flat until the 2001-03 biennium, which marked the introduction of the SAN infrastructure. Since the deployment of the SAN infrastructure, storage costs have again stabilized at a fairly flat rate, albeit a much higher base cost than the pre-SAN infrastructure. Differences in these base costs are clearly a direct result of the class of storage infrastructure that has been deployed.

The SWC has been successful at controlling storage costs while increasing available storage capacity primarily because of increases in storage density. The current replacement cycle for most of the SAN infrastructure provides significant opportunities to expand available storage as disk arrays are replaced for maintenance purposes. In addition to increasing storage density, the SWC has also tailored the appropriate storage solutions for each respective task. Costs for SAN infrastructure are considerably higher than costs associated with direct attached storage solutions. Since SAN infrastructure is generally not necessary for some project level work and data archival, the SWC has been able to integrate non-SAN solutions using direct attached and NAS storage solutions where appropriate. Given the nature of much of the data and costs associated with the SAN infrastructure, the agency will continue to implement cost effective storage options to address the growing demands for storage within the base budget.



Mobile Computing

Beyond the laptop computers assigned to individuals and the laptop pool available for users with an occasional mobile requirement, the SWC currently has not deployed significant mobile resources. This is not because the SWC does not have a need for mobile computing, but more because mobile computing capabilities that were available did not provide an effective platform to fit our mobile needs. There are two criteria that are critical to the effective deployment of mobile technology for the SWC, which include connectivity and screen real estate. With the advent of smart phones and the improved cell coverage throughout North Dakota, the issue of connectivity has now been addressed. While smart phones can provide a viable platform for business applications such as e-mail and occasional web browsing, they lack sufficient screen real estate to be effective tools in the field.

With the recent introduction of Apple's iPad, mobile technology is finally evolving to the point where both the connectivity and the screen real estate are sufficient to provide viable tools for field use. These devices can now provide access in the field to many of the backend data systems to retrieve data and validate data collection efforts while in the field. With the increased screen real estate, they now provide capabilities to display maps and other image data while in the field, which proved somewhat difficult on the smaller form factor of the smart phone. At this point, the SWC will likely begin to deploy these types of mobile platforms with field personnel

during the current biennium. Ultimately, we will see significant growth in this area as the technology and connectivity continue to evolve.

Return on Investment

It is very difficult to separate the IT infrastructure from the context of the agency business model to determine the effectiveness of that investment. If you instead look at the agency business model, there are many factors that require consideration in order to make this type of assessment, and many of these are rather subjective. Ultimately, this becomes a question of how effective the SWC is at managing North Dakota's water resources and the role that the IT investment played in these efforts. This is nearly impossible to accomplish within the scope of an IT strategic plan because we have no way of measuring the effectiveness or value of North Dakota's water resource management efforts. Therefore, other metrics will have to be considered.

In this case, the only metric that provides any insight into the effectiveness of the SWC IT infrastructure is a direct cost comparison. For purposes of this strategic plan, this will be developed by comparing the costs of the existing system at the SWC to the costs that would be incurred if the same services were provided by ITD. This includes File and Print services, storage, application services, application development, and web services. ITD's current service model provides a means of measuring the efficiency of the SWC's IT infrastructure as it represents current state standards. The estimates used here are based upon ITD's current rate structure.

File and Print Services

File Services are currently maintained at the SWC on an internal server that also provides many other services, which include network monitoring, directory services, and others. This server is also used to manage the computational services that are being supported by the server core. The SWC currently does not use any print spooling services. Costs to implement File Services from ITD would present a server cost of $14,400 for the biennium and user fees of $4,590 for a total of $18,990. This service would be dedicated to File and Print services and would not address any of the other services currently maintained on the agency internal server.

Computation Services / Distributed (Grid) Computing

ITD currently does not provide parallel or distributed computational services, nor are there any plans to provide this type of service in the future. Therefore, it is not possible to use the ITD model to properly evaluate this service. It is also difficult to determine the costs associated with performing this function with an alternative infrastructure as the SWC has currently implemented this functionality on top of the existing servers and the existing Macintosh end-user desktops with no additional licensing costs. It would be fairly easy to state that there is no additional cost associated with the deployment of this service using the existing SWC IT infrastructure. Also, any other technology platform would be limited to the server component of the existing SWC xGrid cluster. As a result, it is highly unlikely that the SWC would be able to deploy any form of Grid computing capability under any other architecture.

Application Services / Web Services

The SWC currently maintains ten separate application services that provide the application base and data management services for the agency. ITD's current rate structure is tiered. However, based upon discussions with ITD, the SWC could be looking at a monthly rate of approximately $375 per application. This translates to $72,000 for the biennium. In addition to the application services, the SWC also maintains a web service application that is fully integrated with current data management systems. This application would require some re-design, but just the monthly web service hosting fees would have a biennial cost of $9,000. This brings the total application and web service hosting fees to $81,000 per biennium.

Storage Services

Storage demands for the SWC are measured in terabytes, not gigabytes or megabytes. The SWC is involved with various state and federal partners where large data collection efforts are underway or have been completed. Many of these collection efforts have yielded aerial photography, LIDAR, satellite imagery, and other types of data products that have large storage requirements. Most of the imagery and data products are currently stored in digital format. It has not been practical or feasible to put these data products on-line until just recently as a direct result of the cost-effective data storage infrastructure deployed by the SWC.

The SWC currently maintains a tiered storage infrastructure with approximately 60 terabytes of available SAN storage, and 72 terabytes of Desktop, Direct, or NAS storage. Of the SAN storage, approximately 30 TB would be equivalent to ITD's current Silver storage service, which ITD provides at $5/GB/month. The remaining 30 TB is generally provided as backup disk and would be more equivalent to ITD's Bronze storage tier, which is provided at $1/GB/month. A large portion of the 72 terabytes of Desktop, Direct, or NAS is used as backup or project archive and would be more or less equivalent to ITD's Tape Archive costs at $.55/GB/month.

Using this rate structure, total biennial storage costs for 30 terabytes of Silver storage would be $3,600,000, 30 terabytes of Bronze storage would be $720,000, and 72 terabytes of tape archival would be $950,400. When combined, this brings the total biennial storage cost to $5,270,400.

Application Development

The SWC began using 4th Dimension (4D) in 1990 for purposes of data manipulation and data management because the solutions available from ITD were not capable of meeting agency requirements. The 4D environment extends beyond data management to provide integrated application services. This environment has grown over the past 20 years, and 4D is now the primary data management and application base used by the agency.

The agency has re-evaluated the 4D infrastructure in responses to changes at ITD. While previous ITD (CDP at the time) mainframe solutions did not provide the necessary flexibility, more recent ITD solutions using Oracle or SQL Server could provide the necessary flexibility to meet agency data management requirements. However, maintenance costs associated with data management built around ITD's infrastructure was found to be more than 10 times that of the current infrastructure, and this did not include the costs of re-designing and re-building the existing 4D infrastructure. Therefore, the agency elected to maintain the 4D infrastructure.

In order to utilize ITD's infrastructure, the current application and data management infrastructure at the SWC would need to be re-designed and rebuilt to run within ITD's supported infrastructure using Oracle for data management and Java or .NET for application services. Without a detailed cost estimate, projecting the design costs for the SWC's existing systems is somewhat subjective. However, this exercise does serve to provide a framework for consideration. The estimates presented here were derived by projecting the number of hours anticipated for this type of project. Once the hours were identified, ITD's rate structure for programming and project management were used to develop the cost projections.

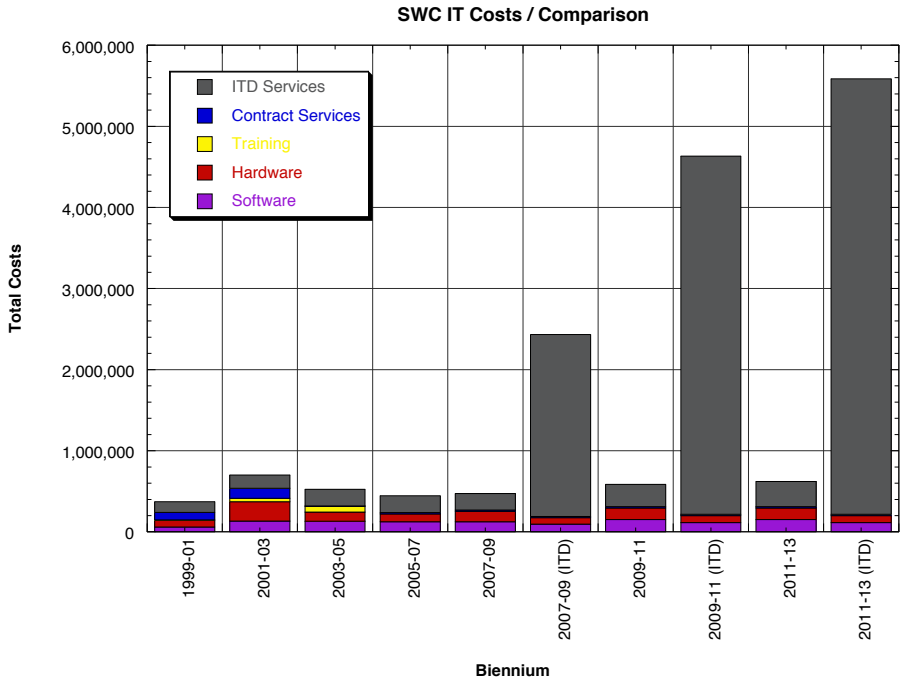
The SWC currently maintains ten application services for general data management that would require re-tooling. In addition, the SWC web services application would also require a significant amount of work to provide the same integration with the new data management infrastructure. In order to rebuild all of the existing services, the SWC has estimated an initial programming overhead of 17,000 hours at a rate of $67/hour. In addition, estimates for project management were placed at 1,500 hours at a rate of $86/hour. The estimates derived for project management were somewhat low because in this case the existing systems should provide a reasonable design, which should reduce the time spent in project management. Using these estimates, the SWC has identified a total cost for rebuilding the current application infrastructure to be $1,268,000. These estimates do not include agency staff time for training relevant to the new system, nor does it include down time and lost time. These estimates also do not include costs and overhead associated with maintaining parallel development efforts that will be required if the agency were to move forward with the existing 4D system during the two to three year period in which the new systems are under construction.

Summary

There would be other unforeseen costs beyond those presented that would impact the overall costs associated with an infrastructure model supported by ITD. However, the costs presented here provide sufficient detail to compare the agency's current infrastructure costs with those provided under ITD's current model. If the standard model supported by ITD has been identified as a cost effective model for state government, then it should provide an effective metric to evaluate the costs and benefits associated with the infrastructure deployed by the SWC.

The IT budget for the SWC is presented below for the last six biennia along with the projected budget for the 2011-13 biennium. In addition, the costs projected for the 2007-09, 2009-11, and 2011-13 biennia based upon an infrastructure provided by ITD are also provided. Only core IT services were included so that the price differences could be presented more clearly. For the costs projected for the 2011-13 under ITD's infrastructure, ITD Services includes the $308,932 that is currently projected for the agency budget as these include network and telephone fees that will still be required. Also, the hardware and software items were lowered for the ITD supported alternative to reflect the reductions in agency server infrastructure requirements. Application development costs presented above were not included in the comparison as these represent one-time costs and are not reflective of base infrastructure costs. However, these costs ($1,268,000) would be incurred in the event that the SWC were to elect to utilize the infrastructure provided by ITD.

Biennium	ITD Services	Contract Services	Training	Hardware	Software	Total
1999-01	132,155	93,000	4,000	84,000	59,000	372,155
2001-03	163,148	123,733	42,500	237,333	133,730	700,484
2003-05	205,352	3,317	7,500	114,169	129,944	460,282
2005-07	206,159	16,445	0	97,356	124,500	444,460
2007-09	204,532	0	0	127,356	140,945	472,833
2007-09 (ITD)	2,432,475	0	0	78,000	112,445	2,432,475
2009-11	274,865	0	0	142,356	169,945	587,166
2009-11 (ITD)	4,417,590	0	0	85,000	130,945	4,633,535
2011-13	308,932	0	0	142,356	169,945	621,233
2011-13 (ITD)	5,370,390	0	0	85,000	130,945	5,586,335



While there would be savings in both the hardware and software line items, these are more than offset by the increases in the ITD Service costs. The overall total presents an increase in base infrastructure costs that approached $4 million dollars in the 2009-11 biennium, which would have only been offset by $96,356 dollars in savings in the hardware and software line items. Likewise, the overall total projected for the 2011-13 biennium represents an increase of more than $5 million dollars. Again, this would be offset by $96,356 dollars in savings in the hardware line items.

The FTE line item was not included in this analysis because of the differences in accounting for FTE applied to IT over this time period. Currently, the agency has 2 FTE's that are considered to have a strict focus on IT. Even if both positions could be eliminated, the ITD supported infrastructure would still represent base increases of more than $3.6 million dollars per biennium. In reality, it is not reasonable that either IT position could be eliminated because agency IT operations would still require internal management and administration even with ITD supported infrastructure.

In addition to the areas identified in this analysis where there are known costs, there are many other facets to the current infrastructure that were not identified or addressed. In particular, the computational services that the agency has developed within the existing infrastructure would not be available within the infrastructure provided by ITD, and if they were to be developed, there would be additional costs associated with these services.

In the end, return on investment can only be determined by applying subjective criteria to evaluate the performance of the SWC in fulfilling the water resource management mission for which it has been tasked. When the costs and functionality of the current IT model developed by the SWC is compared with implementation under the model provided by ITD, the SWC has performed extremely well and has implemented technology that is appropriate and cost effective to meet the agency business requirements. This has been defined and well documented over the years within the strategic planning process. If the agency is to accomplish the same tasks and provide the same functionality to agency staff and the same level of services to the general public using the consolidated infrastructure, it will cost the agency an additional $5 million per biennium.