Wyoming I-Plan
December 11, 2003

Wyoming I-Team
A Subcommittee of the Wyoming Geographic Information Advisory Council

WGIAC

Wyoming Geographic Information Advisory Council

The Wyoming Geographic Information Advisory Council (WGIAC) approved the Draft Wyoming I-Plan on December 11, 2003 by a unanimous vote of the Council. Thus the Wyoming I-Plan is fully endorsed by this Council for the State of Wyoming.

Joseph M. Huss
Chairman
Wyoming State Geological Survey

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Introduction

Overview of the Wyoming I-Team

The I-Team Geospatial Information Initiative (I-Team Initiative) is a joint project of the Federal Geographic Data Committee (FGDC), Federal Office of Management and Budget (OMB), and other strategic partners. This initiative addresses the institutional and financial barriers to development of the National Spatial Data Infrastructure (NSDI). The results of these efforts will help provide integrated information for analysis of issues and decision-making at federal, state, local, and tribal levels of government. Further, it will provide a common frame of reference for communicating information and concepts of complex issues to citizens.

Wyoming's I-Team provides the regional component to the national Initiative. Each I-Team must be adaptive, collaborative, flexible, and most importantly, locally responsive. It is on the regional, state, and local levels where the most accurate spatial data is produced, maintained, analyzed, and distributed. So the national effort benefits by tapping directly to the best sources of information. Additionally, the local level benefits by tapping into the coordination of standards, technologies, financial assistance, and other trusted data sources from all levels of government and the private sector nationwide.

The Wyoming Geographic Information Advisory Council (WGIAC) is an organization providing statewide GIS coordination, offering technical and data acquisition assistance for statewide GIS projects, and assisting with in-house development of GIS capabilities. WGIAC committees, activities, meetings, and events are open to anyone to participate. The current member list includes representatives from state, federal, and local government, and the private sector. The Base Map committee of WGIAC has assumed leadership and coordination duties as Wyoming's I-Team. The I-Team is built on a foundation of cooperation developed over the last decade recognized primarily by extensive data sharing between federal, state, and local governments.

The principles followed by the Wyoming I-Team are based upon the following policy statements that have been adopted by WGIAC and the Base Map Committee:

- Most data should be created and maintained by agencies that have a programmatic need or mandated responsibility for specific layers. (Data should have a designated agency responsible for maintenance, updating, and preservation of specific layers.)

- Because users close to the geographic features usually have first hand knowledge of the data and can provide more accurate and timely data, local governments should be encouraged to create and share data. Local governments should also be encouraged to collaborate with each other and with state and federal agencies to create and share data.

In essence, the Wyoming I-Team provides a forum for information gathering and dissemination to all levels – both for spatial data but also the technologies, issues,

impediments, and solutions associated with spatial data use. It can be viewed as a process focused on using spatial data efficiently.

Overview of the Wyoming I-Plan

Since the I-Team is a "process", the I-Plan is its "product". This implementation plan identifies and details the specifics of using spatial data efficiently. It is focused on data development, maintenance, stewardship, and accessibility. The I-Plan itself is broken down by data theme. The themes that receive the most attention are the seven "Framework" themes: cadastral, digital orthoimagery, elevation, geodetic control, governmental units, hydrography, and transportation. Framework data represents spatial data most commonly used by all groups. However, additional themes have been added to take advantage of the I-Team process as well.

A subcommittee work group has been formed to address each identified layer. Each work group represents agencies having mandated responsibility and/or programmatic need for the data from all levels of government – federal, state, and local. They are responsible for the completion of the following for the data layers associated with their respective theme:

- Inventory of the existing data
- Identify existing standards
- Develop a strategy for completing the data layer
- Develop costs estimate and time requirements for completion of the data layer
- Assign responsibility for creation, integration, maintenance, and distribution of the data layer

Essentially, each subcommittee identifies the structure, both technical and organizational, of the implementation of each data theme statewide. For more specific instructions on subcommittee responsibilities, please see the Appendix.

The Future of Wyoming I-Team and I-Plan

Because the Wyoming I-Team is essentially a process, work on data implementation will be continuous. That means this document will continue to change. Of course new versions of this document will have updates to the data themes already listed. But more data layers will be added over time. Therefore, this document is not static. Please always check for subsequent versions.

The Wyoming I-Team has also formed a subcommittee focused on data access. They are to pursue ways of streamlining the distribution of data across all the themes, thus reducing effort and making implementation even more efficient. Another issue that is common to all the themes is a data inventory. There have been attempts in the past for statewide spatial data surveys. However, there have been issues of timeliness of the results as well as discontinuity between surveys. This subcommittee will address ways to not only conduct a statewide spatial data inventory, but do it to serve the community at large (not just the I-Team) and in a timely fashion.

The only way for this process and product to be successful is of course through participation. So far all efforts have been done on a voluntary basis – no single person or group in Wyoming has been tasked with not only overseeing this effort, but carrying out the day to day responsibilities. Therefore what is contained in this document is based purely on individual and/or organizational motivation. Because this effort and document are new, the absence of other items does not necessarily mean no one is interested in them. It just means no one has stepped forward to participate. For example, the governmental units section was done over a year ago with no one in charge of it currently. Because it is one of the seven framework layers, it has languished not because of a lack of importance, but a lack of individuals and/or organizations available to take on the responsibility.

In conclusion, as participation increases, so will this document's content. As more of this document's content and recommendations are carried out, the better the NSDI becomes, benefiting not only all spatial data users in Wyoming and nationwide, but those decisions being made using spatial data. The fact that Wyoming data adheres to standards and processes regardless of source is tremendous. For example, street centerlines produced by the City of Cheyenne will line up with crash data from the Wyoming Department of Transportation and population data from the U.S. Census Bureau. The outcome is spatial data working together.

More Information

National I-Team Effort: http://www.fgdc.gov/I-Team/

Wyoming I-Team Effort: http://gis.dot.state.wy.us/iteam/

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Cadastral

Theme Description

CADASTRAL /kə'dastr(ə)l/
Of or relating to a survey of land, usually for tax purposes.

This is a common technical term in surveying (and tax collecting), though not widely known outside those specialisms. A *cadastral* survey is one on a scale sufficiently large to accurately show the extent and measurement of every field or other block of land. The most common reason for such a survey is as a basis for taxation, but in some countries, particularly the US, it is associated at least as strongly with the need to accurately identify land boundaries; for example, there is an active *Cadastral Survey* within the Bureau of Land Management in the USA, which is responsible for maintaining records of all public lands. Such surveys often required detailed investigation of the history of land use, legal accounts and other documents, so it often includes a fair amount of detective work in matching physical surveys with records. The word came into English by way of French and Italian from the Greek *katastikhon*, a list or register, from *kata stikhon*, "line by line". (World Wide Words)

The Public Land Survey System (PLSS) is a rectangular survey system that typically divides the land into 6-mile square townships, which are further subdivided into 1-mile square sections. The extension of the rectangular system of surveys over the public domain has been in progress since 1785 (in Wyoming since 1870). The PLSS is the primary survey and legal description system for defining the boundaries of the parcels of public lands, and forms the basis of patents issued when public lands pass out of federal ownership. The legal descriptions for most of the western United States originate from the PLSS. Because the PLSS is the basis for all public and private land entitlement in the West, it is a critical component of the cadastral (land ownership) layer, 1 of 9 primary "framework" themes identified by the FGDC for implementation of the NSDI. The PLSS provides the spatial reference system for land ownership and title information.

Government organizations and private industry use the PLSS to portray parcel boundary and land record information in day-to-day business processes involving land transactions and entitlement. It is also a foundation theme in GIS to support analysis, planning, and decision-making on complex land and resource issues. Many different representations of the PLSS exist that vary significantly in both content and accuracy, resulting in conflicting sources of information. The increasing use of GIS in both the public and private sectors, and the greater necessity for collaboration, identifies the need for a common, integrated cadastral infrastructure to facilitate decision-making at all levels.

There are various interpretations of exactly what cadastral data encompasses, however a generally accepted definition would be a taxable parcel of contiguous private land, or portions of contiguous public land (including BLM, USFS and State lands) no larger than a section. These private land parcels should have a Wyoming State Tax Department, Ad

Valorem Division, Parcel IDentification Number (PIDN). That description can be complicated by many factors including easements, rights of way, non-contiguous parcels owned by the same person, parcels split on various taxation districts etc, so at this point it seems best to simplify the description and work on database solutions to address the anomalies.

Background and Purpose:

In the early 1990's, the Bureau of Land Management (BLM) began collecting data for the Geographic Coordinate Data Base (GCDB), which is a digital representation of the PLSS that provides geographic positions correlating land ownership (cadastral), and other themes, to the earth's surface. GCDB integrates survey records, horizontal control, and land description to portray legal land parcels described by the PLSS. GCDB is the preferred data source to portray parcel boundary and land record information in both public and private sectors. Unlike other PLSS representations, the GCDB depicts the PLSS to the public land parcel level, and can be readily updated with newer, more accurate information to increase its positional reliability. GCDB provides a more precise PLSS land grid for parcel mapping at the local level. The Western Governors Association (WGA) recognizes the GCDB as the, "best hope of standardizing the PLSS in the Western States", and strongly endorses its use and continued enhancement. In June 2000, WGA adopted WGA Policy Resolution 00-005, Public Lands Survey System and Ownership Database, http://www.westgov.org/wga/policy/00/00005.htm and recommended that a unified plan for GCDB implementation across the West be developed in coordination with federal, state, tribal, and local governments. The WGA planning effort is parallel with the Office of Management and Budget's (OMB) Information Initiative to align the needs and resources to continue development of NSDI framework implementation through mutually beneficial partnerships.

Existing Data

This plan primarily addresses BLM's GCDB and its collection, integration, and enhancement with more current survey information from other public sources. Statewide the GCDB for Wyoming is approximately 97% complete. There are several other sources of cadastral data in Wyoming including the United States Geological Survey (USGS), Forest Service, USDA (FS), State of Wyoming and all country governments.

- <u>BLM</u>

  Types of data includes: GCDB, survey records, PLSS GPS coordinates, land ownership attribute information

  The Wyoming office of BLM collects and maintains the GCDB from its most recent survey records and, in some instances, from private survey records provided by the FS. Accuracy of data varies widely, and therefore accuracy of generated coordinates may vary widely.

  BLM collects and stores data on a township basis. The survey boundaries are delineated by computing the geographic positions of township corners, section

corners, subdivision of section corners and non-rectangular survey corners from record survey plats. Next, official land descriptions are linked to each land unit in the grid. The data is then standardized and converted to ARC/INFO coverages, and GIS software can be used to view the PLSS information spatially. The data can be readily updated with new survey and control data.

- USGS

  Types of data includes: unknown at this time.

- Forest Service

  Types of data includes: Survey Records, PLSS GPS-coordinates, land ownership attribute information

  National Forest System lands in Wyoming are: Bridger-Teton Nation Forest, Targhee National Forest, Shoshone National Forest, Wasatch National Forest, Medicine Bow National Forest, Black Hills National Forest, Bighorn National Forest, Caribou National Forest and thunder Basin National Grasslands.

- Wyoming State Government

  Types of data includes: unknown at this time.

- Counties

  Types of data includes: survey records, PLSS GPS-coordinates, land ownership attribute information

  The counties of Wyoming each maintain extensive survey records dating back many years, thus providing a history of survey activities and ownership patterns. As the counties obtain more equipment, trained personnel, and funding, their ability to provide survey-grade GPS coordinates increases. These coordinates, as well as information on land ownership and transfer, form a basis for data that may contribute to the GCDB and Cadastral data layer. However, some Wyoming counties currently do not possess data in a format compatible with the GCDB nor with GIS.

  The Wyoming County Clerk's are required to record, abstract, and make publicly available, all land records instruments affecting private property, including deeds, subdivision plats, etc. The recordation and abstracting of land records occurs ONLY at the county level (i.e. not at the municipal level as is the case in some eastern states, nor are there any state or federal agencies that have responsibilities or jurisdiction for maintaining private land ownership records).

Similarly, the Wyoming County Assessors have various responsibilities for maintaining cadastral records including the circa 1989 Ad Valorem parcel mapping and PIDN mandate.

Teton County Land Development Regulations require that new subdivision plats be tied to Wyoming State Plane, NAD83, US Survey Feet coordinates. 36 subdivision plats were recorded in Teton County in 2002. This is a significant source of geo-spatial data.

PIDNs. Around 1989 the Wyoming State Tax Department, Ad Valorem Division required all County Assessors to adopt their Parcel IDentification Number (PIDN) scheme. Teton County took it a step further and required that all real property related instruments (deeds, easements, mortgages, liens, etc) which are recorded by the County Clerk to have the PIDN(s) of the effected property on the face of the document. The document is then abstracted against the PIDN (as well as standard grantor, grantee, and locational abstracting). This allows these legal records to be tied directly to the GIS.

With just a few mouse clicks a GIS user can: 1. Click a property and get basic ownership information from the assessors records. 2. A second click brings up a land records abstract from the clerk's office. 3. And with a third click the user can view scanned copies of the documents. Teton County's Map Server can be found at: http://www2.tetonwyo.org/mapserver/ The use of PIDNs in abstracting land records is enormously beneficial. A statewide initiative such as this is recommended.

Standards

Standards provide the function of normalizing data and support the automation, exchange, and integration of publicly available data from multiple sources. The standard for Wyoming will be the FGDC Cadastral Data Content Standard. The standard can be found at http://www.fgdc.gov/standards/documents/standards/cadastral.

Bureau of Land Management Instruction Memorandum No. 2001-186 Subject: Standards and Guidelines for Cadastral Surveys Using Global Positioning System Methods and Bureau of Land Management Instruction Memorandum No. 2002-066 Subject: Policy and Guidelines for Bureau Datum Standard Implementation

There are also existing standards for the collection of data at the county level.

Theme Status

Current Investments

- BLM - Total current investment in this theme is approximately $ 6,000,000 for GCDB data in Wyoming.
- Forest Service – unknown at this time.
- State of Wyoming – unknown at this time.

- Various County Governments – unknown at this time.

Completion Strategy

The Wyoming cadastral plan describes the overall status and implementation strategy to collect, integrate, and distribute the most accurate, complete and current cadastral data available through the coordinated efforts of various levels of government statewide. The plan will address technical issues, policy issues, and resource issues, including data content, data sources, funding and resources, and spatial accuracy development.

The basic strategy is as follows:

1) Inventory, catalog, and evaluate existing data files
2) Define standards and business rules for cadastral data functions to facilitate data collection, integration, and exchange
3) Make use of the existing Wyoming Geographic Information Advisory Council (WGIAC) Spatial Data clearinghouse http://wgiac2.state.wy.us/html/index.asp at the state level
4) Develop a systemized program for prioritized data collection and maintenance on a funded project basis and as part of the daily business of each agencies' internal cadastral activities

The plan will consist of detailed area plans for each of the 23 Wyoming counties. Some counties may be combined to address larger geographic areas if needed. Detailed plans will summarize the workload, resources, and time frame to collect, integrate, maintain, and distribute cadastral data in each county through the coordinated efforts of federal, state, local and tribal governments. Maps, tables, and a township level database will be developed to show inventory, status, and progress. Need to research further the capabilities of the Geographic Information Science Center at the University of Wyoming (WyGISC). They may be able to lead these collaborative-based planning projects under the direction of the State Surveyor.

Responsibilities

Coordination of data development and sharing activities should continue as a state-led activity. "Framework" layers or critical data will require funded creation. Integration of differing data among themes should remain a centralized function. Data should be created and maintained by specific agencies that have a programmatic need or mandated responsibility. Local government roles and responsibilities for maintenance will vary by county depending on their resources. Users most familiar with the geographic features can provide more accurate and current data, and will be encouraged to create and share data.

This plan proposes the State of Wyoming create a position of State Surveyor to over see and coordinate the implementation of the collection of future cadastral data at the state and county government levels. This position would report to the State of Wyoming Chief Information Officer.

If Wyoming receives sufficient funding, a person at the county government level would be responsible for supervision of data collection. The state would be divided into 5 regions with a person responsible for the coordination of data collection for each region. A region would include numerous counties. These people would report to and collect data under the oversight of the State Surveyor.

County governments are not subject to the Freedom of Information Act or similar directives and as such are not required to share their non-public data. The Cadastral Plan strongly encourages public distribution of cadastral data.

Data Creation

- BLM - To complete the GCDB data for the areas that are incomplete, and then to integrate the various datasets or information from the best and most accurate datasets.
- State of Wyoming - State Chief Information Officer/State Surveyor
- County Governments – County employees; continue to collect data at the taxable parcel of contiguous private land level.

Cost Estimate

- BLM: $250,000
- State: unknown at this time.
- County Government: unknown at this time.

Time Estimate

- BLM: 1-2 years
- State: unknown at this time.
- County Government: unknown at this time.

Data Integration

Refer to future Data Access subcommittee report.

Data Steward

Refer to future Data Access subcommittee report

Data Access

Refer to future Data Access subcommittee report

Summary

Total Cost Estimate

Unknown at this time

Total Time Estimate

Unknown at this time

Current Action Items

Unknown at this time

Committee Membership

- John Lee, Bureau of Land Management – Chair
- David Chapman, Wyoming Department of Revenue
- Kent Felderman, Sweetwater County
- Richard Greenwood, Greenwood Mapping
- Mike Knapp, Albany County
- Milbert Krohn, Bureau of Land Management

Digital Orthoimagery

Theme Description

The FGDC "Framework Introduction and Guide" (1997) explains that, "Ortho-imagery provides a positionally correct image of the earth. An ortho-image is a georeferenced image prepared from an aerial photograph or other remotely sensed data from which displacements of images caused by sensor orientation and terrain relief have been removed." (p. 18).

Digital ortho-imagery is typically utilized in a digital orthophoto format. A digital orthophoto is a georeferenced image that has the properties of an orthographic projection positionally correct image of the earth – composed of an array of georeferenced pixels that encode ground reflectance as a discrete digital value. The orthophoto combines the image characteristics of a photograph with the geometric qualities of a map.

This dataset can be utilized to derive and compile many geographic features that are part of the framework for utilization in Geographic Information System (GIS) applications. In particular, numerous vector data themes can be compiled from digital ortho-imagery. The dataset can also be used to analyze or reference other data and to update older data based on the visible feature on the digital ortho-imagery. Change detection is another use of this data.

Existing Data

There are various datasets for digital ortho-imagery. The USGS compiles and produces a standard digital ortho-image in 1-meter ground resolution quarter quadrangles (1:12,000-scale, 3.75 X 3.75-minute in extent) that are referred to as digital orthophoto quads (DOQ), which may also be referred to as digital orthophoto quarter-quads (DOQQ). The U. S. Department of Agriculture Forest Service (FS) also produces this standard set.

Standards

Standards for DOQQs are described in the USGS "National Mapping Program Technical Instructions Standards for Digital Orthophotos," dated December 1996.

Theme Status

Completion of once-over DOQQ coverage for Wyoming is 100 percent complete. This represents a first generation product initiated in 1995 using 1994 National High Altitude Aerial Photography (NAPP).

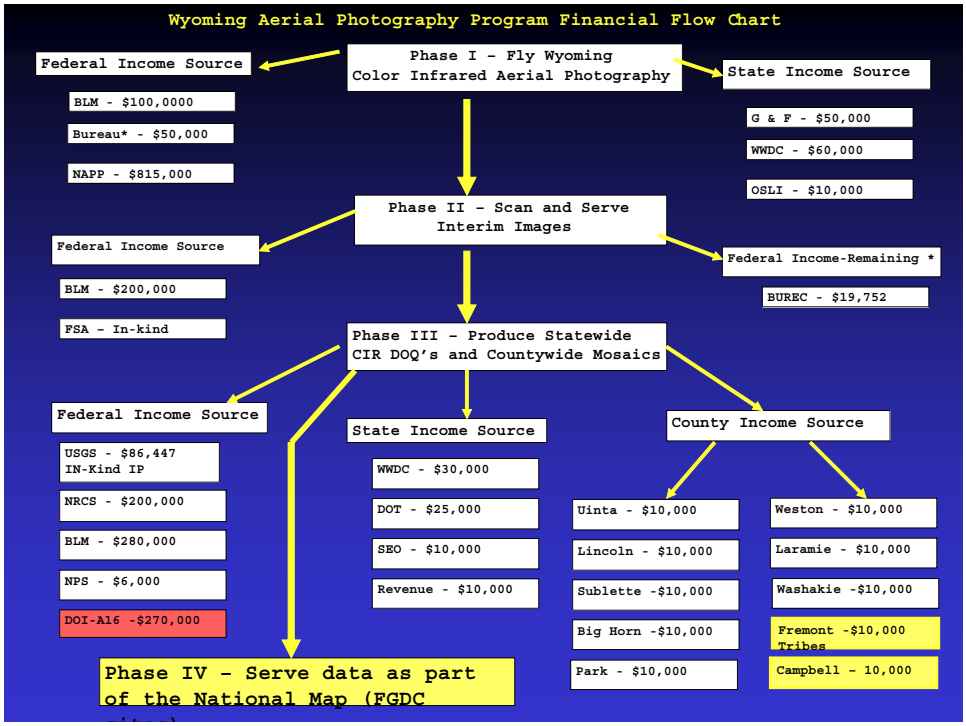
Beginning in Fall 2001, Wyoming and its federal and local government partners began to extend this program by developing second-generation Color IR DOQQs for the entire State. Priorities include areas with significant community and coal-bed methane development.

The 1994 black and white DOQQs are available at the WyGISC, WGIAC, Lighthouse, and FGDC Internet distribution nodes and web sites.

Current Investments

Refer to Wyoming Aerial Photography Financial Flow Chart (see below).

- Phase 1: Flying Wyoming NAPP Color IR—fully funded at $1,068,000
  - Federal Contribution: 90%
  - State Contribution: 10%
  - Wyoming was approximately 85% completed during the 2001 flying season
  - Approximately 13% completed during the 2002 flying season
  - Remaining 2% scheduled for completion during 2003 flying season
- Phase 2: Scanning
  - BLM funded scanning for approximately 16, 768 images: $250,000
  - State is funding image compression and distribution of complete mono coverage for approximately 7,752 images
- Phase 3: 2nd generation Color IR DOQ production: $479,444
  - Federal, State, and County Income Sources are funding production.
  - DOQs are most valuable if produced in within 1 to 2 years of flying



Completion Strategy

Priority for second-generation coverage will include the Powder River Basin where there is coal-bed methane activity and Sublette County for BLM's Planning Priorities. Coal-bed methane activity is expected to increase significantly over the next 10 to 20 years, and this data set can contribute to urban planning and growth, transportation planning, watershed management, and tracking extraction and production of this natural resource.

Responsibilities

The State Of Wyoming (State Engineer's Office) awarded and oversees the contract for Phase 3.

Data Creation

Phase 3: Produce Statewide CIR DOQ's and County Mosaics

Cost Estimate

$479,444

Time Estimate

The final delivery of all DOQ units to the State is projected for March 2, 2004.

Data Steward

The data steward lead will be the State Engineer's Office with WYDOT, BLM and USGS as partners in this dataset. The FS and NPS will be responsible for their areas.

Data Access

The WyGISC, WGIAC, and Lighthouse will serve as distribution nodes for ortho-imagery within and outside of Wyoming. The federal archive and distribution point for ortho-imagery data produced by the USGS is located at the EROS Data Center (EDC) in Sioux Falls, SD. The general public can order ortho-imagery data from this database.

Summary

Wyoming Aerial Photography Program is completing Phase 2 and is in Phase 3 of the cooperative effort between partners to produce Statewide Color Infrared DOQ's and Countywide Mosaics.

Total Cost Estimate

To date, no additional funding is necessary.

Total Time Estimate

Project completion projected for March, 2004 and Data Access projected for April, 2004.

Current Action Items

Scan 2003 reflights for 32 quarter quads and provide scans to contractor for Phase 3.

Committee Membership

- Gretchen Meyer, Bureau of Land Management – Chair
- Ken Driese, Wyoming Geographic Information Science Center, University of Wyoming
- Nancy McCann, Wyoming State Engineer's Office
- Bill Sitterle, Cheyenne/Laramie County GIS Cooperative
- Jim Waller, Big Horn Basin GIS Users Group
- Mary Wilson, Bureau of Land Management

Elevation

Theme Description

The FGDC "Framework Introduction and Guide" (1997) explains, "elevation as data to provide information about terrain. Elevation refers to a spatially referenced vertical position above or below a datum surface. The framework includes the elevations of land surfaces and the depths below water surfaces (bathymetry)." Elevation data can be used as a representation of the terrain, such as a contour map, post elevations or a three-dimensional perspective. The data can also be used to build models to perform applications ranging from line-of-sight calculations, to transportation planning, and watershed management. Elevation data is often combined with other digital data themes for modeling and mapping applications.

There are many ways to represent elevation data sets and/or models. The standard product that the U. S. Geological Survey (USGS) produces and uses is represented as a digital elevation model (DEM) collected in 10 or 30 meter grid spacing with coverage in 7.5 X 7.5 minute blocks. Each coverage provides the same coverage as a standard USGS 7.5 minute quadrangle without overedge. The National Elevation Dataset (NED) is a product produced after an artifact filtering process has been run on DEMs.

Existing Data

Statewide coverage of 90 and 30-meter DEMs (from NED). 10-meter DEMs are available for the western third of the state. Primary sources for NED are the USGS and NASA.

DEMs are available in two formats in Wyoming:

- Standard USGS 7.5 minute format
- National Elevation Dataset (NED) merged statewide coverage produced by ECD/USGS. The WyGISC has both datasets.

Standards

Standards for NED and DEMs are described in the USGS National Mapping Program Technical Instructions Standards for Digital Elevation Models dated January 1998. Standards should meet the ASPRS accuracy standard and FGDC metadata standard. These standards and other information about DEMs can be found at http://rockyweb.cr.usgs.gov/nmpstds/demstds.html and, http://rockyweb.cr.usgs.gov/elevation/dpi_dem.html.

Theme Status

As of 2002 state coverage for 30-meter and 90 meter DEMs is 100%. Coverage for 10-meter DEMs is approximately 30%, with an additional 5% DEM production in progress. We need to identify who is working on the 10 meter DEMs.

The 30 and 10-meter data are from the same source, 7.5' topographic quadrangles that have primarily 40-foot contouring. The accuracy of DEMs produced are:

POSTING	VERTICAL ACCURACY
30 meter	± 7 meters
10 meter	± 7 meters

Two large-area IFSAR projects are scheduled for Wyoming in FY 2002 that are funded by the DOI High Priority Project covering the Northern Big Horn Mountains and the Wind River Indian Reservation. These are planned at 5-meter horizontal posting and ± 2-meter vertical. We need to identify the contacts for this project.

Current Investments

Approximately $_____ has been spent to date for both 30-meter and 10-meter DEM coverage. The estimate is based on $_____ for 100% completion of 30-meter DEMs and $_____ for approximately 30% coverage of 10-meter DEMs. Utah is using $690 per quad as a cost figure for the 10 meter reposted DEMs. If this figure is still valid, and using the estimate approximately 1450 quads remaining, it will cost approximately $1,000, 500 to complete the 10 meter project. This information needs to be firmed up.

Completion Strategy

To have a highly accurate and detailed elevation layer for the state, one must identify all existing data. The Elevation Group of the Wyoming I-Team will assess whether it is worthwhile to utilize the Homeland Security data inventory from the Spring of 2002 (which has not been released as of the writing of this document) or conduct its own survey. Then based on the data being produced in the state, identify contributors.

Priority for 10-meter DEMs is completion of once-over state coverage, which should include the eastern two-thirds of the state. 10-meter data is available west of 109°. Priority for 5-meter IFSAR and LIDAR data should be in the energy-rich portion of the state, starting with the Powder River Basin. Specific priority areas may be coal-bed methane production in the northeast quarter of the state and the North Platte River drainage area. Coal-bed methane production continues to increase, and will do so for the next 10 to 20 years. Wyoming and Nebraska have completed a compact outlining Wyoming's use of water within the North Platte River drainage. This data set can contribute to planning and growth of coal-bed methane development, and aid watershed management within the North Platte drainage system in Wyoming.

Recently, a discussion has begun on what level of DEMs would be needed in order to produce a statewide set of accurate 1-foot interval contours.

Responsibilities

The existing datasets were funded only by the federal sector. The state of Wyoming is providing local distribution through the WyGISC at the University of Wyoming.

Data Creation

As of 2002 state coverage for 30-meter DEMs is 100%. Coverage for 10-meter DEMs is approximately 30%. 10-meter data is available west of 109°. 90 meter

is complete statewide. It is not yet known by the group what level of DEM would be needed to create 1 or 2 foot interval contours that would be useful for flood control work and stream rehabilitation work.

Cost Estimate
The cost estimate is unknown at this time to complete a statewide 10 or 5 meter or higher resolution DEM layer.

Time Estimate
The time estimate is unknown at this time. We are still in the process of discovering what data are available.

Data Integration
The WyGISC provides 90 and 30-meter and completed 10-meter DEMs through its distribution node on the Internet. The primary archive and distribution point for elevation data produced by the USGS is located at the EROS Data Center in Sioux Falls, SD.

The data integration portion of this report is still a work in progress. Because of the number of data producers at different governmental and organizational levels, this portion of the plan will take considerable effort and coordination from all participants. Trying to put together many disparate datasets will be a formidable challenge. The responsibility of data integration will most likely fall upon the stakeholders. The stakeholders need to be identified.

Data Steward(s)
- State Data Steward: State Engineer's Office
- Wyoming Federal Data Steward: BLM
- National Federal Data Steward: Rocky Mountain Mapping Center (RMMC/USGS)

Data Access
The WyGISC provides 90 and 30-meter and completed 10-meter DEMs through its distribution node on the Internet. The primary archive and distribution point for elevation data produced by the USGS is located at the EROS Data Center in Sioux Falls, SD. Then general public can order elevation data from this database.

Cost Estimate
The total cost estimate to establish the DEM portion of the statewide data clearinghouse at WyGISC is unknown at this time.

Summary

Total Cost Estimate

Maintenance, including periodic revisions, will continue through the stewards and process defined. Costs will hopefully be minimal and close to being a part of agencies ongoing operational activities.

Total Time Estimate

Needs to be determined.

Current Action Items

- Conduct a face to face meeting and review goals (complete this project, complete 10 meter DEMs, improve DEM quality, resolution and distribution, move on, etc.)
- As a committee, become informed as to what we are doing.
- Investigate other state's DEM projects
- Develop relationships with people who can help us, i.e., USGS etc.
- Figure out time and cost.
- Identify stakeholders and contributors.
- Develop a data integration plan.

As of December 2002, there is a discussion beginning on the feasibility of creating a statewide 1-foot interval contour layer. At this time we don't know what level of DEM would be required to produce such a dataset. But we do know of efforts under way in South and North Carolina as well as Minnesota.

Committee Membership

- Randy Wiggins, Natural Resources Conservation Service - Chair
- Beth Hoobler, Wyoming State Engineer's Office
- Liz Hepp, City of Casper
- Craig Knight, Knight Technologies, Inc.

Geodetic Control

Theme Description

Geodetic control consists of monumented points surveyed and referenced to nationally supported horizontal and vertical datums. This control provides the basis for referencing features to the earth's surface. Geodetic control is the vital infrastructure to which the spatial component of all others layers must be referenced.

The Federal Geodetic Data Committee (FGDC) has defined Geodetic Control as one of the seven critical framework layers for implementation of the NSDI. The National Research Council has recognized the importance of Geodetic Control in its 1980 document "Need for a Multipurpose Cadastre". This report stated that "A survey control base is needed to create an integrated land records and information system".

I-Team reports from some other states have expanded control to include low order project mapping and survey control. This Wyoming specific draft will concentrate on the need for establishing and maintaining modern high order geodetic control within Wyoming. This direction is necessary due to the relative inaccessibility and scarcity of traditional established control and the lack of modern high accuracy control within Wyoming. Mapping and surveying control for specific projects such as cadastral surveys, GCDB data collection, or transportation and energy development can then be based on the existing higher order framework.

Existing Data

The primary source for geodetic data is the National Geodetic Survey (NGS). The NGS, known by other names in the past, has been responsible for establishing and maintaining a nationwide geodetic reference system since 1807. This network, currently called the National Spatial Reference System (NSRS), contains monumented stations whose horizontal and/or vertical coordinates or both are precisely known. Due to the nature of conventional surveying techniques horizontal control was located on mountain peaks or other high points and vertical control was established along transportation corridors such as railroads or roads.

Lower order horizontal and vertical geodetic control was established by the U.S. Geological Survey (USGS) to support the mapping of the United States. This control came off of NGS control and was propagated using lower accuracy procedures and instruments. Again the horizontal control tends to be located on mountains or other high points and the vertical along transportation corridors. In many cases data on these stations has not been adjusted or published. Much of it has been lost or destroyed and is no longer available for use.

There are approximately 8220 geodetic control stations that comprise the NSRS in Wyoming. Approximately sixty percent of these are vertical control stations. Many of these stations, especially the vertical, have been destroyed by construction, vandalism, or neglect. Other stations have been lost due to descriptions that cannot be retraced or have

not been updated. Other conventional control stations are considered inaccessible and are not suitable for use with modern surveying technologies such as GPS.

Map 1, at the end of this section, depicts the High Accuracy Reference Network (HARN) and Continuously Operating Reference Stations (CORS) within Wyoming. The HARN and CORS are the most modern components of the NSRS and are of sufficient accuracy to support technologies like GPS. Currently the HARN, with the exception of stations in Yellowstone Park, comprises approximately 125 monumented stations within or immediately adjacent to Wyoming, and is composed of approximately 50 Federal Base Network (FBN) points and 75 Cooperative Base Network (CBN) points. NGS policy is that only FBN will be maintained by NGS. The remaining stations of the NSS are the responsibility of local entities. The CORS stations are geodetic GPS base stations that operate continuously. There are three active CORS stations within Wyoming operated by cooperating agencies and the NGS. The rationale is that the CORS and FBN stations, by having extremely accurate positions, will support the national horizontal and vertical datums and that in connection with CBN stations can be used by local surveying entities to effectively establish new geodetic control as needed and provide the basis for lower order densifications or project control to support surveying and mapping projects within Wyoming.

Geodetic control has also been established by other federal agencies such as the BLM or Forest Service, state agencies, local government, and private entities to support survey or mapping projects. This control is not part of the NSRS. Much of this control is of low order having been established without following consistent accuracy standards, procedural specifications, or having adequate monumentation. The number of stations is unknown as there is no requirement for recording of this data or central point of contact within the state to coordinate or advise on geodetic issues.

Standards

Listed below is a partial list of accepted or draft standards that can be used for the establishment of geodetic control or data transfer.

- Geopositioning Accuracy Standards (FGDC-STD-007-1998)
- Spatial Data Transfer Standard (SDTS) Part 6: Point Profile (FGDC-STD-002.6)
- Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques, FGDC 1989 or most recent version.
- NGS Draft Survey Manual, available at http://www.NGS.NOAA.gov/FBN/Guidelines
- Guidelines for Establishing GPS Derived Ellipsoidal Heights, NOAA-TM NOS NGS-58, 1997

<u>Theme Status</u>

The distribution of modern geodetic control within Wyoming is uneven. Many counties have only one or two HARN stations. FBN HARN stations are located on approximate 100 km spacing within the state. CBN HARN stations tend to be concentrated near major population centers, along major highways, or located to support localized survey

activities. Discussions are underway with one county on the feasibility of densifying geodetic control for the purpose of supporting the updating of their GIS base layer. Inquires have been received from several other counties on densification.

CORS stations are located in Casper, Medicine Bow, and Mammoth. The CORS station in Boulder was destroyed and has not been replaced by UNAVCO. A new NGS/FS/BLM CORS station is under construction at the Forest Service Supervisor's Office in Custer, S.D. This will provide enhance coverage to Northeastern Wyoming. The Earthscope and Plate Boundary Observatory program managed by UNAVCO (Boulder, Wyoming) will be installing 5 new CORS type stations across Wyoming over the next several years. Proposed locations are in the area of Kemmerer or Boulder, Rawlins, Wheatland, Ten Sleep or Worland, and Newcastle. Local assistance is being sought to help locate appropriate sites. The BLM and NGS are considering locating an additional site in Wyoming pending funding. This station would be located in either southeastern or northwestern Wyoming. The Wyoming Dept. of Transportation and the Federal DOT is studying options for setting up National Differential GPS (NDGPS) sites in the Rawlins and Jackson areas. These locations can serve as CORS stations as well as broadcasting NDGPS real time GPS corrector signals.

The majority of conventional geodetic control is more than 30 years old. As discussed above, much of the horizontal control is relatively inaccessible. Vertical control lines exist along most of the major highways. There are few modern level lines and many of the older lines have many stations that have been destroyed or lost.

Due to a declining federal budget the NGS is not running active GPS or leveling crews with the exception of two airport survey crews and one crew running levels to CORS stations. The NGS will continue to offer support and direction to local entities conducting geodetic surveys but will not be returning to Wyoming for any major field operations. Station maintenance and the establishment of new permanent high order geodetic control will be the responsibility of entities within the state.

The BLM Geodesist is currently the NGS State Geodetic Coordinator on an as needed basis. He will provide geodetic advice as requested and attempt to educate the public and attempt to develop partnerships for maintenance and development of the geodetic control framework. There is no other single state, local, or federal entity in Wyoming responsible for overall coordination.

Current Investments

The total investment by federal, state, and local entities is significant but the total amount is unknown.

Completion Strategy

There are three immediate needs to be addressed:

a. A cooperative agreement between the NGS and the State of Wyoming to create a Geodetic Advisor position. This person would coordinate with all governmental

agencies, federal and local, as well as the companies or groups in the private sector who are involved in surveying and mapping and offer geodetic advice and assistance in performing control surveys.

b. Densification of HARN points across the state. Approximately 100 new stations would give a 25-mile spacing through much of the state. The vertical control network can be upgrade by converting appropriate existing first or second order vertical control stations to HARN stations. This would permit the use of GPS to establish vertical control. Readily available geodetic control would enable geospatial data to be economically collected and referenced to a common coordinate system and datum at the time of collection. This would be beneficial to many activities including the development of Land Information Systems, energy development, transportation infrastructure projects, land planning and associated monitoring activities, and resource management.

c. Establishment of new CORS GPS stations. CORS stations represent the basis of the future of high accuracy geodetic control and network connections. All modern geodetic control will be based on ties to these stations. Project control can be created by using data from a single or multiple CORS stations or in conjunction with ties to HARN stations. There are other benefits. Meteorologists can utilize CORS GPS observations to determine atmospheric water content. This can improve the accuracy of short-term weather forecasts. By utilizing appropriate communication systems, CORS stations can also support Differential GPS activities for navigation at the one-meter level or Real Time Kinematic Surveying at the two cm level in cities. A minimum of eight new CORS stations would be necessary to provide approximate 100 mile spacing within the state.

   As noted in the Status section there are proposals to create eight new CORS or CORS type stations in Wyoming over the next several years. However, some of these stations will tend to be clustered (example: Rawlins). Additional stations will still be necessary to achieve a nominal spacing.

Completion Strategy

Responsibilities

No current federal, state, or local agency has the responsibility or current budget to oversee or fund this proposed work. A cooperative effort involving all benefiting parties needs to be developed to determine contributions from the different sectors.

Time and Cost Estimates

Geodetic Advisor positions are cooperative agreements between the NGS and a sponsoring state agency. Typical state agencies are Departments of Transportation, universities, or state surveys. The cost is on a 50/50 basis. Approximate state contributions would be $47,000 per year. It could take up to one year to create an agreement and fill the position.

HARN level control stations can cost approximately $6000 per station. This includes monumentation, observation, data reduction and adjustment, and database inclusion. 100 new points could cost approximately $600,000. This cost could be reduced by utilizing time and labor contributions from interested and benefiting agencies for station recovery, monumentation, and observation. It would take one to five years to complete this work.

CORS stations cost approximately $30,000 per station. This includes the dual frequency geodetic GPS receiver, software, computer, monumentation, and telecommunications. Approximately $240,000 for eight new stations would be needed to complete this phase. It would take one to five years to complete this portion of the work.

Data Steward / Integration / Access

We foresee sharing this responsibility between NGS, the state of Wyoming, the Bureau of Land Management, and county surveyors. NGS, through its existent on-line database will remain responsible for the NSRS. However, WyGISC has established a clearinghouse for the distribution of geodetic data. This clearinghouse will also mirror the data provided by NGS resulting in a single local source of geodetic control for local surveyors. All state, local, and private agencies that establish geodetic control would be invited to participate. The NGS State Geodetic Advisor would function as the primary data steward and contact between the agencies.

It would cost approximately $15,000 to purchase the necessary computers and mass storage devices and labor necessary to develop the data directory structures and integrate it into an existing clearinghouse system.

Maintenance Process and Cost

Long tem costs are not known at this time.

Summary

Function	Cost Estimate	Time Estimate		
Geodetic Advisor	$47,000 / yr			
HARN Stations	$600,000 (total)	1 – 5 years		
CORS Stations	$240,000 (total)	1 – 5 years		
Data access	$15,000	1 year		

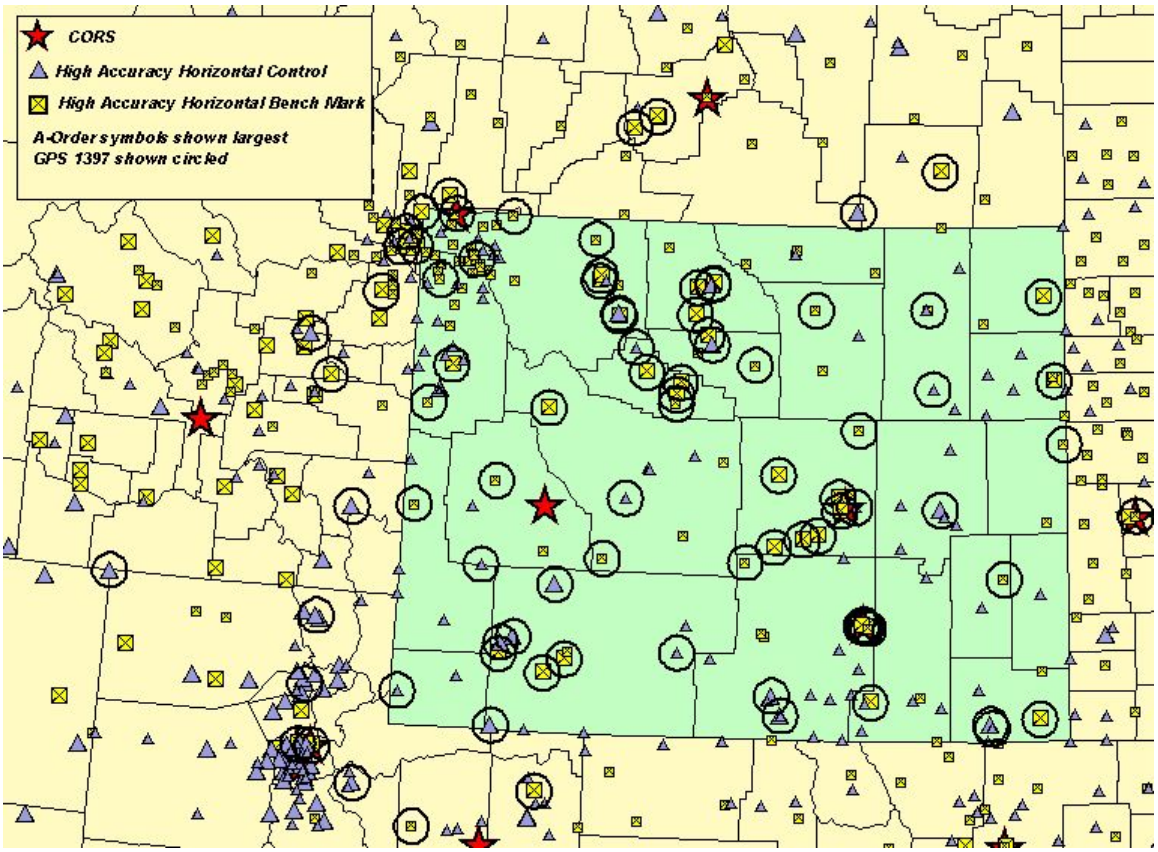
Action Items

a. Identify possible state agencies that could support and host a NGS State Advisor position.
b. Identify interested parties that would be interested in developing a cooperative strategy for HARN and CORS densification.

Committee Membership

- Mike Londe, Bureau of Land Management – Chair

MAP 1


CORS
High Accuracy Horizontal Control
High Accuracy Horizontal Bench Mark
A-Order symbols shown largest
GPS 1397 shown circled

Governmental Units

Theme Description

Boundaries are maintained in a series of layers representing the geographic extent of areas that define jurisdiction, taxation units or administrative management responsibilities. This theme is one of the seven Framework layers.

Existing Data

There are multiple sources for boundary related data in Wyoming. They include, but are not limited to:

- Census Bureau
- Bureau of Land Management
- U. S. Forest Service
- All 23 Counties
- Municipalities
- Office of State Lands and Investments
- State Engineer's Office
- Department of Revenue

Existing Standards

The Governmental Unit Boundary Data Content Standard is currently in the Draft Stage by the Federal Geographic Data Committee. It can be found online at http://www.fgdc.gov/standards/standards.html.

Theme Status

Currently there is no single group coordinating statewide integration of this type of data. While some organizations do collect information covering all of Wyoming, it is for their specific needs and applications.

Current Investments

The current investments for collecting this information by the various groups are unknown at this time.

Completion Strategy

There has been no proposed strategy for completing this theme.

Summary

Total Cost Estimate

Unknown at this time.

Total Time Estimate

Unknown at this time.

Current Action Items

The Wyoming I-Team Coordinator is currently looking for someone to chair this group.

Committee Membership

None.

Hydrography

Hydrography data for Wyoming will be comprised of the 1:100,000 and 1:24,000-scale National Hydrography Dataset (NHD) for surface water hydrographic features and the 1:24,000-scale Watershed Boundary Dataset (WBD) for hydrologic drainage basin boundaries.

National Hydrography Dataset

Theme Description

The NHD will conform to the USGS Standards for National Hydrography Dataset and contains hydrographic features for rivers, streams, canals, lakes, and reservoirs. The NHD model is designed to provide a seamless spatial data layer of hydrographic data for the United States enabling interagency data exchange and continuous maintenance and enhancement. The NHD is intended to improve integration of hydrologically-related data in a variety of water resource modeling and management applications for a growing national user community. It is a comprehensive geospatial dataset containing spatial attribute information for 52 surface water feature types representing stream networks, waterbodies and landmarks such as streams/rivers, lakes/ponds, springs/wells and dams/weirs. Within the NHD, rivers and streams called "reaches" form a routed framework for linking, or indexing, water-related data to the NHD surface water drainage network. Routed reaches enable hydrologic navigation for modeling applications, analysis, and display of water-related data in upstream and downstream order. Additional benefits include hydrologic ordering (stream levels), a unique identifier (reach code) for surface water features, and the spatial accuracy and comprehensiveness of the DLG hydrography. The NHD data is easily accessed via the web in ArcInfo coverage format at http://nhd.usgs.gov/. The NHD will soon become available in the Geodatabase format for use in the ArcGIS environment.

Existing Data

High-resolution NHD can be created from existing 1:24,000-scale vector data such as the Environmental Protection Agency's (EPA) Reach File Version 3.0 (RF3), the USGS's Digital Line Graph (DLG) hydrography files, and Cartographic Feature Files (CFF) where these exists. Because existing base data necessary to create high-resolution NHD in Wyoming is primarily limited to CFF data for Forest Service lands, large gaps exist in high-resolution base hydrography data for a majority of the State. The USGS has developed a process for creating base data called Tag Vector Hydrography (TVH) which contains the minimum major and minor coded attributes needed to conflate to the NHD model. Source data to create TVH is provided from scans of the USGS blue-line separate plates used to create USGS 7.5 minute topographic quadrangle maps. These scans are made available from the USGS Rocky Mountain Mapping Center (RMMC). These scans are then used in the creation of TVH via a semi-automated process to vectorize and attribute of the scanned hydro features. The USGS has also developed a set of ArcView and ArcInfo tools to create NHD.

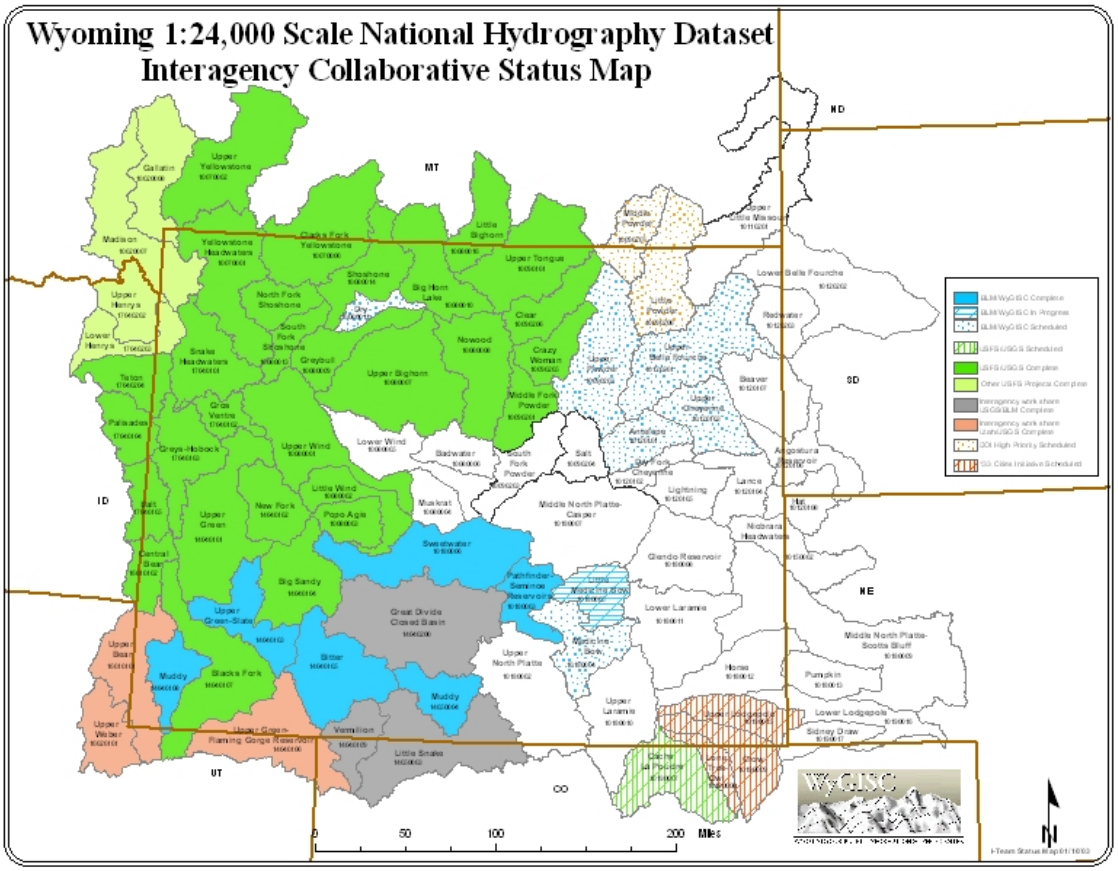
Standards

There are two standards for NHD. One is the USGS National Mapping Program technical instructions entitled, "Standards for National Hydrography Dataset – High-resolution" dated November 1997 and the other is "Standards for National Hydrography Dataset" dated July 1999.

Theme Status

Medium resolution (1:100,000-scale) NHD is complete for Wyoming and available for download at: http://nhd.usgs.gov/ by 4th level 8-digit sub-basin. The Digital Line Graphics (DLG) Hydrography, 1:100,000 scale data will remain available through the Wyoming Geographic Information Science Center (WyGISC) clearinghouse at: http://www.wygisc.uwyo.edu/24k/hydro100.html.

The high-resolution NHD has been completed for much of the western part of the state (see status map) to meet the high priority resource management needs within sub-basins containing large areas of USFS and BLM lands. Of the 83 sub-basins within or intersecting Wyoming, 57 (69%) have been completed, are in progress, or are scheduled for completion.



Current Investments

To date, the Federal sector has provided all funding and impetus to produce high-resolution NHD. Innovative cooperative partnerships existing between the USGS Rocky Mountain Mapping Center (RMMC), USGS Mid-Continent Mapping Center (MCMC), USFS, BLM, and the WyGISC have provided funding and expertise for the completed sub-basins. Costs associated with interagency assistance and coordination are impossible to calculate but are significant and should be acknowledged. The level of effort by each collaborator is described as follows:

- **USFS** - As a result of the USFS's nationwide program for the completion of the NHD over the agency's lands, approximately one third of Wyoming has been completed with high- resolution NHD. Completion of the NHD for these sub-basins is being accomplished through an interagency agreement with the USGS. As part of this agreement, the USFS provides hydrology vector base data in the form of CFFs covering the forest lands within a sub-basin. The USGS assesses and converts the CFF to produce the NHD. Wherever base hydrography gaps exist for the remainder of a given sub-basin, the USGS produces TVH or DLG files. This cooperative effort between the two agencies has been a catalyst for developing interest among other organizations to produce the dataset for other regions of the State. The USFS's interest in the NHD stems from its use of the dataset in its Natural Resource Inventory System (NRIS). Every National Forest and Grassland is responsible for watershed assessments that are developed through the use of NRIS, where NHD is used as the spatial reference system.

- **USGS** - One mission of the USGS is to complete The National Map for the country. Because the NHD is the hydrography theme for The National Map, a part of normal operational funding is directed to NHD production in each of the States. Additional funds from the Department of the Interior (DOI) High Priority Project funds (allocated to the USGS Geography Discipline to produce geospatial data for states) are being used to create the NHD for 2 sub-basins shared between Wyoming and Montana. The USGS is currently providing data inventories for 133 urban areas identified by the National Imagery and Mapping Agency; one of these urban areas is Cheyenne. Three NHD sub-basins are now scheduled to be completed under this initiative to meet the hydrography theme requirement for the city of Cheyenne. Because the NHD is the hydrography theme for The National Map, NHD production in Wyoming supports the USGS mission for populating this data theme for the entire country. Wyoming has become a model for building innovative partnerships to complete high-resolution NHD as part of The National Map program.

- **BLM/WyGISC** - Agreements developed between the State BLM office and WyGISC to create the NHD for sub-basins containing major BLM lands evolved from previous agreements to develop the 1:24,000-scale 4th, 5th, and 6th level hydrologic unit code boundaries known as the Watershed Boundary Dataset for Wyoming. Like the USFS, the BLM is also incorporating the use of the NHD into resource management and planning efforts on public lands. Pressures to

provide industry with drilling lease permits for coal bed methane extraction on BLM lands is the impetus behind the BLMs need for high-resolution NHD in Wyoming. Additionally, the BLM has an agreement with WyGISC to use the reach indexing tools in the NHD Toolkit to link riparian data to reach segments having Proper Function Condition data.

Total approximate investments by sector are listed as follows:

- Federal
  - USGS: unknown at this time.
  - USFS: unknown at this time.
  - BLM: 13 sub-basins @ $300,000
- State: None.
- University of Wyoming, WyGISC: $118,000 cost share
- Adjacent States: unknown at this time.

Completion Strategy

Wyoming priorities are twofold: The first is to create the 1:24,000-scale TVH for the remaining data gaps. The second is to develop the high-resolution (1:24,000-scale) NHD for the remaining sub-basins affecting Wyoming.

Ideally, funding to complete the remaining TVH and NHD needed for the State would come through innovative cost-share partnerships between multiple state, local, and federal agencies based on percentage of ownership, area of interest, and foreseeable use of the dataset. Investment required to complete the NHD for sub-basins intersecting adjacent states should be shared.

One approach for finding potential collaborators is to determine who owns or administers the majority of lands in a particular sub-basin. In some instances, an entity may own or administer only a small portion of a sub-basin but has a prominent need and use for the dataset for decision support, making it the largest stakeholder in a sense. Once stakeholders are identified, their participation should be encouraged through education about how the NHD can benefit their business practices.

Although the Wyoming State agencies have not participated so far in developing the NHD for the State, several issues have highlighted the importance of the NHD (homeland security, coal bed methane development, etc.), and interest in the dataset at the State level is becoming apparent. There is an ongoing effort to educate agencies about the value of the dataset to attract more funding resources for its production in Wyoming. This is being accomplished through presentations and workshops across the State. These workshops and presentations serve to introduce participants to the NHD and provide hands-on experience for participants to use the dataset for analysis and cartographic mapping.

Responsibilities

Preferably, funding to complete TVH and NHD for the state would come from cost-share partnerships between state, local, and federal agencies based on percent ownership, area

of interest, and foreseeable use of the dataset. As NHD for sub-basins are completed to meet the needs for federal agencies having lands within the state, federal interest in partnering with state and local agencies to complete the remaining sub-basins will be greatly diminished. Inevitably, responsibilities and costs for maintenance and revision of the NHD is an additional expense that will eventually need to be addressed. Coordination for these efforts would be through WyGISC and the I-Team Hydrography sub-committee.

Data Creation

As remaining sub-basins are completed to meet federal agency needs within the state, data gaps are foreseeable for sub-basins in the southeastern region of the state and along borders with the adjacent states of northeastern Colorado, Nebraska, and South Dakota. The responsibility to complete these sub-basins would ideally be shared between states, preferably by percent ownership of any given sub-basin along state boundaries. Given the current level of investment by all states for 24k NHD development, obtaining the coordination and support needed to complete these sub-basins is likely to be problematic. Creation of NHD for data gaps will likely continue to through RMMC and WyGISC.

Cost Estimate

Cost estimates vary because agencies producing the NHD have different salary and overhead costs. As the process for creating the base data (TVH) and the NHD is streamlined, the production costs are decreasing, so current estimates will probably be higher than the actual costs. High-resolution data is relatively expensive to produce, at $400 to $550 per 7.5-minute quadrangle. Where gaps exist for the base data needed to create NHD, an additional cost of $200 to $350 per quadrangle for TVH creation is added.

Of the 83 sub-basins intersecting Wyoming, 57 sub-basins have either been completed, are in progress, or are scheduled for completion leaving 25 sub-basins without sponsorship for the creation of 24k NHD. The following estimates to create 24k NHD for the remaining sub-basins are based on an average cost of $550 per quadrangle. Estimates to complete 1:24,000-scale NHD for remaining sub-basins within Wyoming and intersecting adjacent states to Wyoming are as follows:

- Wyoming
  - Total quads to complete all sub basins NHD for Wyoming
    - NHD = 1011
    - TVH = 778
  - 604 quads within 25 sub-basins
    - High-res NHD @ $550/quad = $332,200
  - Remaining sub basins completely within Wyoming
    - 368 quads within 11 sub-basins
    - High-res NHD @ $550/quad = $202,400
- Montana
  - 51 quads within 1 sub-basins

    - High-res NHD @ $550/quad = $28,050
- North Dakota
    - 12 quads within 1 sub-basins
    - High-res NHD @ $550/quad = $6,600
- South Dakota
    - 141 quads within 5 sub-basins
    - High-res NHD @ $550/quad = $77,550
- Nebraska
    - 171 quads within 9 sub-basins
    - High-res NHD @ $550/quad = $94,050
- Colorado
    - 33 quads within 4 sub-basins
    - High-res NHD @ $550/quad = $18,150
- Utah
    - 0 quads within 0 sub-basins
    - High-res NHD @ $550/quad = $0
- Idaho
    - 0 quads within 0 sub-basins
    - High-res NHD @ $550/quad = $0
- Total estimated costs for adjacent states = $224,400

Estimate of current allocation of funding/resources for this theme is unknown at this time.

Time Estimate

Unknown at this time.

Data Steward

National Federal Data Repository: USGS

Data Access

Completed high-resolution NHD can be obtained at: http://nhd.usgs.gov/ by 4th level, 8-digit sub-basin as they become available.

Cost Estimate

No cost.

Time Estimate

Time to obtain the data is minimal and will depend on internet access speed and number of sub-basins being downloaded

Maintenance and updates to the NHD are inevitable as datasets of this scale and complexity will have errors. Cost to maintain the NHD for sub-basins affecting Wyoming are unknown at this time. Under a Memorandum of Understanding (MOU) between WyGISC and the USGS, WyGISC will be the state agent for maintaining and updating this dataset. Revision of NHD using the new color Infrared Digital Ortho

Quadrangle (DOQs) may be considered necessary as many of the USGS blue-line separate plates used to create USGS 7.5 minute topographic quadrangle maps are antiquated and provisional. However, revision costs are substantial and may further deter additional investment to improve the hydrography dataset.

Watershed Boundary Dataset

Theme Description

Hydrologic unit boundaries (HUBs) define the area extent of surface water drainage from a downstream point along a stream to another upstream point to the uppermost headwaters. The Wyoming WBD is part of a seamless, consistent, national Geographic Information System (GIS) database. The WBD is comprised of hydrologic drainage basin boundaries subdivided into sub-basin (4th level, 8-digit), watershed (5th level, 10-digit), and sub-watershed (6th level, 12-digit) hydrologic units in compliance with the NRCS National Cartography & Geospatial Center (NCGC) Federal Standards for Delineation of Hydrologic Unit Boundaries. Polygons are attributed with hydrologic unit codes for 4th level sub-basins, 5th level watersheds, 6th level sub-watersheds, name, size, and downstream hydrologic unit, type of watershed, non-contributing areas and flow modification. Arcs are attributed with the highest hydrologic unit code for each watershed, line source and a metadata reference file. The database will assist in planning and describing water use and related land use activities. The WBD data theme can be obtained via the web in ArcInfo coverage and shapefile format at the Wyoming Geographic Information Science Center's (WyGISC) Wyoming Natural Resources Data Clearinghouse at http://www.wygisc.uwyo.edu/clearinghouse/watershed24k.html. The WBD is available in Geodatabase format for use in the ArcGIS environment but not yet retrievable from the WyGISC Clearinghouse.

Existing Data

Draft HUBs aggregated and edited by WyGISC, were created using USGS National Elevation Dataset (NED) 5000 pixel catchments created by the USGS Earth Resources Observation Systems (EROS) Data Center, along with existing geospatial watershed boundary datasets from USFS, NPS and adjacent states. These data were instrumental in coordination efforts between local, intrastate, interstate, and federal collaborators. The Enhanced Digital Raster Graphic, produced by Beartooth Mapping, http://www.beartoothmaps.com/, contour lines were used in digitizing the final delineations. Enhanced Digital Raster Graphics are a digital representation of the USGS 7.5min quadrangles with the collars clipped. Preexisting 1:250,000 scale Hydrologic units data map of Wyoming, modified from USGS fourth level units were used to reference 4th level sub basin boundaries. More information about these processes can be obtained from the associated metadata at http://www.wygisc.uwyo.edu/clearinghouse/watershed24k.html.

Standards

This data set consists of geo-referenced digital data and associated attributes created in accordance with the "Federal Standards for Delineation of Hydrologic Unit Boundaries 12/06/01" at http://www.ftw.nrcs.usda.gov/huc_data.html.

Theme Status

High-resolution, (1:24,000-scale) WBD is complete through the 5th and 6th levels within Wyoming and available for download at: http://www.wygisc.uwyo.edu/clearinghouse/watershed24k.html (see status map). The 5th and 6th level HUBs for sub-basins intersecting adjacent state boundaries are complete through the 6th level. Completing these 4th level sub-basins through the 6th and 5th level falling entirely within adjacent states will depend on the interest of individual states to invest in the necessary effort required to finish these sub-basins.

Current Investments

The total known costs incurred to create the Wyoming WBD is $202,603.

Primary funding for high-resolution WBD was provided by the Department of Environmental Quality (DEQ) and the Bureau of Land Management. Total approximate investments by sector are listed as follows:

- State - DEQ: $173,218
- Federal - BLM: $29,385
- University of Wyoming, WyGISC - $127,232 cost share

Costs associated with interagency assistance and coordination are impossible to measure but are significant and should be acknowledged. Representatives from the DEQ, BLM, National Resource Conservation Service (NRCS), and the US Geological Survey (USGS) contributed a substantial amount of time and salary towards quality review of the dataset. Additionally, completion of the WBD has involved an extensive collaborative effort between WyGISC and numerous representatives from the DEQ, BLM and individual Field Offices, NRCS and individual Conservation Districts, US Forest Service and individual Forests, the Wyoming State Engineer's Office and individual Water Divisions, the Wind River Indian Reservation Tribal Council, and adjacent state agencies.

Completion Strategy

Theme is complete

Data Steward

State Data Steward: Wyoming Geographic Information Science Center

National Federal Data Steward: NRCS/USGS

The dataset is complete. The WBD is a dynamic theme that will require a dedicated commitment to maintain and update over time as requests from various agency and field personal is offered, as the actual hydrography changes, and as

geospatial technology is enhanced. Future priorities will need to focus on the maintenance and updates necessary for this dataset to integrate with other pertinent high-resolution datasets. At this time, maintenance cost are unknown, but a base yearly maintenance agreement assessed from pertinent state and federal users to be cover expenses incurred by the data steward is an avenue to pursue.

Summary

Committee Membership

- Paul Caffrey, Wyoming Geographic Information Science Center, University of Wyoming – Chair

Land Cover

Theme Description

The statewide land cover theme will represent the spatial distribution of the actual surface cover of Wyoming including relatively undisturbed vegetation communities (and barren areas) and areas whose cover has been impacted by humans to various degrees (including but not limited to agricultural areas, human settlements and mining operations). The land cover layer may be thought of as a hybrid between what has been traditionally called groundcover (which emphasizes natural vegetation) and Land Use/Land Cover, or LULC (which emphasizes human uses of the land surface). It is an attempt to depict, in explicit space and for a particular time, what is present on the surface. An example of a land cover map developed for a particular purpose (animal habitat modeling) is the Gap Analysis land cover map of Wyoming.

Land cover is a critical spatial layer for any state, and arguably is even more important for sparsely populated states like Wyoming where the land is relatively undisturbed in a broad sense. Because Wyoming is rich in natural resources, inventory and monitoring of land cover takes special importance because of its relevance to wildlife habitat, recreation, agriculture and mineral extraction. For these reasons and others, an accurate statewide depiction of land cover is critical. Such a map must be based on remotely sensed data and be stored in a Geographic Information System capable of simultaneously managing the spatial characteristics of the data and the associated descriptive information (attributes).

A statewide land cover theme would likely be used for many diverse purposes and a comprehensive list is beyond the scope of this document. Applications of the land cover theme may range from pure scientific research (e.g., ecological studies, biogeography, climate change research) to more applied projects (e.g., community planning, wildlife management, fire management). Consequently, the land cover theme should be designed in such a way as to be broadly useful. This might be accomplished by developing a structure that allows theme users to move easily between hierarchically organized levels of detail.

The land cover theme should ultimately include a baseline dataset describing land cover at a particular time (dependent on initiation of the mapping, funding, etc.) and periodic updates that provide users with the ability to monitor change in land cover through time. These data should be maintained into the future and be made available to potential users via public data access channels (i.e., the World Wide Web).

Existing Data

Several Land Use and Land Cover (LULC) datasets are available for Wyoming through different organizations and agencies. These datasets were developed to meet different program objectives through time using aerial photographs and satellite imagery. Some datasets were created as part of the national mapping programs such as Gap Analysis Project (GAP) and National Land Cover Dataset (NLCD), whereas other datasets were

created for multi-county regions (e.g., under contract with the Wyoming Game and Fish Department).

In the following section the LULC datasets are grouped by national, state and local effort based on the scope of the project. The following sections will briefly discuss these LULC datasets. A complete review of all the local datasets is beyond the scope of this document.

A. Mapping projects at ***national or international scales***:

1. The *National Land Cover Data* 1992 (NLCD 92) is also a state-wide LULC data set that depicts 21 categories of land cover. This dataset was generated from LandSat TM imagery acquired in 1992 for the US. Several ancillary data sources were used for classification of the satellite data.

   NLCD data are available in raster format, with a spatial resolution of 30 meters and mapped in the Albers Conic Equal Area projection and the North American Datum of 1983 (NAD83). Data can be downloaded from the USGS EDC Land Cover program website. A note of caution is provided by the USGS for the NLCD data users in that these data should be used for state or large regional scale studies. For additional information, visit http://edc.usgs.gov/products/landcover/nlcd.html.

2. Another dataset worth mentioning but with limited use is the *Global Land Cover Characterization* (GLCC) dataset generated by the USGS using Advanced Very High Resolution Radiometer (AVHRR) data. AVHRR data acquired between 1991 and 1993 were used to create this global data set. Several diverse ancillary data sets were used to create this dataset.

   GLCC data are available in raster format, with a spatial resolution of 1000 meters and mapped in the following two projections: Interrupted Goode Homolosine and Lambert Azimuthal Equal Area. For additional information, visit http://edc.usgs.gov/products/landcover/glcc.html.

B. Mapping projects at ***state scale***:

   a. *Land Use and Land Cover (LULC) maps* were developed by USGS using aerial photographs acquired in the 1970s and 1980s. Manual interpretation methods were used along with historic land use maps and surveys to generate up to 21 categories of cover type. The data are based on 1:100,000- and 1:250,000-scale USGS topographic quadrangles.

      USGS LULC data are available in the Universal Transverse Mercator (UTM) projection and referenced to NAD83. The minimum mapping unit (MMU) for natural features is 40 acres (16 hectares) with a width of 1320 feet (400 meters). The minimum mapping unit for manmade features is 10 acres (4

hectares) with a width of 660 feet (200 meters). LULC data are free and available via FTP download only, and available in several data formats. For additional information, visit http://edc.usgs.gov/products/landcover/lulc.html.

b. The first generation *Gap Analysis Project* (GAP) land cover map is a statewide groundcover data set, which depicts 41 cover types that were mapped based on degraded (100 m pixels) LandSat TM satellite data primarily acquired in the late 1980s and early 1990s. This GAP dataset was created using manual interpretation techniques by displaying the images on a computer monitor.

   Wyoming GAP data are available in vector format, geographic projection, NAD83 and can be downloaded from the Wyoming Geographic Information Science Center's (WYGISC) Spatial Data Clearinghouse website or through the National Gap Analysis Program website. The minimum mapping unit of this dataset is 1 square kilometer. For additional information, visit either http://www.wygisc.uwyo.edu/clearinghouse/land.html or http://www.gap.uidaho.edu.

c. *Agricultural Land Use Data of Wyoming* is a special dataset that represents croplands of Wyoming as interpreted from 1:58,200-scale National High Altitude Program (NHAP) color infrared aerial photography. The photos, which were taken in 1980-1982, were interpreted and land use designations were hand-drawn onto plots produced at the same scale as the photos, using a light table. The plots were then digitized as polygons into ARC/INFO 7.0.2. Valid polygons include irrigated croplands, non-irrigated croplands, urban lands, golf courses, and non-agricultural lands. Golf course boundaries, which have changed recently, were later updated with 1994 NAPP photos.

   Agricultural Land Use data is available in geographic projection, NAD83. This data can be downloaded in ArcInfo Interchange format. For additional information, visit: http://www.sdvc.uwyo.edu/clearinghouse/agland.html.

C. Mapping projects at ***local or multi-county scales***:

a. *Landscape characterization dataset,* created as part of the USDA Forest Service Intermountain Region 4, comprises Bridger-Teton National Forest in Wyoming. LandSat TM data acquired for the Gap Analysis Project was used for this project, and the finished product contains more than 71 classes. This dataset was generated by the Utah Cooperative Fish and Wildlife Research Unit and the Remote Sensing and GIS Laboratory at Utah State University.

   GAP Intermountain Region data are available in raster format, with a spatial resolution of 30 meters and available on CD-ROM for a small fee. For additional information, visit http://www.gis.usu.edu/docs/data/cd-rom_utah_intermountain.html.

b. *Moxa Arch Vegetation Classes* dataset was derived from a supervised classification of EOSAT LandSat TM imagery (25 meter data from a scene recorded on June 30, 1994) for the Moxa Arch area of southwestern Wyoming. USGS 7.5 minute quadrangles covered by the vegetation map include: Church Butte, Church Butte NW, Cow Hollow Creek, Fontenelle, Fontenelle SE, Granger, McCullen Bluff, Moxa, Sevenmile Gulch, Shute Creek Lake, Verne, and Whisky Buttes. Eleven types were distinguishable: low density sagebrush, high density sagebrush, greasewood/mixed shrub, saltbush/playa, playa/barren, riparian scrub/shrub, riparian forest, wet meadow, industrial, agricultural wet meadow, and water.

   This data is available in geographic projection, NAD83. This data can be downloaded in ArcInfo Interchange format. For additional information visit: http://www.sdvc.uwyo.edu/clearinghouse/moxaveg.html.

c. *Pinedale Anticline Vegetation* was created from NHAP film photos. The photos were visually interpreted for vegetation classes and boundaries, which were then hand-drawn on a plot of the Gap land cover data set. The hand drawn additions were digitized on a tablet.

   This data is available in geographic projection, NAD83. This data can be downloaded in ArcInfo Interchange format. For additional information visit: http://www.sdvc.uwyo.edu/clearinghouse/pineveg.html.

d. USGS and the National Park Service (NPS) are involved in a cooperative effort to classify, describe and map the vegetation communities in the national park units across the US. Under this program vegetation maps have been generated for Devil's Tower National Monument and Fort Laramie National Historic Site. Aerial photographs were used to generate these vegetation maps. For the classification scheme used and all additional information, visit http://biology.usgs.gov/npsveg/states/wy.html.

e. The Wyoming Game and Fish Department (WGFD) is actively involved in mapping Wyoming land cover. However, maps are generated based on administrative regions. In 1991, the Sheridan Region mapped the land cover for the Sheridan and eastern portions of the Cody regions using LandSat TM data. The map has 43 land cover types. Ancillary data in the form of aerial photographs and field-collected data were used for mapping the land cover types.

   WGFD data are in raster format, with a spatial resolution of 30 meters, but not available for download via the Internet.

D. Mapping projects or datasets developed at a ***city scale***:

Cities and townships in Wyoming have developed maps for their administrative areas depicting land use. Such maps can be downloaded or obtained from their respective administrative offices or websites.

Standards

For numerous reasons a universal standard or a set of standards does not exist for mapping land cover in general. However, standards are defined at the onset of any land cover mapping project and are influenced by several factors. Some of the important ones include:

A. Land cover classification scheme
B. Type of input data used for mapping
C. Positional accuracy of the input data
D. Minimum mapping unit (MMU)
E. Classification accuracy

Specific standards for mapping land cover will necessarily be defined during the planning process. For creating a Wyoming land cover, it is necessary to discuss these issues and warrants a discussion of guidelines that might be used to define standards.

A. **Land cover classification schemes**: Land cover classification schemes have been a source of debate since humans began making land cover maps. It may not be too far from the truth to suggest that there are as many land cover classification schemes as there are land cover mappers. In recent years attempts have been made to standardize land cover classifications, at least for national or international mapping efforts (e.g., NLCD, Gap Analysis), but even these efforts include cover classes that may be incompatible with one another or with the requirements of a particular project. Additionally, because any land cover classification scheme is determined in part by the methods being used to make the map (e.g., the type of satellite data), it may be unproductive in this document to attempt an exhaustive list of particular schemes.

   For these reasons, we outline here some generally accepted standards for land cover classification schemes and provide examples of a few of the current national schemes that are being used to categorize land cover.

   A well designed classification scheme for mapping land cover using remotely sensed data should meet the following criteria:

   1. The scheme should be **hierarchical** – fine level categories must nest into coarse level categories unambiguously.
   2. Categories in the classification scheme must be **explicitly defined** to prevent misinterpretation in the imagery or on the ground.
   3. Categories in the classification scheme must be **mutually exclusive**.
   4. The categories must be **distinguishable** using the data available.

5. The classification scheme must be **flexible** to allow new classes to be added during the mapping process without altering the greater logic of the scheme.
6. The classification scheme should be **compatible** with broader scale mapping efforts (e.g., a Wyoming land cover map should be compatible with surrounding states and ultimately with national efforts like the National Map).
7. The categories in the classification scheme must be **useful** for the purposes for which the map is being created.

Non-hierarchical schemes are used not infrequently, but are better suited for small area mapping where the number of types is limited and where the resolution of the remotely sensed data is very high. Even in these situations, a hierarchical classification scheme is more flexible and allows incorporation of mapping "surprises."

Examples of national level mapping schemes that fit the above criteria include, but are not limited to:

1. The Anderson land use and land cover classification system.

   This system is best suited for the interpretation of aerial photography and is not particularly compatible with data like that provided by the LandSat ETM+. See http://landcover.usgs.gov/pdf/anderson.pdf for a full description.

2. Ecological Systems.

   This scheme is being developed by NatureServe, a research arm of The Nature Conservancy to help create a standardized system for national mapping efforts. Details are available at: http://www.natureserve.org/publications/usEcologicalsystems.jsp. The system is being adapted for current regional Gap Analysis efforts nationally.

The classification schemes listed above are but a small sample of available schemes. Land cover mapping for Wyoming should use a scheme that meets the criteria listed above and if possible should fit with other mapping efforts to assure compatibility across regions without regard to state boundaries. To accomplish this will require a survey of the status of national mapping efforts at the time of initiation of land cover layer creation.

B. **Type of input data used**: The source (aerial photographs or satellite imagery) and characteristics (scale and resolution, among others) of the data used to create land cover maps often dictate the detail that one can discern during the mapping process. Therefore, it is important that the appropriate classification scheme is chosen so that input data can be selected to identify the desired classes. A mismatch between the classification scheme and the type of input data will result

in an ineffective map. Although ideally one should use the most appropriate data, sometimes the cost and time required to process the data influence the type of data used for mapping.

C. **Positional accuracy of the input data**: The type of input data used to create a land cover map often determines the positional accuracy of the mapped features. When aerial photographs are used, for example, two sources of positional errors can influence the accuracy of the land cover map. These include geometric distortions in the individual aerial photos, and the accuracy of the base map used for transferring the photo-interpreted data. Photo interpreters have devised methods to minimize these errors, but it is not possible to eliminate them completely. If one uses digital satellite imagery to map land cover, the positional accuracy of the features is dependent upon the image rectification methods used by the image processing team or the data vendor.

   Theoretically, one could generate a land cover map with very high accuracy for relatively small geographic areas, using the Global Positioning System (GPS), but the cost would be prohibitive for large areas. Also, due to issues related to the approximation of the shape of the earth and to map projection issues, such high-accuracy maps cannot be created for large geographic areas. Cadastral maps are an example of such high accuracy maps.

D. **Minimum mapping unit (MMU)**: The smallest area or length of a feature in map is expressed as the map's minimum mapping unit. Features failing to meet this minimum value will be aggregated to adjacent larger features. Similar to the classification scheme, this is also an important factor that needs to be defined at the onset of any mapping project. MMU is determined by the map purpose and the resources that are available for mapping. For example, MMU may be defined based on a viable habitat patch size for a species of interest. In other instances, agencies are mandated to protect and maintain certain land cover features based on legal criteria and often the size of the feature is one of them. National Wetland Inventory (NWI) maps are good examples where the MMU is based on a legal definition of a wetland. These maps exclude those wetlands that do not meet this 'legal' definition. MMU can be based on a management purpose as well. For example, the MMU might reflect operational units within a forest.

   Land cover maps can have either one MMU for all features or individual MMUs for different land cover features. Some maps have different MMU values for linear features such as streams and riparian areas than for land cover polygons. If satellite data are used, then the pixel resolution of the data defines the smallest MMU one could achieve theoretically. For example, if AVHRR data are used for mapping land cover, the smallest MMU that could be achieved would be 1 square kilometer. Features less than this size would be aggregated into larger adjacent classes.

E. **Classification accuracy**: Of the three types of standards discussed here, classification accuracy is the most commonly reported in remote sensing literature. It is usually not economically or technically feasible to correctly identify and label all land cover features in a map domain. It is also not possible to visit every mapped location to evaluate map accuracy. Therefore, a predetermined acceptable level of error, based on statistical estimates, is usually proposed as a mapping standard.

To calculate classification accuracy, a set of points or locations where the true land cover is known is superimposed on the derived land cover map. Based on the proportion of locations that are classified correctly, an accuracy (or error) rate can be estimated. This accuracy can be reported for the map as a whole and for individual cover classes. The former number is referred to as overall map accuracy, and the latter as individual class accuracy. For example, the overall map accuracy of a land cover map might be 80% while individual class accuracies range from 60% to 95%. It is also common to find maps with high individual class accuracy for the features of interest, and a lower accuracy for less important classes in the context of the map purpose.

Theme Status

LULC or groundcover data is generated by several organizations and agencies to meet their information requirements. For instance, agencies involved with managing natural resources will generate groundcover maps emphasizing natural vegetation. Examples of this type would include mapping forests and vegetation in a region. On the other hand, agencies associated with natural resource development might map features associated with human activities. Examples of this type would include mapping newly constructed roads, oil extraction sites and so on.

In Wyoming, federal and state agencies are currently mapping or attempting to map groundcover and LULC. The following sections briefly discuss the current mapping efforts that are either in progress or in discussion stages.

A. Mapping projects at ***national or international scales***:

a. The NLCD 2000 program is currently underway and the data acquisition is complete. USGS EROS Data Center (EDC) has divided the country into several zones and Wyoming falls in three different zones. The exact date is not set for the commencement of this project in Wyoming, however EDC is interested in in-kind collaborative efforts with other agencies. Researchers at WyGISC are discussing with EDC personnel about such collaborative efforts to benefit WyGISC, EDC and the state of Wyoming.

B. Mapping projects at ***state scale***:

a. Discussions are underway between USGS/Biological Resources Division and several federal agencies for RE-GAP, the next iteration of the national GAP project. In the RE-GAP program the vegetation classes will be mapped based on

the National Vegetation Classification System (FGDC, 1996). The "FGDC vegetation classification and information standards" manual was published by the USGS, Reston, Virginia in 1996.

b. USDA Farm Services Agency (FSA) has undertaken an ambitious project to map the boundaries of all farmlands in the US. For this mammoth project FSA is going to acquire color infra-red (CIR) aerial photos and digitize the boundary of all the farmlands. Like the NLCD 2000 project, no dates have been specified for Wyoming and the funding level for each year will dictate the extent of mapping.

C. Mapping projects at ***local or multi-county scales****:*

a. WGFD is involved in mapping the vegetation or land cover in WY on a regional basis. Three regional offices in southwest Wyoming are planning to use LandSat data to map vegetation. Negotiations are underway regarding the classification scheme to be adopted and releasing the requests for proposals (RFP).

b. Several BLM district offices are also involved in mapping the vegetation and land use in Wyoming. Emphasis is placed on mapping new features associated with land use changes along with surface disturbances caused by human activities.

c. The USGS and NPS collaborative effort is currently involved in mapping Grand Teton National Park. Efforts are underway to acquire the aerial photographs required for mapping the vegetation classes in this NP.

d. Efforts are also underway to map changes in land cover. These maps and datasets focus on a few land cover types and assess changes in their spatial extent between any two or more time periods. For instance, the Sheridan Region of WGFD has contracted a private company to map land cover changes since 1992. LandSat data is used for this activity. The finished product will highlight 10 different types or magnitudes of changes. Another example is the effort by the Laramie Region of WGFD to map changes in the shrub community in southeast Wyoming. LandSat scenes acquired in the 1970s, 1980s and 2002 are used for detecting changes in the shrub community.

Current Investments

Program: NLCD 2000, Sponsor: USGS, EDC, Sioux Falls, SD
Cost: Difficult to obtain since this is part of a national project.

Program: RE-GAP, Sponsor: USGS
Cost: Unknown at this time; program is in the discussion stage.

Program: Farmland Information System, Sponsor: USDA-FSA
Cost: Unknown at this time.

Program: Vegetation Mapping Program – three regions, Sponsor: WGFD
Cost:

Program: USGS-NPS Vegetation Mapping Program, Sponsor: USGS, NPS
Cost:

Completion Strategy

While the overall goal is to guide development of land cover data for Wyoming, the State recognizes that satisfying a wide variety of needs for land cover classes of interest, levels of detail, accuracy, and timeliness is a primary challenge. That local and regional land cover will likely continue to be mapped at higher resolution for individual entities under varying standards is an accepted fact reflected by the varying needs of these entities. However, such data, both existing and to be developed at a future date, should be gathered together and made accessible via the Internet – a clearinghouse of available Wyoming Land Cover. As entities complete local and regional projects that include the mapping and delineation of land cover, they must be encouraged to submit the new data to the clearinghouse (subject to distribution limitations) and mechanisms must be in place for them to do so as efficiently as possible.

On a parallel track to clearinghouse development, Wyoming will build on existing land cover mapping programs that inherently address the above challenge at a statewide level – NLCD and GAP. These are the most current data available statewide. An organizational framework must be developed to guide the mapping and delineation of a future land cover layer of Wyoming. Such a reference will encourage and promote partnerships in funding the production of this layer, where compatibility among and between the land cover products of entities with different goals in mind is of paramount importance. The foundation for this framework will be the recommended standards to employ, inter-agency cooperation and funding partnerships.

Responsibilities

Completion of a statewide land cover layer of Wyoming will require a lead entity with experience in satellite imagery interpretation, delineation and mapping of land cover, and large project management experience to take the initiative by writing and submitting a proposal for funding. However, a special oversite group of representatives from various organizations that would potentially contribute to funding such a proposal, as well as others who may not be able to contribute funding but would still use such a product, should be formed to work out the details of how the lead entity would develop the land cover layer. Such an oversite group would function during all phases of work related to creation of a final product, including, but not limited to, proposal development, project initiation and development, and product distribution.

Data Creation
NLCD 2000 Program: USGS
RE-GAP: USGS

Cost Estimate
Re-GAP: Unknown, requires a proposal to be written.

Time Estimate
Re-GAP: Dependent on funding; potentially a two-year project.

Data Integration
Land cover data from various sources and time periods, at various resolutions, and created for various purposes can be integrated only at the organizational or accessibility level; that is, they will not be "mosaiced" or "stitched" together in a seamless statewide single layer. Thus, data integration to a large extent addresses the clearinghouse development detailed above.

Cost Estimate
~$100,000

Time Estimate
One year, based on funding.

Data Steward
Stewardship would include obtaining and processing updated versions of the NLCD, GAP and other local and regional land cover data. Processing would involve projecting updated data to the projection designated as the Wyoming standard projection.

Cost Estimate
To be determined.

Time Estimate
To be determined.

Data Access
Land cover data should be available for download across the Internet. If the data cannot itself be centrally located, then links to all available land cover data should be created.

Cost Estimate
To be determined.

Time Estimate
To be determined.

Summary

Total Cost Estimate

Unknown at this time.

Total Time Estimate

Potentially three years, with adequate funding.

Committee Membership

- Kirk Nordyke, State of Wyoming, Game & Fish - Co-Chair
- Barbara Ray, USGS - Co-Chair
- Ken Driese, University of Wyoming, WyGISC
- Ramesh Sivanpillai, University of Wyoming, WyGISC
- Larry Neasloney, BLM
- Pam Curry, Sublette County

Soils

Theme Description

This theme consists of 1) digital polygon maps of the soils of an area and 2) an electronic database or text document that describes the polygon map units. The electronic database or text document provides information on the soils within each polygon, including soil name, chemical properties, physical properties, and the suitability or limitations of the soils for various land uses or land treatments. The number of soils described by a polygon map unit varies by the detail of the mapping presented by an individual soils theme. There exists a close association between soils and landforms. Therefore, the extent of a soil map unit polygons in all the soils themes commonly coincides with that of a landform.

The soils theme is used by state and local units of government, landowners, private companies, and land use planners. Proper land use and resource management is guided by the use of this theme.

Existing Data

Several soils themes exist or are being developed for Wyoming. The themes are differentiated by the degree of accuracy of the maps and kinds of data associated with the maps. The Soil Survey Geographic Data (SSURGO) and State Soil Geographic Data (STATSGO) are being developed under the leadership of the Natural Resources Conservation Service (NRCS) within the framework and standards of the National Cooperative Soil Survey (NCSS). The 1:500,000-Scale Digital Soils Map of Wyoming and the 1:100,000-Scale Digital Soils Map for each Wyoming county were produced by the University of Wyoming.

1. **SSURGO** is the most detailed soil map theme developed for counties, parts of counties, or other administration boundaries. SSURGO consists of the digital soil map data and the soil property and interpretation data. This data is archived by Soil Survey Areas. The soil surveys currently used were developed starting in the early 1960s to the present day. This map theme was designed for use by landowners, units of government, planners and land use managers. Field mapping methods using national standards are used to construct the modern soil survey maps for SSURGO data. The maps were created at a scale of 1:20,000 to 1:24,000. Soils layers provide information and interpretations of soils, soil units, and a host of related information that can be derived from the soil data. This data is used to make decisions related to natural resource management and land uses for areas 40 acres or more in size.

   SSURGO data is available for approximately 50 percent of Wyoming. The areas with SSURGO data are primarily private and state lands but some federally managed lands are included.
   The source of the digital maps for the SSURGO is the detailed soil survey maps. The maps were either from published soil survey reports or produced during recently completed soil mapping projects. The detailed soil maps in these reports

were developed using on-the-ground soil mapping protocols according NCSS standards. All of the maps were compiled to a DOQ base in order to produce digital maps that meet national map accuracy standards. The SSURGO maps are digitized at a standard scale of 1:24,000 and duplicate the original detailed soil survey maps. The map base used is an orthophotograph that meets national map accuracy standards.

Digital SSURGO soil maps can only be produced for areas where the soils have been mapped within the standards of the NCSS. Soil maps that meet NCSS standards are available for approximately 64 percent of Wyoming. The areas with soil maps are primarily private, state lands and National Forest lands, but include some other federally managed lands. Of the areas that do not have soil maps completed, approximately 50 percent is federal land managed by the BLM, 35 percent is private land, 11 percent is federal land managed by the USFS, and 4 percent is state land.

The BLM manages nearly 19 million acres of public land and have completed soil surveys in the late 70's early 80's on approximately 80% of these lands. The quality and completeness of the soil surveys are, however, extremely variable. Most of these inventories were never brought to completion according to National Cooperative Soil Survey (NCSS) standards. They do not have adequate electronic databases or descriptions. Some soil maps were digitized and archived, but most of these need conversion to current geographic information system (GIS) formats and standards.

2. **STATSGO** provides a statewide general soils theme and is available for all areas of Wyoming. The STATSGO map was developed using 1:250,000 scale USGS Topographic Quadrangles or 1:250,000 scale digital orthophotographs as the map base. The primary source of the digital maps for the STASTGO soil theme is the detailed soil survey maps. The maps were either from published soil survey reports or produced during recently completed soil mapping projects. The information from the detailed soils maps was aggregated through a manual process to create generalized soil map units. Where the detailed soil maps are not available, information on geology, climate, landform, and vegetation other parameters where used to predict the general soil types for STATSGO.

   The STATSGO map theme was designed for planning and management of large areas (state, county, or multi-county). The current version was created in about 1985. Updates to this theme are currently in progress by NRCS with an estimated completion date of December 2003.

3. **1:500,000-Scale Digital Soils Map of Wyoming** represents soils of Wyoming at 1:500,000- scale. The layer contains 45 separate soils descriptions across 10 Wyoming soil zones. The layer was compiled based on the five-factor soil forming model using digital surficial geology, bedrock geology, and elevation. This dataset is documented in the report: Munn, L.C. and C.S. Arneson, 1998.

Soils of Wyoming: A Digital Statewide Map at 1:500,000-Scale. Agricultural Experiment Station Report B-1069. University of Wyoming, College of Agriculture, Laramie, Wyoming. This layer was originally created specifically for use in the Wyoming Ground-Water Vulnerability Mapping Project being conducted at the Wyoming Water Resources Center, a statewide study of aquifer vulnerability to contamination from pesticides. In that context, it was to be used to assist in the generation of a rating map of how soils affect aquifer sensitivity to surface contaminants. The Soils of Wyoming Map can be used, however, for many other purposes. The data should not be used without first reading the full data documentation in UW AES Report B-1069. This data should not be used for analysis at a scale larger than 1:500,000. This map provides a generalized description of soils within the state of Wyoming. This map should be used for broad scale planning and general assessment of large areas of land.

4. **1:100,000-Scale Digital Soils Maps** represents soils of Wyoming by county. The layer contains 350 separate soils descriptions across 23 Wyoming counties. The layer was compiled based on the five-factor soil forming model using digital surficial geology, bedrock geology, and elevation. This dataset is more fully documented in 23 AES publications. These publications use the designation AES Bulletin B-1071 followed by a two letter abbreviation for each county. This layer was originally created specifically for use in the Wyoming Ground-Water Vulnerability Mapping Project being conducted at the Wyoming Water Resources Center, a statewide study of aquifer vulnerability to contamination from pesticides. In that context, it was to be used to assist in the generation of a rating map of how soils affect aquifer sensitivity to surface contaminants. The Soils of Wyoming layers can be used, however, for many other purposes. It is intended to supplement other existing 1:100,000 scale digital natural resource layers of the state. This data is currently in draft form and should not be used for any purpose without first contacting the authors. This map provides a generalized description of soils within each county of Wyoming. This map should be used for broad scale planning and general assessment of large areas of land.

Standards

SSURGO and STATSGO: The NCSS standards used in the development of both soil data themes are at the web sites listed below. Public land areas managed by the Forest Service, Bureau of Land Management, and National Park Service may have additional local standards.

Soil Data Subcommittee controls the development of the FGDC soil digital standard (NRCS): http://www.fgdc.gov/

Soil Survey Standards including mapping and FGDC map accuracy standards are listed at the following web site within a link called Standards for Soil Survey: http://soils.usda.gov/procedures/main.htm

National Soil Survey Handbook, parts 647.07, 648.03, and 648.04 describes the digitizing standards, and archiving of the soil map information.
http://soils.usda.gov/procedures/main.htm

Theme Status

SSURGO data is available for approximately 50 percent of Wyoming. The areas with SSURGO data are primarily private and state lands but some federally managed lands are included. This data was created at a scale of 1:24,000. Many of the soil maps on National Forests are in digital form, but have not been produced in SSURGO form for distribution outside the Forest Service. Digital SSURGO soil maps can only be produced for areas where the soils have been mapped. Approximately 22.5 million acres need to have soil survey maps developed that meet NCSS standards.

STATSGO data (1985) is available for all areas of Wyoming. This data was created at a scale of 1:250,000. It is currently being revised by NRCS to incorporate information from SSURGO maps completed since 1985.

1:500,000-Scale Digital Soils Map of Wyoming is available for all areas of Wyoming.

1:100,000-Scale Digital Soils Maps is available for each of the Wyoming counties

Current Investments

Developing the soils theme requires several activities. The activities required vary by the individual soils theme and include:

1) Conducting soil mapping through on-the ground studies or GIS-modeling, developing the associated soil descriptions and soil property databases, and interpreting the soil maps and data for use. The total investment in soil mapping to-date is approximately 50 million dollars using a current dollar value.

2) Compiling hard copy soil maps to a base that meets national map accuracy standards, digitizing the compiled maps, and digitized soil maps currently being created. The compiling and digitizing investment to-date is approximately 3 million dollars.

3) Updating the soil databases/descriptions and interpretations of the data in order to integrate these data sets with new technology and to make them available for new applications. Investment to-date is approximately 250,000 dollars.

4) Updating older SSURGO maps (more than about 30 years old) to collect data not currently available and to produce more detailed soil maps to meet the needs of users of soil surveys. Investment to-date is about 10,000 dollars.

The amount of funding available in 2003 for creating this theme is about 1.4 million dollars. Of these funds $70,000 was contributed by counties and conservation districts, $41,500 from BLM and the 1.29 million from NRCS.

Completion Strategy

Responsibilities

The soil themes must be continuously maintained to be useful in future years. NRCS is responsible for coordinating efforts to identify maintenance needs of SSURGO and STATSGO. The University of Wyoming is responsible for coordinating the identifying of need for updating the 1:500,000-Scale Digital Soils Map of Wyoming and 1:100,000-Scale Digital Soils Maps and coordinate updating activities.

Data Creation

SSURGO—The NRCS will complete the digitizing of all published paper maps by the end of 2004. All soil maps created in the future by NRCS will be digital as part of normal business operations. Plans to create SSURGO soil maps on National Forests are indefinite. Digital SSURGO soil maps can only be produced for areas where the soils have been mapped. Approximately 22.5 million acres of land remain to be mapped. Soil maps are currently being produced at a rate of about 500,000 acres per year.

NRCS in 2003 contributed approximately 1.3 million dollars to complete SSURGO data. Other 2003 contributions include $35,000 from Uinta County, $20,000 from Uinta County Conservation District, $10,000 from Johnson County, and $5,000 from Lake DeSmet Conservation District. The BLM contributed $48,000 in FY2001 for developing SSURGO data in FY2002 and 2003. The BLM has also funded a project to determine the status of soil maps and data on BLM lands in Wyoming. The USFS is contributing to the completion of SSURGO of SSURGO data on National Forests. Wyoming U.S. Senators and Representative were successful in allocating an additional $300,000 in FY2003 to NRCS to accelerate soil mapping on private lands in Wyoming. The Congressional delegation has expressed intent to renew this allocation at the same level for 9 more years. For 2004, in addition to the contribution amount listed above for NRCS, counties and conservations districts, commitments have been made by Sublette County in the amount of $54,000 And BLM in the amount of $120,000.

The NRCS is responsible for working with the BLM, Counties, Conservation Districts, and the Wyoming Association of Conservation Districts to promote local, state and federal contributions to complete SSURGO soil maps for all lands in Wyoming.

Creating the SSURGO soils theme for federal lands is the responsibility of the federal land management agency.

The State of Wyoming is responsible for the completion of SSURGO data for state-owned lands. The citizens of Wyoming would benefit from a State contribution to completing SSURGO data on private lands.

The State of Wyoming, NRCS, BLM, and Forest Service should pool resources to accelerate the rate of soil mapping-an essential component for completing the SSURGO data theme for Wyoming.

STATSGO—NRCS is currently updating this data to incorporate new data and to enhance its use for GIS. NRCS will complete this update by December 2003.

Cost Estimate
Approximately 22.5 million acres need to have soil survey maps developed that meet NCSS standards in order to complete the SSURGO theme. The cost to complete these soil maps for these areas is approximately 35 million dollars. The cost to digitize these maps and the remaining paper maps is approximately 2 million dollars.

Time Estimate
The time estimate to complete the SSURGO soils theme depends on availability of resources. At the current rate of progress, the estimated time to complete this theme is 40 years.

Data Integration
The National Cooperative Soil Survey is the vehicle for data integration. NCSS is a nationwide partnership of Federal, regional, state, and local agencies and institutions. This partnership works together to cooperatively develop SSURGO and STATSGO data according to a common set of standards. The Natural Resources Conservation Service (NRCS) is responsible for the leadership of SSURGO and STATSGO data development.

Data Steward

- **SSURGO**
  - Wyoming Federal Data Steward: NRCS
  - National Federal Data Steward: NRCS
- **STATSGO**
  - Wyoming Federal Data Steward: NRCS
  - National Federal Data Steward: NRCS
- **1:500,000-Scale Digital Soils Map of Wyoming**
  - Wyoming Data Steward: University of Wyoming
- **1:100,000-Scale Digital Soils Maps**
  - Wyoming Data Steward: University of Wyoming

Data Access

- **SSURGO**: http://www.ftw.nrcs.usda.gov/ssur_data.html
- **STATSGO**: http://www.ftw.nrcs.usda.gov/stat_data.html
- **1:500,000-Scale Digital Soils Map of Wyoming**: Wyoming Geographic Information Science Center

- **1:100,000-Scale Digital Soils Maps**: Wyoming Geographic Information Science Center

Because of the complex nature of the SSUGO soils theme, specialized GIS toolkits make using the data easier for most users. Soil Data Viewer, an extension to ArcView developed by the NRCS, is an example of such an application. This application is offered to all those who request SSURGO data from Wyoming NRCS. However, this toolkit is in need of being updated to the current version of ARCGIS and will require regular updating in order remain useful with the most recent GIS technology. Another application that could be employed to enhance usability of the SSURGO theme is the web mapping service.

Summary

Total Cost Estimate

Approximately 22.5 million acres need to have soil survey maps developed that meet NCSS standards. The cost to complete soil maps for these areas is approximately 35 million dollars. The cost to digitize these maps and the remaining paper maps is approximately 2 million dollars.

The cost to maintain these themes is estimated at approximately $400,000 per year. Maintenance activities include developing products for identified new uses of soil data, updating the soil properties data to reflect new science, updating soil maps in response to identified needs for more detailed maps, and collecting and analyzing soil samples to provide data in response to an identified need.

Current Action Items

The Wyoming Association of Conservation Districts (WACD) is leading an effort to develop State of Wyoming contribution to the development of the SSURGO theme for the remaining state and private lands.

The BLM plans to develop a strategy for completing the SSURGO data for lands managed by the agency.

The NRCS will meet with individual counties and conservation districts to discuss the role of counties and conservations districts in developing the SSURGO theme.

The BLM, NRCS, and Utah State University are currently engaged in a pilot project designed to reduce costs and increase the rate at which soil mapping can be completed for SSURGO. This pilot project integrates the use of analyzing spatial data themes such as digital aerial photographs, digital elevation models, geology, and climate, to produce preliminary soil maps that are used during the field investigation phase of soil mapping. The project will also develop, test, and implement a standard protocol for utilizing geographic information and processing to improve the efficiency and quality of soil surveys in Wyoming. The protocol will specify minimum data needed for the various phases of soil mapping, suggest additional resources needed, provide specific instructions

on where and how to obtain and download or digitized data, and manage and display data in a GIS. The pilot project began on three 1:24,000 quadrangles in an area in northern Johnson County, and is being expanded to four in Sublette County.

The BLM has also funded a project through Utah State University to determine the status of soil maps and data on BLM lands in Wyoming with the goal of identifying priority survey areas where existing substandard surveys can cost effectively be enhanced to NCSS Standards using the GIS tools being developed.

Committee Membership

- Darrell Schroeder, Natural Resources Conservation Service – Chair
- Scott Miller, University of Wyoming
- Rick Schuler, Bureau of Land Management

Transportation

Theme Description

The transportation layers include features of transportation networks and facilities. For the purpose of this initial plan, only roads are included. For transportation issues related to growth, economic development, disaster preparedness, emergency response (especially wildfires), and public land management, all roads must be included in the transportation framework layer.

Existing Data

The Wyoming Department of Transportation (WYDOT) began with 1:100,000 scale Bureau of Transportation Statistics (BTS) data and realigned all "On-System" Roads for the State of Wyoming to a scale of 1:12,000 using the 1994 USGS DOQQ'S. The "On-System" roads are all roads that WYDOT is responsible for which includes: Interstate, Primary, Secondary and State Highways. That data set also includes some service roads. Route features in the data set carry measure values that correspond to reference markers on the ground (commonly know as "mileposts"). Additional attributes are also maintained.

BLM began with USGS transportation coverages. They realign and edit all roads at 1:100,000 scale and attribute according to BLM printed 100k product. This is being done in tiles of 30 x 60 minute geographic quadrangles. Approximately 1/5 of the State has been completed. Some of the quadrangles are adjacent but most are not.

Platte County has aligned all county maintained roads to the 1994 DOQ mosaic produced by NRCS-Fort Worth. Vectors originated from TIGER data and maintain those attributes for roads in Platte County that are "On-System". At this point the entire county maintained road network has been corrected. There will be periodic reviews and revisions with county staff.

Laramie County and the City of Cheyenne, in coordination with the Cheyenne – Laramie County GIS Cooperative, have created and maintain a line coverage representing the centerlines of roads, including county roads, county subdivision roads, town roads, state roads, interstates and a select set of private roads that are publicly maintained. Attribute information includes address ranges, jurisdiction, functional classification and maintenance responsibility. The road centerlines were aligned using USGS quadrangles, aerial orthophotos, subdivision plats and land surveys.

TIGER data is available at 3 distribution nodes, the U. S. Census Bureau, Wyoming Geographic Information Science Center (WyGISC) at University of Wyoming and the Wyoming Spatial Data Clearinghouse. Map scale is 1:100,000. TIGER data does contain the best statewide addressing information currently.

Bureau of Transportation Statistics data is available only by request.

Standards

The Wyoming State Standards are still in draft form. They will augment and enhance the current work being done on the NSDI Framework Transportation Identification Standard by the FGDC found at http://www.fgdc.gov/standards/status/sub5_7.html. The current draft State standards have been included in the Appendix.

Theme Status

Many state, county, and federal agencies have transportation datasets, but there has been little organized effort to tie these datasets together.

Some counties have started GPS mapping efforts to collect their data.

Current Investments

Up to the present time WYDOT has invested approximately $65,000 to bring their dataset current to the 1994 USGS DOQQ'S while supporting their existing internal applications.

BLM has a significant investment in their dataset at this time and it appears to be duplicate effort in some cases.

Platte County estimates an investment of $1300 for realigning their "on-system" roads.

Completion Strategy

To have a highly accurate and detailed roads layer for the state, one must identify all existing data. The I-Team will either utilize the Homeland Security data inventory from the Spring of 2002 (which has not been released as of the writing of this document) or conduct its own survey. Then based on the data being produced in the state, identify contributors. Special emphasis will be placed on those organizations who actually maintain roads. It is extremely important that focus is given to these groups – they are the most knowledgeable of not only the geographic location of features, but information about those features (road names, addresses, etc.). Those organizations must be included in this I-Team process and involved in the planning and implementation of any statewide roads layer.

To accomplish the completion strategy, a consultant will be hired to help prioritize efforts for a statewide public transportation layer. There are many data producers in Wyoming and collecting and integrating data would be a large and complicated undertaking. Every data set was developed for that organization's specific purpose and each organization has unique requirements. The consultant will help define processes and standards to integrate their datasets. To accelerate this process, WYDOT will conduct a data inventory to identify those areas that need improvements.

Responsibilities

The most important and practical way to fund this process would be to have dollars come from a federal source to all road maintenance organizations: federal, state, and local. Current efforts have all been single organization funded and produced. The USGS,

Forest Service, and the BLM have been able to utilize some money, but most are focused on their specific roads. So far, the State of Wyoming and the counties have contributed the largest percentage of funds to this data layer, but again, for their own means. Because of this situation, the federal government should allocate funds to agencies that can be distributed to all road maintenance organizations to make this a truly integrated, collaborative layer.

Data Creation

Creation of the data will continue as it has in the past. Those who maintain actual physical roads should be the source of information.

Cost Estimate

The cost estimate is unknown at this time to complete a statewide transportation layer.

Time Estimate

The time estimate for data creation is unknown at this time. We are still in the process of discovering what data are available.

Data Integration

Data integration will be planned out with the assistance of the consultant. Because of the number of data producers at different governmental and organizational levels, this portion of the plan will take considerable effort and coordination from all participants. Because there is so much data available it would be very difficult for one organization to incorporate all the data into a statewide dataset in a timely manner. It would be more feasible for a consultant to accomplish this task.

Cost Estimate

The cost estimate for data integration is unknown at this time, but will be funded by WYDOT.

Time Estimate

The time estimate for data integration is unknown at this time.

Data Steward

The data steward will most likely be WYDOT, since they are responsible for statewide transportation data in general.

Cost Estimate

The cost estimate for the data steward is unknown at this time.

Time Estimate

The time estimate for the data steward is unknown at this time.

Data Access

There are currently many options for accessing data for Wyoming. The statewide roads layer could be distributed from one of the NSDI clearinghouses in the state.

It could also be distributed by WYDOT, who will shortly be part of the NSDI as well.

Cost Estimate
The total cost estimate to establish a statewide data clearinghouse is unknown at this time.

Time Estimate
The time estimate for data access is unknown at this time.

Summary

Total Cost Estimate

Maintenance, including periodic revisions, will continue through the stewards and process defined. Costs will hopefully be minimal and close to being a part of agencies ongoing operational activities.

Total Time Estimate

The time estimate for a complete transportation layer is unknown at this time.

Current Action Items

1. Inventory existing road data and producers.
2. Develop a data integration plan.

Committee Membership

- Jim Nelson, Wyoming Department of Transportation – Chair
- Ben Saunders, Wyoming Department of Transportation
- Bill Sitterle, Cheyenne/Laramie County GIS Cooperative
- Mary Wilson, Bureau of Land Management

Data Access

Using Technology for Accessing and Disseminating Geospatial Data A Blueprint for Wyoming

Project Title

The Wyoming GeoPortal

Project Leader

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Executive Summary

The Wyoming I-Team with support of the Wyoming Geographic Information Advisory Committee (WGIAC) is requesting $680,596 be distributed over two years to the Wyoming Geographic Information Science Center (WyGISC) allowing for the creation of the Wyoming GeoPortal, an Internet portal using scalable and distributed geospatial and Internet technologies to create a framework for statewide coordination towards providing all Wyoming GIS users the ability to view and access the most accurate and up-to-date geospatial data found in and around Wyoming. The creation of such a portal will not only benefit the state of Wyoming financially through economies of scale and coordination but also provide geospatial users – public, industrial, and governmental – the ability to utilize geospatial data in a wide range of activities.

This project will have three main components: (1) a distributed Internet geolibrary (Wyoming GeoLibrary) for access and dissemination of geospatial data, (2) a distributed Internet mapping application (WyMAP) for viewing and analyzing geospatial data, and (3) an outreach and education component in order to promote the long-term viability and use of both applications. The Wyoming GeoLibrary will be a centralized, digital library providing reference to geoinformation distributed among a network of data providers for which the primary search mechanism is place. WyMAP will be a web mapping portal which allows users to display, query, and access geospatial data and mapping services from a wide variety of Wyoming geospatial contributors. These two applications will be developed and maintained at WyGISC thus mitigating many of the hardware and software costs associated with the GeoPortal through the University of Wyoming (UW) matching funds toward these expenses. WyGISC will also assume the lead in educating users and data contributors through workshops, on-site training, and user guides.

The initial implementation of both the GeoLibrary and WyMAP will focus on providing data access and dissemination to the nine themes addressed in the Wyoming I-PLAN.

These nine themes will comprise several fundamental data layers and will be utilized within any GIS developed to address Wyoming issues. Once implemented, this ability to grow and enhance the Wyoming GeoPortal will be accomplished by providing a base maintenance funding estimated at $183,590 per year in the subsequent years after development. The annual maintenance funding would provide the resources necessary to expand both Internet applications with regards to different user groups and new and updated data. This expansion and growth will be the focus of outreach efforts beginning with the implementation of the site. Benefiting this project will be WyGISC's ability to support such data storage and serving in a uniquely cost-saving way due to existing software site license agreements and personnel.

Background

Wyoming I-Plan

This project proposal was initiated through the Wyoming I-Plan activities. Many states across the U.S. have developed or are currently developing similar plans trying to address the production, maintenance, and exchange of a community's geospatial information resources (FGDC, 2003). Each I-Plan is being created by a team of voluntary representatives from all sectors of the geospatial information community. Within the I-Team are subcommittees focusing on producing plans specific to a theme. Each subcommittee reports on the current status of the theme (e.g. data availability, source and contributors of data, and current standards being followed), plans for further development or enhancements of the theme, and finally creates a maintenance plan. The number of themes addressed within the I-Plan is unlimited; however the majority of states are focusing on base themes (e.g. hydrography, roads, ownership, etc). Since the I-Plan is a dynamic document, any themes can be added after the initial plan is submitted and updates to the original thematic plans can be continuous.

Within Wyoming, the I-Team process is very active with currently nine themes in the I-Plan. These include

- cadastral,
- digital orthoimagery,
- elevation,
- geodetic control,
- geology,
- hydrography,
- land cover,
- soils, and
- transportation.

The initial Wyoming I-Plan was submitted on February 2003 to the Federal Geographic Data Committee (FGDC) with five theme plans completed. A major update of this plan will be completed by the end of 2003 with three additional themes. Also included in this update will be this proposal providing a plan for giving users access to these data while

giving data stewards of these themes a method to publish, disseminate, and update their data.

This project proposal was developed by the Wyoming I-Team Data Access and Dissemination Subcommittee (DADS). This group met to discuss and identify issues relating to the distribution of data being addressed within the Wyoming I-Plan. The subcommittee is chaired by Jim Oakleaf, WyGISC Data Manager. Others include: 1) David Rush, WyGISC Internet Programmer, 2) Mary Hopkins, GIS Coordinator, Wyoming State Historic Preservation Office, 3) Frank Romero, Data Resource Program Manger for the Medicine Bow-Routt National Forest, 4) Dennis Feeney, Department of Agriculture and Applied Economics, UW, 5) Carol Norris, GIS Specialist, Wyoming Legislative Service Office, and 6) Steve Vossler, GIS Specialist, Wyoming State Engineer's Office.

It quickly became apparent to all I-Team members that the issues with distribution of I-Plan themes were not limited to these themes, but had a much broader scope. It was determined that any plan put together for data access and dissemination of I-Plan themes could provide a framework for all Wyoming geospatial data. Implementation of such a plan could also lead to improving coordination among the whole Wyoming geospatial community, something currently lacking with those not involved with the I-Team.

The DADS elected not to focus strictly on only the I-Plan themes but also look at data access and dissemination activities occurring for Wyoming and how these activities could be enhanced for both users and providers of geospatial data. In order to accomplish this goal, DADS felt it necessary to first understand what really is behind data access and dissemination of geospatial data. Once that was accomplished, the group looked at what was occurring within Wyoming with respect to data access and dissemination, identified current issues, and provided potential solutions to these issues. It was decided that a technical implementation plan was needed to provide guidance in producing tools and processes to help facilitate the resolution of these issues while at the same time provide a mechanism for the various subcommittees to distribute their data.

Definitions of Geospatial Data Access and Dissemination

The difference between the terms "access" and "dissemination" relate to the flow of data. Access refers to the ability of users to obtain data whereas dissemination focuses on how data stewards distribute the data. In other words, access is the process of "pulling" information whereas dissemination is the process of pushing the information. Regardless of the process, both data access and dissemination basically involve the same components; data, developers of data or the "data stewards", providers of data or "data broker", users of data, and the method of delivery or "transfer technology". In the past, data creators were often viewed as the sole distributor of their data. Many times this is still true in cases of small amounts or seldom used data. However, more and more users want to be able to access a wide assortment of data through a single, convenient portal. This has lead to the creation of "data brokers" – those providing access to data but do not developed or maintain data.

Geospatial data can be regarded in a variety of ways. Probably the most utilized and recognized geospatial data are static maps. Before the digital era, static maps were the most common way to provide location information. Today, however, the data used to produce the maps are more valued by those utilizing GIS. Digital data found within a GIS can be broken into two primary data models – "vector" and "raster". Vector data displays features through points, lines and polygons created by the XY coordinates describing the feature. Raster data generalizes earth features or phenomena by associating cells in a grid matrix with a value representing that feature. Aerial photos and satellite images are contiguous raster data for which each cell has a color or shade value, collectively rendering an overall image. Both vector and raster data can become substantial in file size especially as the scale and resolution of these data are increased. These file sizes can make data distribution of geospatial data a challenge.

Traditional geospatial data can be manipulated to create a variety of digitally available products. Digital static maps, Internet mapping applications, or the mapping services created to display data inside of these applications are all forms of geospatial data. Location information, such as latitude and longitude, legal descriptions, distances, and/or street addresses, contained within tabular data are geospatial. Additionally reports or documents relating to a specific area are geospatial in nature.

Those tasked with creating and maintaining data are considered "data stewards". Once created, some geodata may never (or very rarely) change where as other spatial data may change from one minute to the next. This maintenance process can involve assimilating or modifying features or attributes in existing data. It can also involve the creation of new data on a periodic basis. Once created, data will almost always be shared within and/or across groups of people. An additional task of the data steward which helps others use the data is to produce and maintain the metadata. "Metadata" are data about data and describe the what, when, who, and how of the geospatial data created. Almost all data, either formally or informally, are distributed with some kind of associated metadata.

Although the distributor of data is initially the data steward, many times the data steward may only have to distribute data to a data brokering service which then provides a "portal" (access point) to a wide audience of potential users. By doing this, the data steward has eliminated his/her time required to fill data requests. The goal of a data brokering service is to provide the user (the "consumer" of the data) with a convenient and reliable method of accessing data while giving data stewards the ability to efficiently post and update their data housed by the service.

Data access and dissemination heavily involves the technology of transferring data. Digital data have been, and continue to be, distributed through storage media such as magnetic tapes and disks, CDROMs, and DVDs. Data has also been distributed through the use of file transfer protocols (such as FTP). These continue to be mechanisms with which data is delivered to users. However, to make it easier, users now often interact with web pages instructing and assisting in accessing data. Most brokering services currently follow this approach. The broker obtains data from the creator and then posts these data to their data/FTP server. Many times the name "data clearinghouse" is used to

describe these sites. By following certain standards and procedures, such sites can be recognized as a National Geospatial Data Clearinghouse.

For those data sets having high maintenance schedules, the clearinghouse method relies heavily on the brokering service to post changes. Lags in updating can lead to a lack of currency in data holdings. To address this issue and utilize Internet technologies more effectively, many brokering services are starting to use a "distributed model". In such a model, the data broker continues providing access to data via the portal, and the metadata records may be maintained within broker's facilities but data holdings may be housed and maintained at the data steward's facilities. This allows for the maintainer of the data to fully control which data set is distributed at any one time and leads to currency within the data set. The data steward is also given the full ability to post and modify his/her metadata records within the brokering service. This relieves maintenance pressures from the brokering service while at the same time giving the data steward the ability to effectively maintain the currency of data. The broker continues to provide a consistent portal for access to the data.

The last component of data access and dissemination is the "user community" – those people who apply data within their own business practices. Users may range greatly in sophistication, knowledge, and needs. Users can range from a person viewing data for information on their upcoming vacation to private consultants making a living analyzing data. This creates many challenges for brokering services since both extremes need to be accommodated. Basic users may only need access to a simple Internet mapping application for displaying data. Advanced users, on the other hand, may need the ability to download and manipulate data with their own software. Additionally, these latter users may want to contribute the modified data back to a brokering service.

All data access and dissemination components (data, data steward, data broker, user, and technology) must be present to effectively distribute data. Current movements toward distributed technologies provide excellent opportunities to provide users with the most current and accurate geospatial data available while reducing some of the inefficiencies with the traditional approach of massive data clearinghouses containing all geospatial data for an area of interest. Due to technical and financial constraints of data stewards this traditional approach will not entirely be replaced by a distributed structure. The ideal brokering service would provide geospatial data users with the true "one-stop-shopping" experience through their portal by utilizing a mixed but scalable approach. This will put pressure on existing brokering services to provide leadership and expertise in adapting to future technologies while maintaining their current activities and services.

Wyoming Data Access and Dissemination

Current Activities

Currently within Wyoming there are two recognized NSDI Geospatial Data Clearinghouses: the Wyoming Natural Resource Data Clearinghouse (WNRDC) (http://www.wygisc.uwyo.edu/clearinghouse/) maintained by WyGISC and the Wyoming Spatial Data Clearinghouse (WSDC) (http://wgiac2.state.wy.us/) maintained by Wyoming Department of Administration and Information for WGIAC. Both of these

sites provide the public with the tools necessary to search, understand, and retrieve data. Currently WNRDC maintains over 300 geospatial data layers focusing on statewide distribution. WSDC provides access to general framework data (roads, streams, political boundaries, etc.) supporting county and local GIS efforts.

In addition to these two sites, there are a number of other entities distributing geospatial data in Wyoming. At the federal level, some of the agencies providing data are the US Geological Survey (USGS), the Natural Resource Conservation Service (NRCS), the Bureau of Land Management (BLM), the US Forest Service (USFS), and the US Census Bureau. This by no means is a complete list and many times within each agency there can be several different groups providing geospatial data. At the state level, geospatial data is disseminated by several agencies such as:

- Wyoming Department of Transportation (WyDOT),
- Wyoming State Historic Preservation Office (SHPO),
- Wyoming State Engineer's Office (SEO),
- Wyoming Department of Environmental Quality (WyDEQ),
- Wyoming Department of Revenue,
- Wyoming Game and Fish,
- Wyoming Oil and Gas Conservation Commission (WOGCC),
- Wyoming Water Resources Database (WRDS),
- Wyoming State Geologic Survey (WSGS), and
- Wyoming Natural Diversity Database (WYNDD).

Most state agencies distribute geospatial data related to their business practices which they create and maintain "in-house". For example, the WSGS distributes geologic maps and data of Wyoming whereas SHPO provides users with the ability to view cultural resource data through an Internet mapping application. More recently even counties and municipalities throughout Wyoming are starting to distribute geospatial data referencing their extent of influence. Many of these groups require fees or limit access to their data due to the cost associated with maintaining highly accurate and changing data such as parcels.

Geospatial data being distributed by these agencies exist in any of the geospatial formats discussed earlier. Besides paper maps, the majority of digital geospatial data being distributed is in a vector or raster GIS format. A number of challenges face users who try to mix data from different agencies because of discrepancies in the software used while creating the data, the projection and units associated with data, the scale of the data, and the accuracy of the data. Even if two data providers are using identical or compatible GIS software and provide data in the same projection and units, the user could be confused with the different proprietary formats being distributed. For example, the most commonly used GIS software in Wyoming developed by Environmental Research Institute Inc (ESRI), has five different data formats for which it supports – grids, triangular irregular networks (TINs), shapefiles, coverages, and geodatabase. All of these ESRI formats require a different skill set to effectively utilize the data. So even within

one agency solely using proprietary GIS software, users are faced with issues limiting their ability in using GIS.

One technology that has had tremendous growth within the GIS data dissemination arena is Internet mapping. This is also true for Wyoming. There are currently several different Internet mapping sites displaying Wyoming data with many more currently planned. A majority of these sites are being created and maintained by federal agencies but some Wyoming state agencies (e.g. WSGS, SHPO, WyDOT) have also created sites. Even at the local level, Laramie County and the City of Cheyenne have developed a very sophisticated Internet mapping site. Almost all these sites will display similar reference data such as roads, streams, and boundaries. Differences in how these groups display these data and which data each are using within their mapping application can cause difficulties with the users.

Actual access of geospatial data from any of these Wyoming geospatial data developers and disseminators can involve a wide variety of methods. Some have elaborate web pages interacting with an FTP data server. Others have a simple ftp site. Most still rely on users contacting them directly and requesting data. These requests may be handled by e-mailing the data or by saving the data directly to a media (such as CD-ROM) and physically mailing the information.

Issues

The data distribution issues for Wyoming occur from both the brokering/disseminating side and also from the users' perspective or access side. Both the Wyoming Geographic Information Advisory Council (WGIAC) and the I-Team are trying to address this issue. However these groups are strictly voluntary and have neither authority nor financial support to fully address coordination. In 1997, the University of Wyoming's Spatial Data and Visualization Center (SDVC) tried to fill this role through the creation of the WNRD Clearinghouse and a metadata outreach program. This activity was funded via a federal grant with no long-term commitments guaranteeing the maintenance and growth of this Wyoming service. Additionally the State of Wyoming tried to foster this coordination through the creation of a state GIS Coordinator position in 1999. Due to funding being limited to a coordinator's salary only (no technical support staff) it was impossible to accomplish the mission of the office.

Without coordination and funding being directed towards data stewardship and dissemination, the state of Wyoming will run the risk of spending more money on collectively funding each agency to perform this activity verses having a group provide this service for all agencies. Currently many agencies are moving forward in providing Internet access to their data. For each agency to accomplish this goal, they will have to purchase the hardware and train employees to support this activity. Additionally, as these agencies move toward Internet mapping even more hardware and human resource skills are needed. All of this will lead to an increase in staff and hardware directed toward supporting data requests externally and limits the time directed toward supporting that agencies business practices internally.

A different and opposite issue facing some data providers is their inability to disseminate data to users. These providers do not have the technical or financial resources necessary to create and maintain data distribution sites. Additionally, they may only have one or two items to contribute. The problem in Wyoming is specifying appropriate outlets for distribution of their data. If such sources could establish a partnership with a data clearinghouse, another issue would be how to maintain their data holdings when updates occur?

From a user's perspective all of these issues affect their ability to access and utilize data efficiently. Without coordination supported by technical resources, users will continue to be faced with accessing data via interaction with several different agencies. For example if the BLM wanted to perform a site analysis on a proposed well location, it would be necessary for them to access data from a variety of agencies. At a minimum, BLM would contact WOGCC to obtain well information, SHPO to look at cultural resources, WYNDD to examine endangered species, Wyoming Game and Fish for critical habitat, and possibly WRDS for current water quality information. Currently this assembly of data would require several days of work. If a well-drilling company were to perform this activity, it or its consultant would also be required to gather all the accurate reference data to complete the data set. The current time required to gather this information is billed directly to these companies, thus increasing their costs.

Additional issues for users may center on not knowing who to contact for data. Currently within Wyoming there is not an accurate and up-to-date list of who maintains what data layers for what extent of Wyoming. This requires users to make several inquiries before finding the appropriate data. Even if data are available, they may not be the most current and accurate data, requiring the user to still contact an agency.

As more users start to utilize Internet mapping applications, issues will arise with these users having to view several different sites. The inability to combine multiple Internet mapping services from different agencies will frustrate users. Additionally, by having several different sites, application functionality differences and thematic display differences will lead to even more confusion. Many of these mapping services will not have access to current data which also could lead to viewers being given an inaccurate picture of a situation. This could prove costly if decision makers don't have access to the most current and accurate data.

Need

Wyoming's biggest need in geospatial data dissemination and access is the creation and financial support of one centralized data access portal. In this instance centralized does not mean that all data or Internet mapping resides with one group or that one group, is charged with maintaining and distributing all geospatial data within Wyoming. Rather, it refers to a centralization of information pertaining to who has what, and the provision of a technological infrastructure permitting users to obtain or view data from a variety of sources without having to independently interact with each.

Solution

Establish and maintain the Wyoming GeoPortal – an Internet portal for all Wyoming geoinformation. This collection of centralized, Internet applications would provide all Wyoming GIS users the ability to view and access geospatial data available for Wyoming and vicinity. Additionally in funding such an activity, Wyoming would establish a direct method to promote and facilitate coordination among GIS activities in the state. In order for this undertaking to be successful, Wyoming should utilize the technical expertise and existing hardware/software resources available at the Wyoming Geographic Information Science Center (WyGISC) at the University of Wyoming.

Benefits

By assigning the task of creating the Wyoming GeoPortal to WyGISC, a substantial cost savings would be recognized. Additionally, WyGISC is not hindered by institutional constraints requiring a focus on a specific thematic need. This is especially important due to the wide variety of disciplines using GIS data. More importantly, implementation at WyGISC could leverage existing activities and knowledge with data brokering and thus provide users a working application in a timely and efficient manner.

Resulting cost savings associated tasking WyGISC with development and maintenance of the Wyoming GeoPortal can be divided into three major resources – hardware, software and human. While this effort would require WyGISC to migrate its current clearinghouse to a more open, distributed system, many of the hardware components supporting the clearinghouse could be used thus eliminating the need of large expenditures towards hardware. Additionally the hardware necessary to support a staff would be limited due using current staff equipment. Finally networking capacity necessary to support the Wyoming GeoPortal already exists at WyGISC. Outreach and educational cost savings could also be seen with WyGISC ability to use video conferencing and its mobile teaching lab.

Software costs associated with developing spatial data access and dissemination via the Internet is extremely expensive. Software requirements for this project include GIS desktop software for manipulating and maintaining spatial data, software for development, deployment and maintenance of Internet applications and an enterprise relational database for managing and maintaining data holdings. Fortunately for this project, WyGISC through the University of Wyoming has licensing agreements which allow for all of these necessary software expenditures to be eliminated. This not only reduces costs associated with the initial development but also with future expansion and maintenance costs thus allowing for savings to continue on a yearly basis.

Although a large amount of funding directed toward human resources is necessary to support the development and maintenance of the Wyoming GeoPortal, contributors will gain cost benefits thru assigning tasks to WyGISC employees already experienced with providing geoinformation via the Internet. This

eliminates the need to initially train people with use of GIS, Internet application deployment or relational database management. This can be a substantial cost due to the amount of time necessary to reach WyGISC's current level of expertise. Additionally, WyGISC has information technology specialists with proven abilities in supporting GIS data serving. This is evident by the reliability Wyoming data users have come to expect from WyGISC's current data clearinghouse. This critical role of system administration (SA) is often overlooked however the duties necessary to support a large spatial data clearinghouse are far beyond in scope and size of what typically challenges these professionals. Once again, this project would directly benefit from leveraging this WyGISC experience and eliminate the "learning curve" costs others may face.

One substantial benefit, besides cost reduction, of tasking WyGISC with development and maintenance of the Wyoming GeoPortal is the flexibility WyGISC has in its current mission. To direct funds to an existing state agency would likely limit data access and dissemination activities to the priority data of such agency. For example, it would be very hard to justify WyDEQ giving users the ability to access demographic data. At the very least, demographic data would not be a priority until DEQ's data are first accessible. Since spatial data are used in a wide variety of disciplines to favor one discipline over another would be a disfavor to the numerous users of these data and limit the ability to use GIS throughout Wyoming.

Finally from a user's stand-point, one important benefit for selecting WyGISC would be its ability to use current projects to provide a foundation from which to build the Wyoming GeoPortal. This would limit the amount of time required for working applications to be in place and operational. This is due not only to current applications developed at WyGISC but also the level of expertise employed at WyGISC to perform such duties.

Risks

With the responsibility of developing and producing the Wyoming GeoPortal, WyGISC would also assume the risks associated with implementation. One substantial risk is the ability to secure long term funding and support for the GeoPortal. After implementation, the maintenance duties many times are not realized or noticeable to users and contributors. This can lead to a lack of understanding and eventually misconception about how dollars are being appropriated eventually eroding the financial support.

One way to mitigate this risk would be the creation of a Wyoming GeoPortal advisory board. This group would be made up of representatives from a wide selection of contributors and/or users. Essential to the group would be the WGIAC president, an I-TEAM representative, the Wyoming Computer Information Officer (CIO) or some representative from this office, WyGISC Director and at least one individual from each financial contributor. Board meetings would be held on a periodic basis assisting with long term planning and financing.

Another risk that must be addressed by WyGISC is the potential lack of participation by data providers throughout the state. Without a majority of data providers contributing to the Wyoming GeoPortal, users will have to continue to search and obtain data from a variety of different sources which feeds back to many of the issues identified previously. WyGISC must address this issue in a number of ways but should foremost make contributing to the GeoPortal easy and convenient to the data providers.

Finally one substantial political risk is the appearance of WyGISC controlling data dissemination activities within Wyoming. Hopefully, through outreach and education, it will become clear that this is truly a collaborative, Wyoming-wide effort and not self-promotion of one group. As mentioned before without the support of other data providers WyGISC will have difficulties in creating the Wyoming GeoPortal, therefore it is of their interest also to see that this misconception does not propagate among potential data contributors.

Wyoming GeoPortal Implementation Plan

Goal

Through the use of scalable, distributed and standards-based geospatial technologies create a framework for statewide coordination in the process of providing all Wyoming GIS users the ability to view and access the most accurate and current geospatial data available for Wyoming and vicinity.

Objectives

1) Create a distributed geolibrary which allows for all Wyoming geoinformation to be collected, cataloged and accessed through one centralized web portal.

2) Create a "one-stop" Wyoming Internet Mapping portal which allows users to view data from a distributed network of interoperable mapping services.

3) Facilitate the use and contribution of geospatial data by educating potential users and partners in the functionalities of the geolibrary and map viewer.

Methods and Approaches

Objective 1: Wyoming GeoLibrary

Definition

A centralized, digital library providing reference to geoinformation distributed among a network of data providers for which the primary search mechanism is place.

Functionality

1. Collect and gather geoinformation from a variety of sources
2. Search for data by location, place name, theme, time, and/or data provider
3. View data descriptions – metadata
4. Display geoinformation
5. Access geoinformation

Tasks

1. Identify and assess potential contributors/partners of the GeoLibrary.
2. Identify and create necessary IT infrastructure to support GeoLibrary.
3. Design and create database to support GeoLibrary.
4. Create a customized web interface for users to interact with GeoLibrary.
5. Create desktop and internet applications to support contribution and maintenance of geoinformation found within the GeoLibrary.
6. Maintain and update GeoLibrary.
7. Provide support and help in the use of and contributions to the GeoLibrary.

Implementation Discussion
Task 1 requires the development of an interactive and dynamic GIS directory for those parties maintaining and distributing Wyoming geospatial data. This directory database would contain contact information and available spatial data. The database must be Internet accessible not only for querying potential partners but also allowing for parties to update their own contact information.

This GIS directory forms the foundation from which WyGISC would start to evaluate potential data contributors to the Wyoming GeoLibrary. Partners will be assessed on their ability to provide access to geospatial data. Those found unable to host their own data and still willing to participate would be provided with space and access to WyGISC ftp server. This allows for partners to update and post their own data while limiting the requirements of WyGISC. Any partner willing to pay for WyGISC performing all duties of data maintenance and posting would also be accommodated. To formalize these partnerships, agreements will be established identifying commitments between WyGISC and the data provider with the overall goal of data being accessibly through the Wyoming GeoLibrary.

Based on results of Task 1, an information technology infrastructure will be created to support initial and future requirements. This means the infrastructure must be scalable (performance remains consistent as data volume increases) with the idea that additional partners and data will added to the GeoLibrary. Current WyGISC infrastructure will provide a solid platform from which to build upon.

For fulfilling Task 3 and Task 4, ESRI's ArcIMS Metadata Server will be utilized and modified in order to build the customized, Wyoming GeoLibrary. A few of the customized enhancements will focus on query/location mechanisms specific

to Wyoming (e.g. by Township/Range or watershed name). A gazetteer will be developed which also focuses on features of Wyoming and bordering states. An interactive map specific to Wyoming will allow users to interactively define their location of interest by drawing a rectangle. Software required to fulfill these tasks will be ESRI's Spatial Data Engine (SDE) and an ESRI-supported RDBMS (e.g. ORACLE 9i). Both SDE and ORACLE are currently being used and maintained by WyGISC in a production environment.

Task 5 will allow contributors convenient posting and updating ability for their geoinformation contained within the GeoLibrary. A customized toolbar utilized by ArcGIS's ArcCatalog will be created through ArcObjects development. For those who want to contribute but do not have this software, a suite of Internet tools will also be created to perform the same functionality as the desktop ones. Finally, for those contributors who do not have the means to allow for outside access of their data, Internet tools will be created to aid in posting and updating their geospatial data to the centralized repository.

Task 6 will require WyGISC to perform periodic updates and maintenance of the GeoLibary. Update and maintenance refers to applications and hardware infrastructure. A yearly funding source will be required in order to insure long-term success and growth of the GeoLibrary.

For Task 7, documentation and a tutorial for contributors will be created. Also it will be necessary to provide in-house training for contributors. Extensive help documentation will also be needed for the users of the GeoLibrary. To provide local support of the GeoLibrary, a training workshop would be held inviting all librarians across the state to attend. Current WyGISC classroom facilities and a mobile teaching lab will be utilized to support this activity.

Objective 2: WyMAP

Definition
A web mapping portal which allows users to display, query, and access geospatial data and mapping services from a wide variety of Wyoming geospatial contributors.

Functionality

1. Provide simple GIS viewing and mapping capabilities via the Internet.
2. Provide custom tools for determining area of interest.
3. Provide user with the ability to utilize distributed mapping services.
4. Provide ability to utilize personal data holdings.
5. Have metadata accessible through application.

Tasks

1. Identify requirements for contributing mapping service to WyMap.

2. Identify and assess potential contributors/partners of the WyMap.
3. Develop a web mapping partner network for Wyoming.
4. Create internet mapping application built around distributed network of mapping services.
5. Create ability of GeoLibrary and WyMap to work together.
6. Maintain and update WyMap.
7. Provide support and help in the use and contribution of the WyMap.

Implementation Discussion
In order to fully understand how to create a distributed mapping portal, a requirements list must be established in Task 1. WyGISC will assess possible contributors based on human resources, software, and hardware. An initial WyMap prototype will be developed by WyGISC in conjunction with those Wyoming I-Team participants currently using Internet mapping technologies. This prototype will provide the basis for a requirements list. Some of the issues will be security, reliability, hardware configurations, types of software utilized, data being maintained, and the overall knowledge and time which could be committed to maintaining and updating their mapping service(s).

One key requirement of any mapping service being utilized by WyMAP will be the need for this service to follow the OpenGIS interoperability standards. Currently there are two Internet mapping standards established by the Open GIS Consortium (OGC) of interest to this proposal: Web Map Service Implementation Specification (WMS) and Web Feature Service Implementation Specification (WFS). The WMS standard applies to image Internet mapping services while the WFS standard provides guidelines for feature streaming Internet services. The initial version of WyMap will utilize WMS services and will be a minimum requirement for producing an interoperable mapping service. WMS and WFS provide standards-based, non-proprietary protocols for requesting geo-referenced data. Another advantage of a WMS-compliant mapping service is the ability of the service to return a transparent image which then can be overlaid with one or more other WMS map images from the same or from different servers. Currently within Wyoming only WyGISC is known to be using this technology. While WyGISC uses ESRI's ArcIMS to provide WMS services, the standards-based nature of WMS (and WFS) enables a variety of server software to be utilized without a loss of interoperability.

Once a set of requirements is established, Task 2 will examine how entities can contribute to WyMap. Similar to the GeoLibrary, it will be beneficial to the WyMap development to have access to and utilize a dynamic GIS directory for those parties maintaining and distributing Wyoming geospatial data. If potential partners fail to meet the requirements established in Task 1, they could still become a partner by having either WyGISC or another entity host their mapping service. All partners must agree upon allowing WyMap to utilize their mapping service.

For Task 3, an initial web mapping network will be established within the Wyoming I-Team and will be expanded to include others once a working model of the technology is developed. This mapping network team will provide oversight and potential direction to WyGISC while developing WyMap. It will be necessary for the group to meet on a yearly or semi-annually basis.

To complete Task 4, it will be necessary for WyGISC to create a customized Internet mapping viewer "from scratch". Most off-the-shelf software currently does not allow for multiple image mapping services to be displayed simultaneously on top of each other, particularly when the data come from different brands of server software. For this reason, the initial application development will focus on providing basic GIS web functionality. This includes zooming in and out, pan, identifying and querying features, and printing a map. Currently WyGISC has begun work toward the development of such a viewer. These efforts will provide a substantial decrease in development time. As the application matures further enhancements could be developed such "clip and zip" functionality (for downloading data to one's desktop GIS application), buffering, location tools, and area calculations. Most of these features will be identified and prioritized by the network team created in Task 3. This map viewer would be publicly accessible via the Internet.

Development of Task 5 would require giving the user the ability to view the metadata of any of the layers found within WyMap. The user could click on the layer and automatically be transferred to the GeoLibrary displaying the metadata associated with that layer. This would give the user the ability to download and understand the data being displayed.

Task 6 will require WyGISC to perform periodic updates and maintenance of the WyMap. This update and maintenance relates not only to the application but also the hardware infrastructure. A yearly funding source will be required in order to insure long-term success and growth of the WyMap.

Finally for Task 7, WyGISC will create on-line documentation for using WyMap. It will also be necessary to provide the network partners with a set of guidelines for developing a WMS mapping service. This documentation would go into greater detail on how to create such a service and describe what capabilities must be available at minimum for WyMap to interact with their service.

Objective 3: Outreach and Education

Definition
Methods and practices which promote the long term viability and use of the Wyoming GeoLibrary and WyMap.

Purpose

1. Increase public awareness of Internet tools.

2. Provide financial backing for startup and long term maintenance.
3. Continue the growth of applications in both data and functionality.
4. Assist in use of applications.
5. Provide directions to data providers.
6. Provide feedback mechanism for users and data providers.

Tasks

1. Travel throughout Wyoming and United States promoting applicability and use of WyMap and the GeoLibrary.
2. Create an advisory board.
3. Help network partners through white papers, implementation guidelines, and workshops.
4. Help users by creating extensive help documentation.
5. Train identified local experts.
6. Provide Internet accessible commenting tools for the public.

Implementation Discussion
Task 1 will require WyGISC to present both WyMAP and the GeoLibrary to a variety of organizations through meetings, workshops, and conferences. For Federal partnering, this travel may be outside the state of Wyoming. The goals of these presentations would be to promote the use of the two Internet applications, solicit feedback from users and partners, and look for additional partners. Efforts will be directly made to coordinate with national geospatial data dissemination efforts. This would include partnering and sharing services with the USGS National Map, contributing directly to the FGDC Geospatial One-Stop and Geodata.gov application, and integrating with other national efforts such as the AmericaView Consortium and/or Open GIS Consortium.

Task 2 would create an advisory board to initially help secure continuing funding and guide project expenditures for the development of the GeoLibrary and WyMap. After implementation, this board would perform the same duties but more in a maintenance role. Ideally this board would be made up of decision-makers who could use the tools but more importantly, are also well connected to financial decision makers of agencies. It is important to separate this group from the technical groups in each of the other objectives since the focus of this group must be funding. Essential to the group would be the WGIAC president, an I-TEAM representative, the Wyoming Computer Information Officer (CIO) or some representative from this office, WyGISC Director and at least one individual from each financial contributor. Board meetings would be held on a periodic basis assisting with long term planning and financing.

One side benefit from having an advisory group would be the ownership of both products by decision-makers with state financial influence.

In order to help current and future data providers, Task 3 will create on-line documentation describing the details of creating WMS mapping services, posting

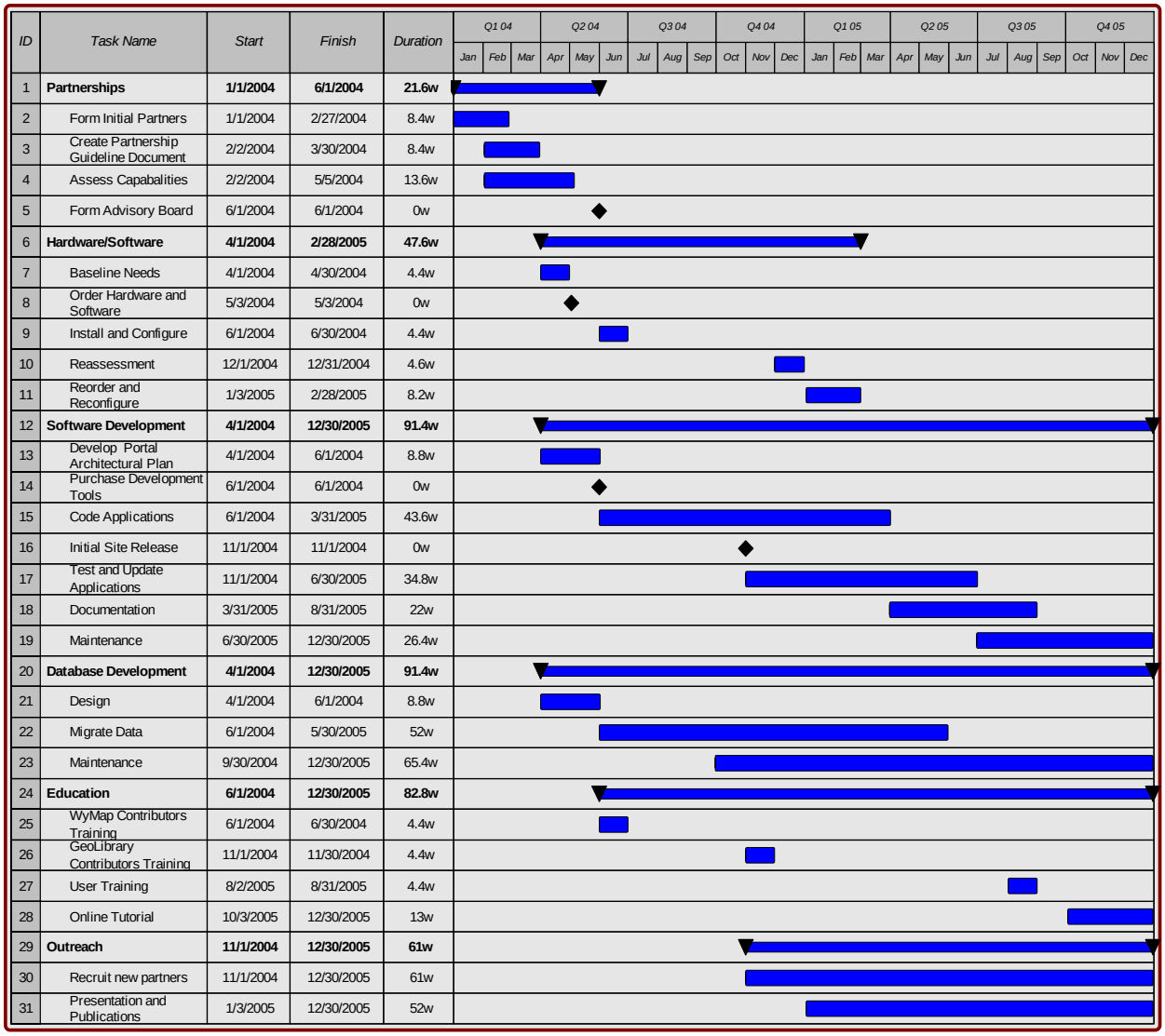
and updating data within the GeoLibrary, and how to effectively use the other tools created for them. Initially there should be a number of workshops giving data providers hands-on experience with contributing to GeoPortal. This may require the development of tutorials to aid in teaching.

Providing help to the users of both applications is the focus for Task 4 and 5. On-line documentation will be created. There will be help contacts posted for users to interact with those managing the applications. There will also be training sessions geared toward creating community experts for which users can interact directly. WyGISC current education facilities and mobile teaching lab will benefit these tasks greatly.

Finally Task 6 will allow for the growth and expansion of both WyMap and the GeoLibrary to replicate what users would like to see. Comments will be cataloged and maintained in order to prioritize at technical and advisory meetings. Implementation of these ideas will be dependent on funding and decisions made by groups.

Overall Wyoming GeoPortal Timeline

The overall Wyoming GeoPortal has a projected implementation period of two years (Figure 1) and can be categorized under six general tasks: partnerships, hardware/software, software development, database development, education and outreach. These general tasks are groupings of similar activities necessary to fulfill each objective previously described. For example, hardware needs, ordering, installing and configuring all can be accomplished at the same time for both the Wyoming GeoLibrary and WyMap.



ID	Task Name	Start	Finish	Duration
1	**Partnerships**	**1/1/2004**	**6/1/2004**	**21.6w**
2	Form Initial Partners	1/1/2004	2/27/2004	8.4w
3	Create Partnership Guideline Document	2/2/2004	3/30/2004	8.4w
4	Assess Capabalities	2/2/2004	5/5/2004	13.6w
5	Form Advisory Board	6/1/2004	6/1/2004	0w
6	**Hardware/Software**	**4/1/2004**	**2/28/2005**	**47.6w**
7	Baseline Needs	4/1/2004	4/30/2004	4.4w
8	Order Hardware and Software	5/3/2004	5/3/2004	0w
9	Install and Configure	6/1/2004	6/30/2004	4.4w
10	Reassessment	12/1/2004	12/31/2004	4.6w
11	Reorder and Reconfigure	1/3/2005	2/28/2005	8.2w
12	**Software Development**	**4/1/2004**	**12/30/2005**	**91.4w**
13	Develop Portal Architectural Plan	4/1/2004	6/1/2004	8.8w
14	Purchase Development Tools	6/1/2004	6/1/2004	0w
15	Code Applications	6/1/2004	3/31/2005	43.6w
16	Initial Site Release	11/1/2004	11/1/2004	0w
17	Test and Update Applications	11/1/2004	6/30/2005	34.8w
18	Documentation	3/31/2005	8/31/2005	22w
19	Maintenance	6/30/2005	12/30/2005	26.4w
20	**Database Development**	**4/1/2004**	**12/30/2005**	**91.4w**
21	Design	4/1/2004	6/1/2004	8.8w
22	Migrate Data	6/1/2004	5/30/2005	52w
23	Maintenance	9/30/2004	12/30/2005	65.4w
24	**Education**	**6/1/2004**	**12/30/2005**	**82.8w**
25	WyMap Contributors Training	6/1/2004	6/30/2004	4.4w
26	GeoLibrary Contributors Training	11/1/2004	11/30/2004	4.4w
27	User Training	8/2/2005	8/31/2005	4.4w
28	Online Tutorial	10/3/2005	12/30/2005	13w
29	**Outreach**	**11/1/2004**	**12/30/2005**	**61w**
30	Recruit new partners	11/1/2004	12/30/2005	61w
31	Presentation and Publications	1/3/2005	12/30/2005	52w

Figure 1. Overall Wyoming GeoLibrary Timeline

Budget

Two Year Implementation Budget

For the Wyoming GeoPortal to be successful adequate funding must be committed not only for the first two years of implementation but also for maintenance in subsequent years. The two-year implementation funds required for the Wyoming GeoPortal is $680,596. As seen from Table 1, the true cost of a project of this magnitude is approximately $1,099,800. By utilizing WyGISC to fulfill this role, the funding required is reduced by $419,205or 38% due to contributions made by university salaries and existing hardware and software.

Category	Overall Expense	WyGISC/UW Match	Requested
Totals Year One	$647,966	$271,460	$376,506
Totals Year Two	$451,835	$147,745	$304,090
Total	$1,099,800	$419,205	$680,596

Table 1. Total Project Costs

The two year implementation of the GeoPortal can be broken down in Year One (Table 2) and Year Two (Table 3) funding. Year one is heavily supported by the University match due to initial hardware and software purchases being contributed to the project. Each year has been broken down in five general categories: human resources, hardware resources, software resources, travel and training and overhead. Further financial breakdowns of each of these categories have been created to substantiate the dollar amounts and can be examined following this section.

Category	Overall Expense	WyGISC/UW Match	Requested
Human Resources	$275,000	$65,000	$210,000
Hardware Resources	$70,000	$30,000	$40,000
Software Resources	$94,550	$84,550	$10,000
Travel and Training	$20,000	$0	$20,000
Overhead	$188,416	$91,910	$96,506
Totals	$647,966	$271,460	$376,506

Table 2. Year One Funding

Category	Overall Expense	WyGISC/UW Match	Requested
Human Resources	$275,000	$65,000	$210,000
Hardware Resources	$10,000	$0	$10,000
Software Resources	$15,450	$15,450	$0
Travel and Training	$20,000	$0	$20,000
Overhead	$131,385	$67,295	$64,090
Totals	$451,835	$147,745	$304,090

Table 3. Year Two Funding

Yearly Maintenance Budget after Implementation

After implementation, it will be necessary to fund this activity at an approximate yearly level of $183,590 (Table 4). The majority of this dollar amount is direct toward maintaining the appropriate staff to support growth and development of a centralized site. Continued leadership will be necessary in working with all federal, state, and local entities to ensure the appropriate data are being delivered to the users. Additionally staff will be required to not only maintain data and data links, but also to stay current with technology which leads to a continue increase functionality and "user friendliness" of the Wyoming GeoPortal. One significant cost savings achieved by the establishing this service at WyGISC not obvious in the budget would be the minimal costs associated with growth of the GeoPortal.

Hardware growth will center on CPU and disk space expansion. Since enterprise software (e.g. ArcIMS and ORACLE) is priced based on a per CPU basis, software costs could dramatically increase due scalability. Scalability is the ability to maintain speed and efficiency (i.e. user output) as the size of data and users increase. The most common approach to maintaining scalability is adding CPUs to a server or adding a machine to an array of servers. Regardless of the approach, each method requires additional ESRI software license for their server applications (i.e. ArcIMS and ArcSDE).

Category	Overall Expense	WyGISC Match	Requested
Human Resources	$137,500	$32,500	$105,000
Hardware Resources	$10,000	$0	$10,000
Software Resources	$25,450	$15,450	$10,000
Travel and Training	$20,000	$0	$20,000
Overhead	$79,110	$40,520	$38,590
Totals	$272,060	$88,470	$183,590

Table 4. Yearly Maintenance Funding after Implementation

Human Resources Budget

Staffing requirements include a project manager, a software engineer, a data manager and a system administrator. All four positions require advanced skill sets dictating competitive salaries. The project manager will maintain and establish new partnerships, provide leadership at advisory board meetings, provide an outreach and education role, and organize and manage activities necessary to keep the project on task. The software engineer will focus on internet application development related to viewing and disseminating data. The data manager will assimilate data and provide expertise in manipulating data for ease of use. Finally the systems administrator will be necessary for hardware development and maintenance. By utilizing WyGISC the systems administrator duties will be supported by the University of Wyoming. These four staff requirements are critical not only for developing the site but also allowing for growth and development in the future. It will be necessary for the state to continue to support these positions into the future through maintenance funding. A benefit of using WyGISC which is not recognized in the budget is both a Software Engineer and Data Manager are currently employed by WyGISC. This will allow for the GeoPortal to be developed and maintained by an experienced and proven technical staff.

Category	Overall Expense	WyGISC Match	Requested
Project Manager	$80,000		$80,000
Software Engineer	$65,000		$65,000
GIS Data Manager	$65,000		$65,000
Systems Administrator	$65,000	$65,000	$0
Totals	$275,000	$65,000	$210,000

Table 5. Human Resources Funding including Fringe per Year for Implementation

Category	State Expense	WyGISC Match	Requested
Project Manager	$40,000		$40,000
Software Engineer	$32,500		$32,500
GIS Data Manager	$32,500		$32,500
Systems Administrator	$32,500	$32,500	$0
Totals	$137,500	$32,500	$105,000

Table 6. Human Resources including Fringe for Maintenance Funding

Hardware Resources Budget

For the success of the GeoPortal, it will be necessary to purchase a high end data server with sufficient disk capacity to maintain and manage all data required for the project. This server must be optimized for a relational database. There will also be the need for application servers to support Internet application deployment. This will be an array of machines allowing for load balancing of incoming user requests and thus limiting user waits. Additional hardware to support all staff will be required. Growth potential will lead to future purchase of disk space and/or processors with a possible need for increased network capacity due to the size of geospatial data files.

Category	Overall Expense	WyGISC Match	Requested
Data Server	$20,000		$20,000
Array of Application Servers	$20,000		$20,000
Staff Computers	$20,000	$20,000	$0
Other (networking, printers, etc)	$10,000	$10,000	$0
Totals	$70,000	$30,000	$40,000

Table 7. Year One Hardware Funding

Category	Overall Expense	WyGISC Match	Requested
Expansion CPUs	$5,000		$5,000
Expansion Disk Drives	$5,000		$5,000
Other (networking, printers, etc)	$0	$0	$0
Totals	$10,000	$0	$10,000

Table 8. Year Two Hardware Funding

Category	Overall Expense	WyGISC Match	Requested
Hardware Maintenance	$5,000		$5,000
Growth Expansion Funds	$5,000		$5,000
Totals	$10,000	$0	$10,000

Table 9. Hardware Maintenance Funding after Implementation

Software Resources Budget

Software for this project will mainly be ESRI products centered on building highly efficient Internet applications. ArcSDE will allow for the use of a relational database and is recommended by ESRI for Internet applications having a large volume of users. ArcIMS will provide the tools necessary to create Internet mapping services and will provide a foundation for application development. ArcGIS licenses will be needed in order to accomplish many of the data manipulations and data management functions. Fortunately, this is a cost which will be absorbed by the University and does not increase projects costs. Moreover, as the growth of the GeoPortal dictates additional CPUs or machines, neither the software nor maintenance cost will increase.

- ESRI Suite
  - ArcSDE – One server with two CPUs
    - Cost: Purchase $10,000 + First Year Maintenance $3,000 = $13,000
    - Purchase: First 2 CPU $10,000, each additional CPU $2,500
    - Maintenance: First 2 CPU $3,000/year and $500/year/additional CPU
  - ArcIMS – Two servers with two CPUs
    - Cost: Purchase $22,500 + First Year Maintenance $4,500 = $27,000
    - Purchase: First CPU $7,500, Each additional CPU $5000
    - Maintenance: First CPU $1,500/year, and $1000/year/additional CPU
  - ArcGIS – Two ArcView and Three ArcInfo
    - Cost: Purchase $32,100 + First Year Maintenance $6,000 = $38,100

    ArcView: Purchase $1200 single license
    Maintenance: $400/year primary, $200/year secondary

    ArcInfo: Purchase $9900 floating license
    Maintenance $3000/year primary, $1200/year secondary

Purchase Total	$ 64,600	
First year maintenance Total	$ 14,500	
ESRI Total		$ 79,100

- Relational Database
  - SQL Server

Purchase - one CPU license	$4,500	
First year maintenance	$ 950	
SQL Server Total		$ 5,450

Figure 2. ESRI and SQL Server Price Structure for Wyoming State Purchase

Category	Overall Expense	WyGISC Match	Total Request
ESRI Software	$64,600	$64,600	$0
ESRI Software First Year Maintenance	$14,500	$14,500	$0
Relational Database - SqlServer	$4,500	$4,500	$0
RDBMS First Year Maintenance	$950	$950	$0
Other	$10,000	$0	$10,000
Totals	$94,550	$84,550	$10,000

Table 10. Year One Software Funding

Category	Overall Expense	WyGISC Match	Total Request
ESRI Software Second Year Maintenance	$14,500	$14,500	$0
RDBMS Second Year Maintenance	$950	$950	$0
Totals	$15,450	$15,450	$0

Table 11. Year Two Software Funding

Category	Overall Expense	WyGISC Match	Total Request
ESRI Software Second Year Maintenance	$14,500	$14,500	$0
RDBMS Second Year Maintenance	$950	$950	$0
Other	$10,000	$0	$10,000
Totals	$25,450	$15,450	$10,000

Table 12. Software Maintenance Funding after Implementation

Travel and Training Budget

To promote outreach and training, traveling throughout Wyoming will be necessary. Additional out-of-state trips will be required for federal partnering. Finally there will be several day trips to partners found in Cheyenne. These trips will continue as the project moves from implementation to maintenance.

Category	Overall Expense	WyGISC Match	Total Request
Out-of-state - 4 trips @ $1500/trip	$6,000	$0	$6,000
In-state Overnight - 25 trips @ $120	$3,000	$0	$3,000
In-state day trips - 20 trips @ $50/trip	$1,000	$0	$1,000
Totals	$10,000	$0	$10,000

Table 13. Travel Funding per Year

Although WyGISC employees have a strong background with the deployment of Internet GIS applications, additional training will be necessary to increase the efficiency of their work. Training will also allow for the Wyoming GeoPortal to adapt to GIS technology change. Finally training will allow for more integrated and modular approaches which can lead to an overall better product.

Category	Overall Expense	WyGISC Match	Total Request
ESRI Training	$5,000	$0	$5,000
RDBMS Training	$2,500	$0	$2,500
Internet Programming	$2,500	$0	$2,500
Totals	$10,000	$0	$10,000

Table 14. Training Funding per Year

Appendix A: Subcommittee Requirements

The following are requirements of the various subcommittees of the Wyoming I-Team. These are in place to not only outline what is expected of the subcommittees, but also to guide them in their work.

- **Be Integrative**
  Minimum one member each from Federal, State, and Local Government.

- **Update I-Plan Continuously**
  Because of the ever changing nature of GIS, the I-Plan must also change regularly. Updates to the I-Plan will occur semi-annually.

- **Follow Chapter Format**
  To provide consistency throughout the I-Plan and to ensure coordination issues are being addressed, each subcommittee will be responsible for a chapter in the I-Plan having the following content:[*]

1. Theme Description - a description of what the theme is.
   1.1. Existing Data - a listing of current data sources of the theme.
   1.2. Standards - a listing of standards associated with the theme.

2. Theme Status - a description of the status of statewide coordination and coverage of the theme.
   2.1. Current Investments - a listing of who and how much has been invested so far.

3. Completion Strategy - what's the plan?
   3.1. Responsibilities - a section detailing who gets involved and how.
      3.1.1. Data Creation - what gaps need to be filled and by whom
         3.1.1.1.Cost Estimate
         3.1.1.2.Time Estimate
      3.1.2. Data Integration - how is the data going to be integrated into a statewide dataset and by whom
         3.1.2.1.Cost Estimate
         3.1.2.2.Time Estimate
      3.1.3. Data Steward - who is responsible for being the repository of the dataset
         3.1.3.1.Cost Estimate
         3.1.3.2.Time Estimate
      3.1.4. Data Access - what are the mechanisms for getting access to the data and from whom
         3.1.4.1.Cost Estimate
         3.1.4.2.Time Estimate

[*] The format of the Data Access Chapter will be determined.

4. Summary
   4.1. Total Cost Estimate
   4.2. Total Time Estimate
   4.3. Current Action Items
   4.4. Committee Membership

Appendix B: Draft Wyoming Transportation Standards

The transportation standards were developed by reviewing other transportation models and some brainstorming by a group of individuals with diverse transportation systems needs. It is meant to supplement the NSDI Framework Transportation Identification Standard from the FGDC (http://www.fgdc.gov/standards/status/sub5_7.html). The idea is to identify the most important entities and attributes involved with transportation. This model is not intended to be restrictive. It is considered a minimum set for a basic transportation model and for data sharing. Further elaboration and discrimination on items will be done by the Transportation Subcommittee.

1. Line Feature
    - 1.1. Authority ID – an identification number representing the organization who created the record.
    - 1.2. Line ID - unique feature identification number.
    - 1.3. Date - date of record creation.
    - 1.4. Horizontal Accuracy Measurement Method - scale/methods used to collect record.
    - 1.5. Status - Proposed, Active, Retired
    - 1.6. Name – road name.
    - 1.7. Shield Name – highway name.
    - 1.8. Address Range
        - 1.8.1. From Address
        - 1.8.2. To Address
    - 1.9. Road Code
    - 1.10 Surface Type - paved, improved, unimproved and trail.

All of the details have not been finalized at this time.