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GEOGRAPHIC INFORMATION SYSTEMS

REGULAR FEATURES

A biannual analysis of public policy issues confronting Montana's communities and those who serve them.
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Wednesday, September 12, 2007.max

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REFLECTIONS ON LOCAL GOVERNANCE

This edition of the Montana Policy Review differs a bit from what our regular reader might expect. We believe that the recent expansion of Geographic Information System (GIS) applications in Montana county and municipal government needs to be documented and reported to potential local government users of this amazing technology. This issue of the Policy Review is dedicated to that purpose.

This past spring the Local Government Policy Center and the MSU Geographic Information and Analysis Center jointly sponsored a mini-conference and workshop in Kalispell for Montana's local government GIS users and for some rather eager "wantabees" from state and local government. We also commissioned a series of papers for presentation at the conference which would provide practitioner benchmarks defining the present state of GIS computer mapping technology in Montana local government. The best of these papers are included in this issue of the Policy Review.

Although the papers have been edited for space considerations and to facilitate readability by a somewhat wider audience, these papers remain technical reports. Their purpose is to provide future local government decision-makers and users of GIS technology - which we believe will include all but the smallest units of county and municipal government - a well documented reference point on our collective local government learning curve.

In publishing these reports of successful applications of this "hi-tech" GIS technology we also realize that too many county and municipal governments have not yet taken first steps in acquiring and applying "lo-tech" microcomputer technology. Too many town halls and courthouses have yet to make even word processing and data base management software available to their staff. We often hear that the start-up costs are the reason for delaying the plunge. In reality, we suspect that "computer apprehension" remains the real barrier just as it was for most of us when we got started. Interestingly enough, those mayors and commissioners who have waited until now to make their first computer decision have probably been advantaged by the incredible advances in "user friendly" systems. Any more, if you can turn it on, you can use it!

To help jump start those units of municipal and county government who are now ready to take advantage of "lo-tech" information processing, the Local Government Center has launched a new Computer Assistance Program. Two new staff members, Jackie Magnant and Sandy Palakovich, are now spending a lot of time on the road and on-site with local officials helping to install "appropriate" software in "appropriate" computers. They also hang around long enough to make sure that new users get started on the right foot. Even after installation and familiarization training they remain available for quick response telephone assistance because we have learned that all of us need a little "hand holding" to get started.

Kenneth L. Weaver, Director
Local Government Center

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Wednesday, September 12, 2007.max

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Wednesday, September 12, 2007.max

MONTANA
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Wednesday, September 12, 2007.max

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Wednesday, September 12, 2007.max

MONTANA
Policy Review

THE POWER OF GIS APPLIED TO LOCAL GOVERNMENT

John P. Wilson: Professor of Geography, Dept. of Earth Sciences. Director, Geographic Information and Analysis Center. Montana State University, Bozeman

A Geographic Information System (GIS) is a computerized data base management system for the storage, retrieval, analysis and display of spatial data.[1] These systems can be distinguished from other computer mapping and computer-aided design (CAD) tools in that they: (1) fully integrate map and attribute data; (2) use modern coordinate systems to define the positions of features on the earth's surface so that they can be accurately represented in the database; and (3) provide spatial analysis tools unavailable in most other software packages. This paper will describe these features and use the location of a new park to illustrate how they can be applied to assist local government planning efforts.

> ***Geographic Information Systems combine map and attribute data and afford local governments new opportunities for integration in that these data can be processed together as a single product with little manual intervention. This integration is possible because geography is a common reference used by virtually every activity in local government, whether it to be to find a water main valve, set property tax assessments, or begin a new solid waste recycling program.[2]***

Database Integration

Maps and data associated with locations have been used throughout history by local governments for delivering public services, managing public resources, and setting public policy.[2] Most of these information resources are still stored in file cabinets and map drawers and used as paper records and products in city and county government offices. In addition, those property tax and other financial data that have been computerized during the past twenty years only acquire meaning when they are used with a map as a reference, and these data will often have to be manually transferred to maps for further review, display, and analysis. Huxhold[2] opened his recent book on Urban GIS with the following quotation:

> We have for the first time an economy based on a key resource that is not only renewable, but self-generating. Running out of it is not a problem, but drowning in it is.
>
> (Naisbitt, p. 24)[3]

This last statement indicates how information can (and should) be viewed as a resource by an organization (similar to people, money, and equipment) and why careful management will be required if it is to improve the effectiveness and efficiency of local government operations.

Wednesday, September 12, 2007.max

Geographic Information Systems combine map and attribute data (Figure 1) and afford local governments new opportunities for integration in that these data can be processed together as a single product with little manual intervention. Hence, these systems can be used to integrate information from many different sources (e.g., the engineering, finance, and planning departments) and at many different levels of responsibility (i.e., the operations, management, and policy levels) in an organization. This integration is possible because ***geography*** is a common reference used by virtually every activity in local government, whether it to be to find a water main valve, set property tax assessments, or begin a new solid waste recycling program.[2]

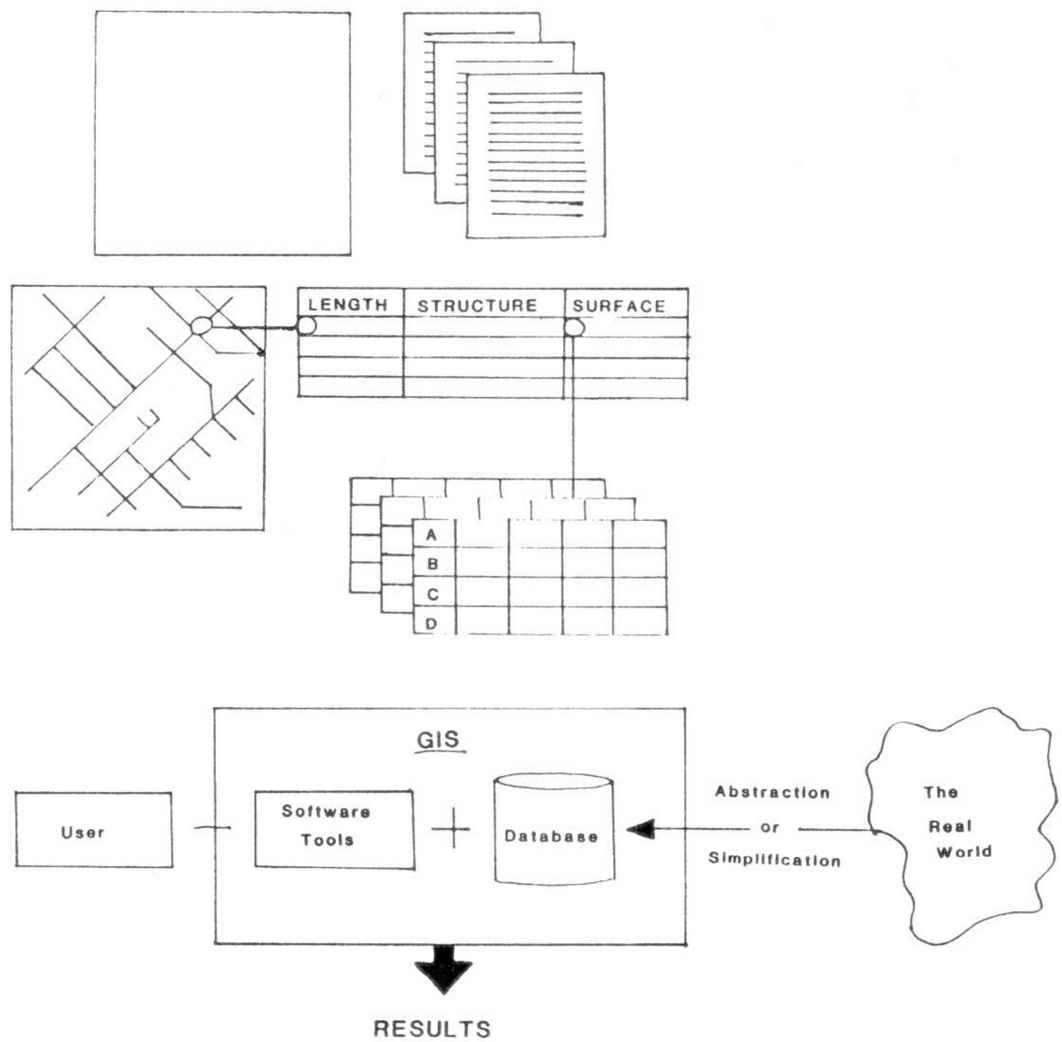


Figure 1: Components of a modern GIS. [4]

Most GISs store attribute data in a series of relational database tables. The records can be combined so long as a common item exists in two or more tables. A property tax identification code is often used for this purpose in local government GIS applications (Figure 2). The spatial or map data are usually stored in some proprietary format, although these data can be linked with the tabular data based on a common item as well. There are two choices: (1) adding an item to the spatial data, or (2) adding one of the items from the spatial data to one of the tables with your attribute data. The first option is

Wednesday, September 12, 2007.max

illustrated in Figure 2 where an item representing a property tax identification code has been added to the four default items generated by PC ARC/INFO[5] when topology is constructed.

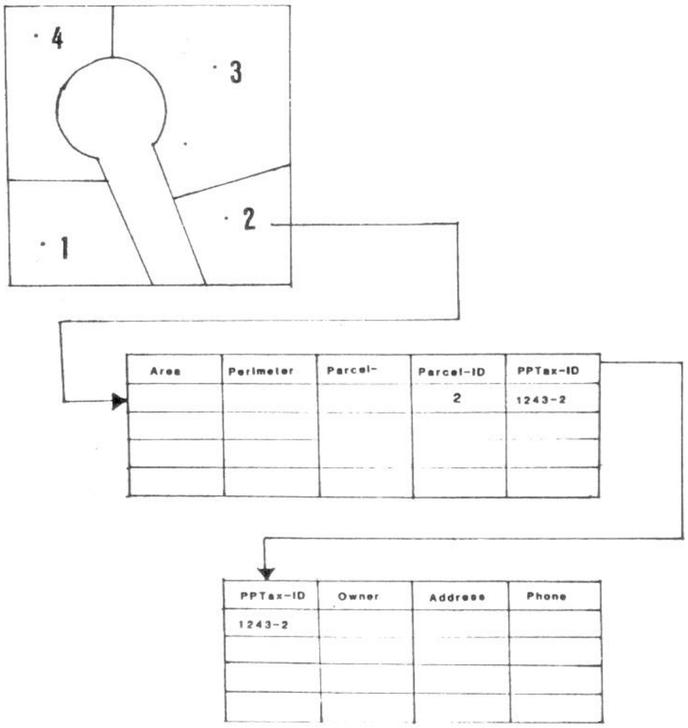


Figure 2. Relational database structure used by PC ARC/INFO[5].

The presence of these common items means that the records in two or more tables can be permanently or temporarily joined based on the values of the common item. This capability means that database queries can be implemented via the spatial features or the tabular database items. Hence, we can query the attribute data to identify all of the land parcels with delinquent property taxes and color a map of land parcels accordingly. Alternatively, we could point to one or more features (i.e., land parcels) in the spatial database and obtain key information such as the name, address, and telephone number of the landowner(s).

Modern Coordinate Systems

The locations of the features stored in the database must be accurately recorded in terms of their real-world positions to perform the spatial operations described in the next section. Their locations can be recorded in global coordinates (latitude, longitude) or planar coordinates (e.g., State Plane feet or Universal Transverse Mercator (UTM) meters) although both types of system imply the existence of a survey control network and the ability to convert measurements (e.g., distances and directions) to locations measured in at least one of these coordinate systems.

This requirement is often a problem for small cities and rural counties because they: (1) lack a survey control network, and (2) use a local coordinate system. A considerable effort is required to establish a control network and record the locations of important features in some modern coordinate system prior to GIS implementation in these instances. The two papers by Magnant et al. and Breckenridge which appear later in this special issue discuss some of the options as well as the importance of this task in greater detail.

Spatial Analysis Tools

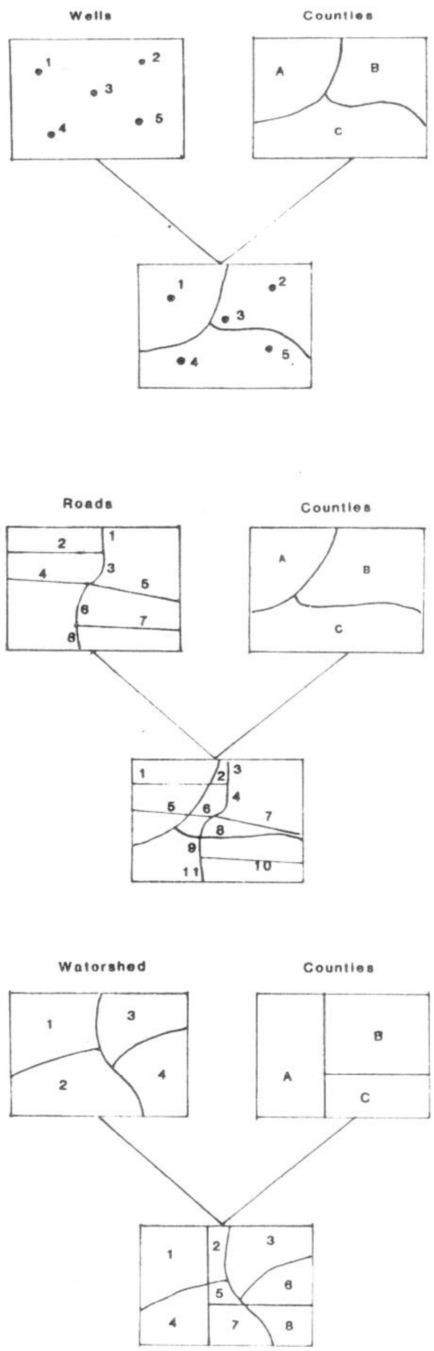
Most successful GIS applications utilize geographically-referenced data as well as non-spatial data and include operations which support ***spatial analysis.*** Two database models are commonly employed: (1) the raster GIS divides the world into a series of pixels or cells, and (2) the vector GIS represents the world as a series of points (nodes), lines (arcs), and areas (polygons). The latter database model will usually be required for GISs that are constructed from land records and applied to city and county government. However, it is the ability of GIS to perform ***spatial operations*** (overlays, buffers, etc.) rather than the choice of database model that distinguishes GIS from the other computer programs (spreadsheets - Lotus 123, Quatro, etc.; statistical packages - Minitab, SAS, SPSS-X, etc.; and drafting packages - MacPaint, AutoCAD, etc.) which also utilize spatial data.[4] Overlay and buffering capabilities are found in most GIS software packages and they are used here to illustrate some of the spatial operations that can be implemented to assist local government.

Topological overlay is the general name given to the procedure in which two or more data layers are

Wednesday, September 12, 2007.max

combined and then planar enforced. The rules of planar enforcement are required in most vector GISs and mean that new intersections are computed and created wherever two lines cross and that lines crossing area objects create at least two new area objects when overlays are performed. These rules ensure that the relationships between the different geographic features and their non-spatial attributes will be updated for the new, combined maps that are created when one map is overlaid or superimposed over another map.

Figure 3 illustrates the point-in-polygon, line-on-polygon, and polygon-on-polygon overlays that can be performed in a vector GIS. A point coverage showing water wells was overlaid with a polygon



ID	Owner
1	Dickinson
2	Murray
3	Smith
4	McBran
5	Harris

ID	County
A	Park
B	Gallatin
C	Madison

ID	County	Owner
1	Park	Dickinson
2	Gallatin	Murray
3	Gallatin	Smith
4	Madison	McBran
5	Madison	Harris

ID	Highway
1	35
2	22
3	35
4	60
5	60
6	35
7	82
8	35

ID	County
A	Park
B	Gallatin
C	Madison

ID	Original	Highway	County
1	2	22	Park
2	2	22	Gallatin
3	1	35	Gallatin
4	3	35	Gallatin
5	4	60	Park
6	4	60	Gallatin
7	5	60	Gallatin
8	6	35	Gallatin
9	6	35	Madison
10	7	82	Madison
11	8	35	Madison

ID	Status
1	Natural
2	Natural
3	Controlled
4	Controlled

ID	County
A	Park
B	Gallatin
C	Madison

ID	H2o ID	County ID	H2o Status
1	1	A	Natural
2	1	B	Natural
3	3	B	Controlled
4	2	A	Natural
5	2	B	Natural
6	4	B	Controlled
7	2	C	Natural
8	4	C	Controlled

Figure 3: Point-in polygon (a), line-on-polygon (b), and polygon-on-polygon (c) topological overlays.[7]

coverage showing county boundaries to produce a new composite map and attribute table showing both sets of features (wells and counties) in Figure 3A. A line coverage representing a road network was overlaid on a polygon coverage showing the same county boundaries to produce a new composite map and attribute table showing both sets of features (road segments and counties) in Figure 3B. Notice in this example how the lines (roads) were broken at each area object (county) boundary and that the number of output lines (road segments) is greater than the number of input lines (roads). The final example in Figure 3C shows what happens when one area object layer (watershed boundaries) is overlaid on another area object layer (county boundaries). Notice again how the boundaries are broken at each intersection and how the number of output areas (watershed/county combinations) is greater than the total number of input areas (watersheds and counties).

Buffers can also be constructed around points, lines or areas in a vector GIS to create new areas that enclose the buffered objects (Figure 4). Some GISs give the user the option of using one of the attributes of the object to determine the width of the buffer. Hence, the type of street (major, secondary, tertiary) might be used to buffer residential buildings away from a street network (using setbacks of 600 feet for a major street, 200 feet from a secondary street and 100 feet from a tertiary street, etc.). Buffers can help with numerous local government tasks; for example, they can be used to find the names and addresses of all of the property owners who own property that is located within a certain distance of one or more land parcels. The owner of these parcels may have applied for a zoning variance and the city may have a legal obligation to notify surrounding landowners of a public meeting and/or comment period in these circumstances. GIS can speed up and reduce the likelihood of errors in this example so long as the buffer and subsequent queries are properly formulated and the appropriate databases are regularly updated.

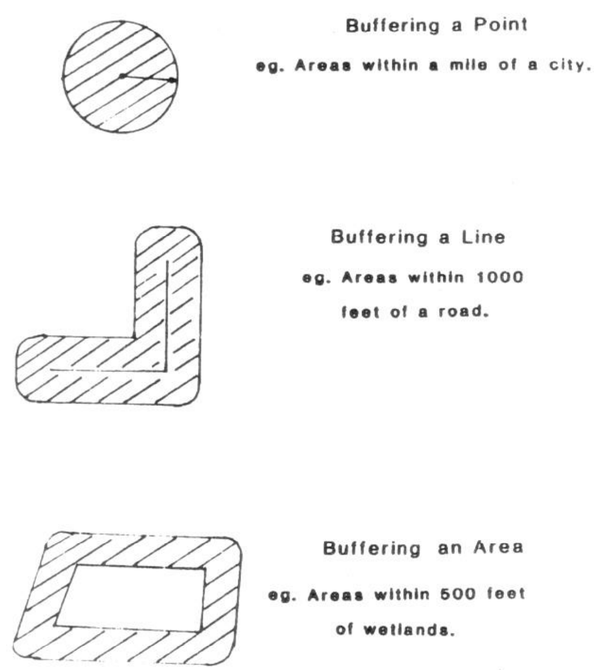


Figure 4: Buffering examples.[7]

Finding the Best Site for a New Park: An Exemplary Application

The number and variety of local government GIS applications can be increased as more and more data are brought into a GIS format and the analytical tools described above are applied to those data. Table 1 covers several pages and shows how street and stream data layers can be used in conjunction with the overlay and buffering tools in PC ARC/INFO[5] to choose the location for a new city park.

Wednesday, September 12, 2007.max

1. Establish the objectives and criteria for analysis

State clearly what you want as follows:

"Site must be easily accessible from major highways, yet must not be located too close to highways in order to minimize noise levels and other disturbances"

"Site should be designed around small, natural streams"

2. Prepare the data for spatial operations

Identify and prepare data for analysis; this may necessitate adding items to a coverage as follows:

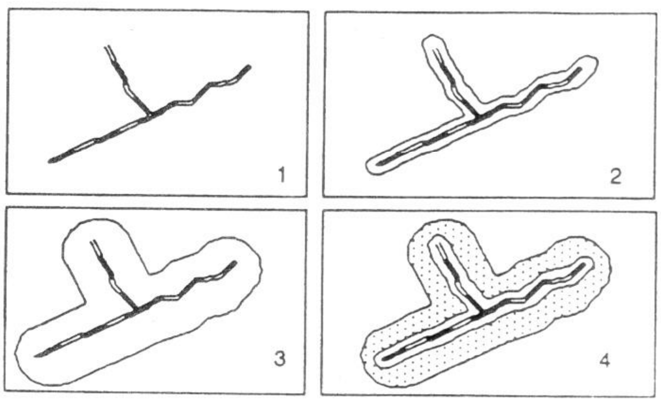
Identify major highways in roads coverage
Add item to streams coverage to identify class value

3. Perform spatial operations

This is the crux for using a GIS and in this instance it involves translating the problem statement into a series of ARC/INFO commands as follows:

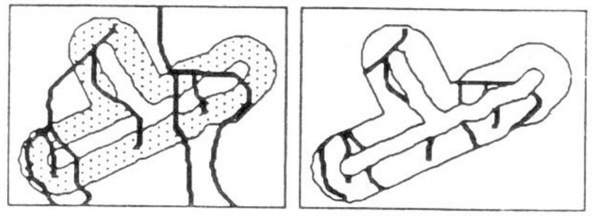
"Site must be easily accessible from major highways, yet must not be located too close to highways in order to minimize noise levels and other disturbances" can be translated into the following series of spatial operations:

1) define major highways in study area
2) generate a half-mile buffer (2,640 feet) around major highways
3) generate a two-mile buffer (10,560 feet) around major highways
4) erase the inside of the wide buffer using the narrow buffer



"Site should be designed around small, natural streams" can be translated as:

intersect (a type of overlay) a line coverage of streams onto the results of the buffer coverage generated above to identify only those stream segments which are within the desired distance of the highways.



4. Perform tabular analysis

May need to add items that combine information for previously separate coverages

Add an item SUITABILITY to the overlay output coverage

Determine logical expressions that segregate your results into necessary categories as follows:

"Site must be easily accessible from major highways, yet must not be located too close to highways in order to minimize noise levels and other disturbances" can be translated from the results of the two buffer zones around major highways so that:

Only sites within the areas defined by the buffers will be considered for further analysis

"Site should be designed around small, natural streams" can be translated as follows:

Select all streams which fall within the buffer zones whose CLASS value is 2. The value 2 for CLASS might represent small first- and second-order streams which have characteristics desirable for a new park site. Calculate suitability to be 1.

5. Evaluate and interpret the results

Are the results meaningful? Are the results what you expected? Do you need to prepare your data differently? For the park example described above the conclusion might be:

"The results of the analysis match the expectations of resource specialists. The selected sites contain areas that they think are suitable for new park sites."

6. Refine the analysis as necessary

GIS makes this step <u>much</u> easier; the planner could rework the process beginning anywhere from Steps 1 through 5

7. Produce final maps and tabular reports summarizing the results

Use PC ARCPLOT to create maps; TABLES or dBASE for reports

Table 1: Geographic Analysis Steps Required to Choose a New Park Site.[6]

This example is useful because it illustrates several important features of GIS. First and foremost, the first three steps in Table 1 show how the GIS Specialist must translate the objectives specified by the City or County Commissioners into a series of criteria that are used in the GIS analysis. This portion of the analysis demonstrates how the elected officials specify what kind of park is needed and the GIS is used to accelerate or improve the chances of finding one or more sites that satisfy these criteria. The GIS staff can only do their job if they find or generate the appropriate data and perform the spatial and tabular database operations that will be required to identify one or more sites. Notice as well in this example how new items are added to several attribute tables (i.e., in Steps 2 and 4) and how topological overlays and buffers were used to identify those land areas which satisfied the criteria laid down by the City Commissioners. The fifth and sixth steps demonstrate two additional advantages of GIS for decision-making in that the implementation of GIS makes it much easier to: (1) track the rationale and method that was used to make a particular decision, and (2) vary the criteria and perform the analysis again in those instances in which no "suitable" sites were identified the first time. The final step highlights another important benefit of database automation given that a good GIS can also be used to produce multi-colored maps and tables for final reports once the analysis is completed.

Final Remarks

A Geographic Information System is a particular type of information system that can be applied to geographical (spatial) data. It is not surprising, therefore, to find that GIS is commonly applied to help with the management of land and other resources, transportation, retailing and other spatially-distributed entities, and that the connection between the elements in the system is geography (i.e., location, proximity, spatial distributions, etc.). The observations by Huxhold and others that geography is important to 80% or more of the information managed and utilized by local governments indicates how and why this technology is suited to local government applications[2]. The three papers which follow describe the initial attempts of three Montana cities and counties to turn this potential into reality.

Notes

[1] J.C. Antenucci, K. Brown, P.L. Croswell, and M.J. Kevany, "Geographic Information Systems: A Guide to the Technology", (New York: Van Nostrand Reinhold, 1991).

[2] W.E. Huxhold, "An Introduction to Urban Geographic Information Systems", (New York: Oxford University Press, 1991).

[3] J. Naisbitt, "Megatrends", (New York: Warner Books, 1982).

[4] D.W. Rhind, "Why GIS?", ArcNews, 1989, Vol. 11(3): 28-29.

[5] Registered trademark of Environmental Systems Research Institute, Inc., 380 New York Street, Redlands, CA 92373.

[6] Extracted from the Introduction to PC ARC/INFO course materials with the permission of Environmental Systems Research Institute, Inc., 380 New York Street, Redlands, CA 92373.

[7] Adapted from diagrams, in Goodchild, M.F. and K.K. Kemp (ed.), "GIS Core Curriculum", (Santa Barbara: University of California, National Center for Geographic Information and Analysis, 1990).

Wednesday, September 12, 2007.max

MONTANA
Policy Review

CONSTRUCTING GIS BASE MAPS FROM EXISTING DATA SOURCES: THE BOZEMAN EXPERIENCE

Jackie Magnant and Sandy Palakovich:
Computer Specialists, Local Government Center
John P. Wilson: Professor of Geography, Dept. of Earth Sciences Director, Geographic Information and Analysis Center, Montana State University, Bozeman

The development of a GIS base map is an expensive but crucial component leading to the successful implementation of a local government GIS. A suitable base map will: (1) maintain the spatial accuracy and relationships between features included on the layer, and (2) incorporate a coordinate system which references the features of interest to locations on the earth's surface. Two base maps were constructed from existing data products for the City of Bozeman and their usefulness and accuracy was examined using a combination of USGS map products and Global Positioning System (GPS) coordinates.

Local governments are continually being asked to improve services and reduce costs. The adoption of modern information systems may help to minimize duplication and increase the efficiency of their daily operations.[1] Geographic Information Systems (GIS) offer numerous opportunities in this regard because 85% of the activities and information handled by local governments involves geographically referenced data and the functions that can be accomplished with a GIS include everything from simple mapping to complex land use analyses, site selection, and hydrological modeling.[2]

The development of a GIS base map is an expensive but crucial component leading to the successful implementation of a local government GIS. The graduate research project described in this paper examined the potential of using readily available local government and United States Geological Survey (USGS) data products for building accurate and cost-effective base maps. Two base maps were constructed from existing data products for the City of Bozeman and their accuracy was examined using a combination of USGS map products and Global Positioning System (GPS) coordinates.

GIS Base Maps

A GIS base map can be defined as a graphical representation at a specified scale of selected fundamental map information.[3] These maps incorporate important information and provide a framework on which additional map layers can be compiled and attached. A suitable base map will: (1) maintain the spatial accuracy and relationships between features included on the layer, and (2) incorporate a coordinate system which references the features of interest to locations on the earth's surface.

Wednesday, September 12, 2007.max

of accuracy required for such a base map. Some analysts have argued that real-world entities must be represented to sub-meter levels of accuracy for GIS to serve local government needs.[4] Others have argued that engineering accuracy of this nature is not essential, and that such stringent accuracy requirements will only impede GIS implementation by driving up the cost of base map creation.[1] This debate is important because the consequences of a spatially inaccurate base map can be far-reaching and costly if errors are replicated when additional layers are developed from or overlaid on the base map.[5]

Digital base maps can be constructed with a GIS in one of three ways: (1) conversion of existing paper maps using a digitizer or a scanner, (2) development of new planimetric base maps from orthophotos, and (3) development of new cadastral base maps with coordinate geometry (COGO) software and surveying measurements.[6] Many communities favor the first alternative because of real or perceived budget constraints even though the choice of this option may have adverse long-term consequences:

> Nearly all potential users already have some kind of manual mapping system; for many users, it seems natural to use these existing maps as the base map foundation for a GIS. However, because most of the base mapping in many communities has been acquired by different departments for their own needs -- and because scales, accuracies, and mapping detail were not intended for universal applications -- existing mapping may not be adequate as a base map foundation for a GIS.[7]

This state of affairs suggests that the automation of existing maps may not guarantee adequate spatial accuracy nor a cost-effective database automation strategy for local governments. Our goal was to examine the data products used by the City of Bozeman and their potential usefulness in building a digital base map.

The City of Bozeman contains 25,000 people and is located in southwest Montana. It is typical of many small cities and counties in terms of management of data. Financial transactions and the accompanying data are handled by a Data Processing Department with the help of an IBM System 38 minicomputer and numerous PCs. Land records information is maintained and stored in offices at three different locations and consists of paper maps (drawn at a variety of scales), index cards, and paper files stored in map drawers and file cabinets. The maps all use a local coordinate system and there is currently no system of survey control points (benchmarks) available for a GIS base map or other software applications that require real-world coordinates.

The data resources maintained by the engineering and planning departments included two products used for the current study: (1) a road map digitized in AutoCAD[8] from the city's existing quarter section maps (Figure 1), and (2) 200 oblique black and white photographs obtained from a 1990 aerial survey at an altitude of 9,000 ft. (Figure 2).

Methods and Data Sources Used to Construct GIS Base Maps

The quarter section maps and aerial photographs were used with USGS 7.5 minute map quadrangles, GPS coordinates, and several different software packages to construct two GIS base maps. The final base maps were assembled and compared in ARC/INFO[9] because this software was able to accommodate the various data formats used for the different data base components.

AutoCAD Drawing

A digital copy of the AutoCAD drawing file was obtained from the City of Bozeman, converted to a DXF text file, compressed, and imported into ARC/INFO as a vector coverage. The double lines used to portray the streets in the AutoCAD drawing were

Wednesday, September 12, 2007.max

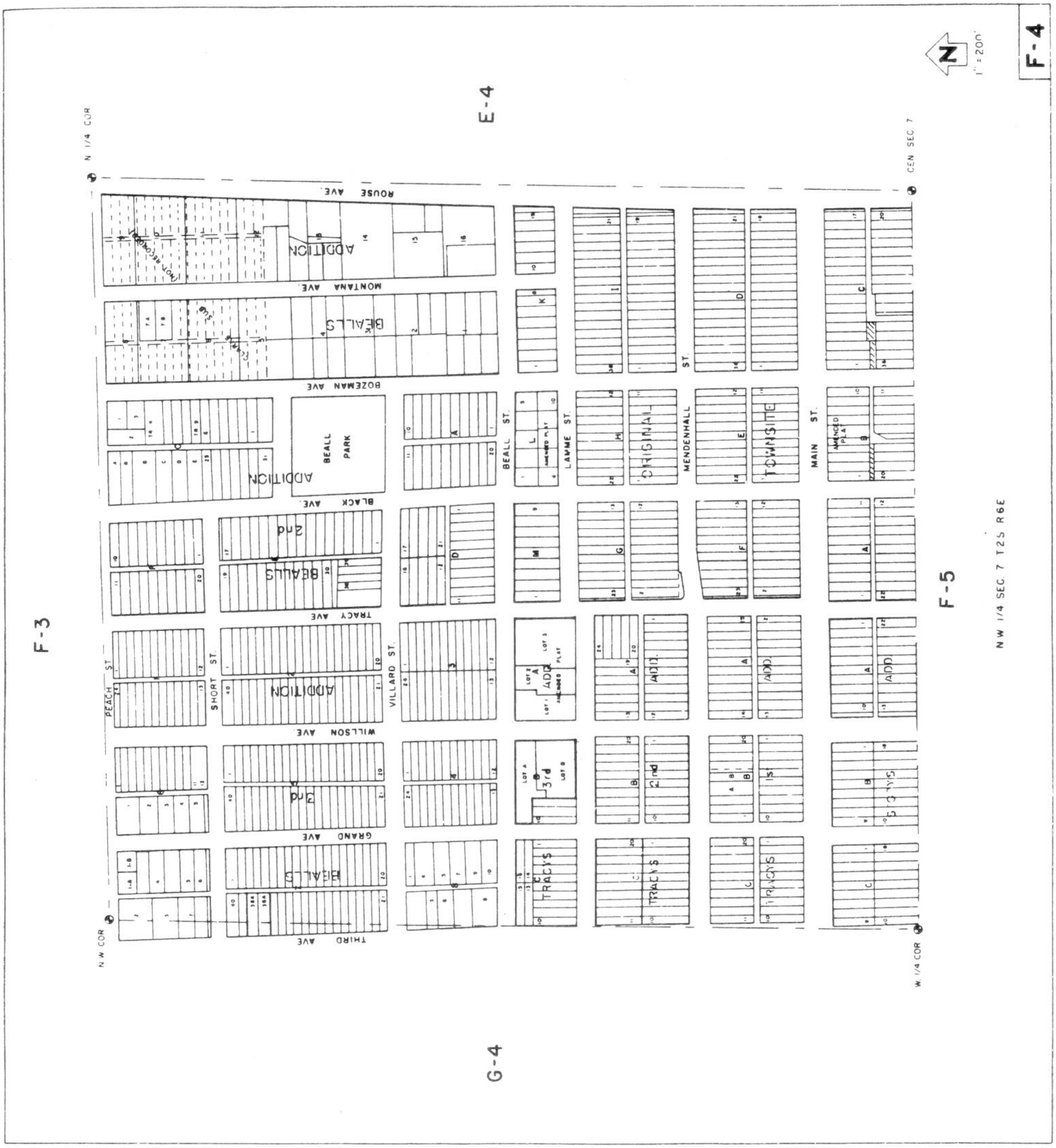


Figure 1: Sample Bozeman quarter section map.

Wednesday, September 12, 2007.max

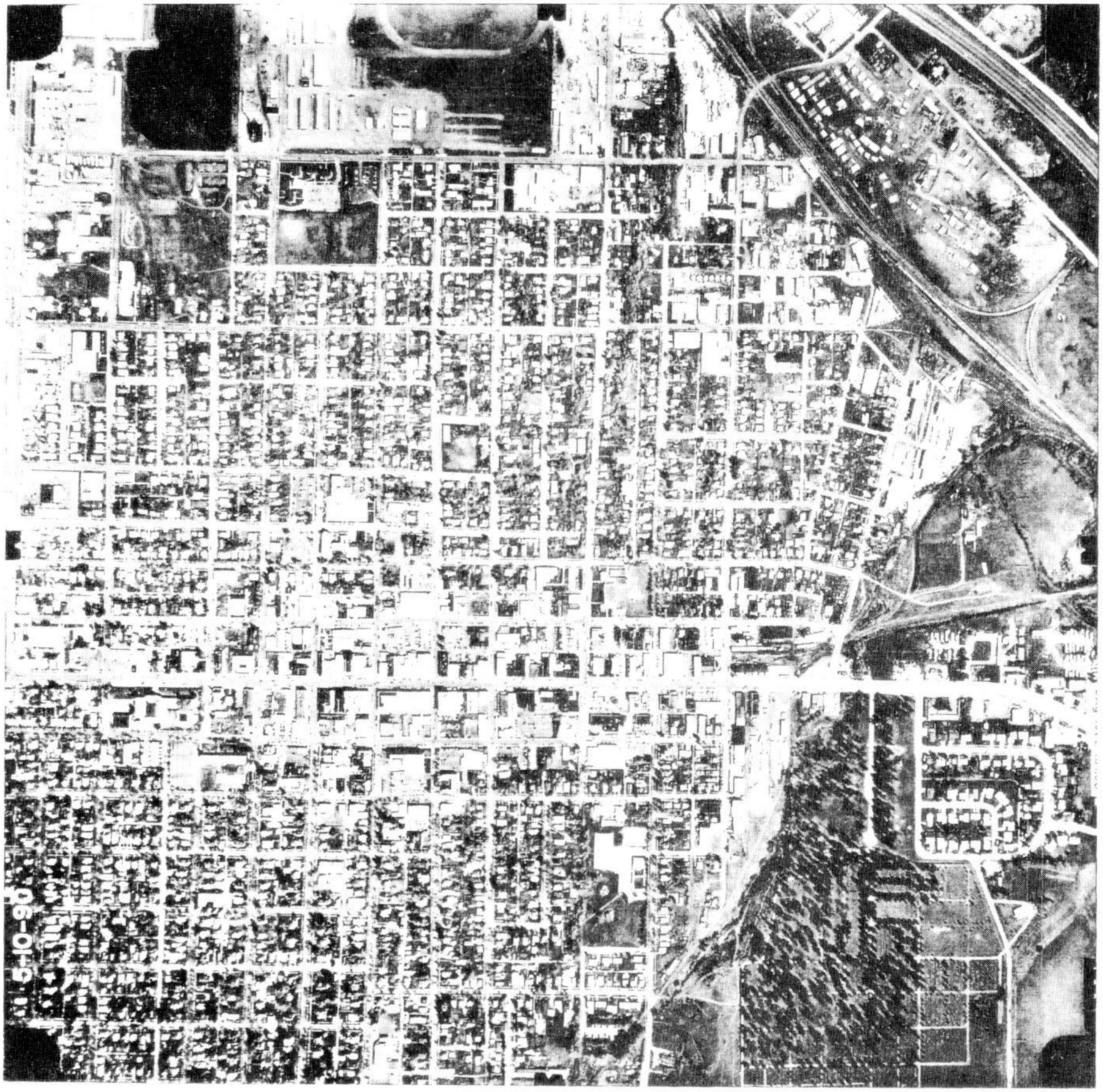


Figure 2: Sample oblique aerial photograph.

Wednesday, September 12, 2007.max

saved as line features when the DXF file was imported into ARC/INFO. Real-world coordinates were later added to this coverage using information extracted from the USGS map quadrangles and the GPS coordinates collected by the authors. The original AutoCAD drawing was based on quarter section maps which used a local coordinate system (see Figure 1 for sample quarter section map).

Digital Aerial Photograph Mosaic

The 200 standard 9 in. by 9 in. black and white aerial photographs were taken with a standard 6 in. lens at an altitude of 9,000 ft. in May of 1990 (see Figure 2 for example). The photographs came with an index that was compiled by placing the negatives over the 1:24,000-scale USGS 7.5 minute Bozeman map quadrangle. Digital versions were obtained by scanning the aerial photographs with a Houston Instruments LDS 4000 scanner operating in greyscale mode at a resolution of 400 dots per inch. This procedure generated 9 MB TIFF images (one for each aerial photograph) and provided an accuracy level of ±0.25% on both axes so long as the photos were scanned within ±5°F of the calibration temperature. Scanning the aerial photographs yielded the same features on the screen as in the image. Some additional processing was required so that the images provided an accurate backdrop for a geometrically corrected base map.

The level of success and difficulty encountered rectifying oblique aerial photographs depends on the amount of overlap between adjacent photos:

> One technique of planning flight alternatives which has been successfully used (e.g., Riverside, California) is 60% sidelapped photography. Although this is more expensive because (it generates) nearly twice the number of photographs, the results are excellent because only the central portion of each photo is used for ortho-rectification, so there is far less outward radial displacement of building roofs and elevated bridges, and less radiometric variation across each image. Using 60% forward and sidelap, the resulting aerial triangulation solution is extremely strong because each passpoint is measured on as many as nine different photographs.[10]

We were fortunate that the Bozeman photos contained 60% overlap and removing all but the very center of the photo was easily accomplished by cropping and rectification with the Image Integrator in ARC/INFO. The cropping process also reduced the size of the image files by approximately 67% (to 2-3 MB per image). The clipped photos were assembled into a single photomosaic in ARC/INFO, and the information extracted from the USGS map quadrangles and the GPS data collected by the authors was used to assign real-world coordinates to this composite photomosaic (as discussed below).

USGS Mylar Separates

The accuracy of GIS products depends on the requirements of the user, the characteristics of the source document, and the instruments used to create that document.[11] The 1:24,000-scale USGS 7.5 minute topographic map series is often used for natural resource planning at local and regional levels due to its low cost, availability, cartographic detail and extensive geographic coverage.[5] These maps provide 10 m 3-dimensional positional accuracy for well-defined features[10] and selected themes (representing cultural features, hydrology, transportation routes, UTM grids, etc.) can be purchased from the USGS as mylar separates or composites that are amenable to scanning.

A 7.5 minute Bozeman mylar composite with cultural features, hydrography, transportation and the UTM grid was purchased from the USGS, and scanned with the same Houston Instruments scanner used for the aerial photographs. Scanning the mylar product offered the advantages of increased speed and higher accuracy compared to manual digitizing of paper maps. The raster coverage produced with the scanner was then recoded and converted to a vector coverage (format) in ARC/INFO. The vector coverage was then projected to the UTM coordinate system using the 1927 datum. This datum was chosen because most of the city's maps are in

Wednesday, September 12, 2007.max

this datum and conversion to the 1983 datum would have required full implementation of a GIS.

The cropped images were registered and rectified with the digital version of the 7.5 minute Bozeman mylar composite. Four data themes were used in the rectification process because the accuracy of the affine transformation performed in ARC/INFO is directly proportional to the number of points used to register the aerial photos to the scanned USGS composite. ARC/INFO computes a Root Mean Square Error (RMSE) term and this can be used to measure the precision of the transformation. The number of registration points used for each image ranged from 4 to 8 and was set to the minimum number of points required to achieve an RMSE of 1.5% or smaller. Some of the same registration points used to rectify the photomosaic were marked on the AutoCAD drawing (road map) and used to register this map as well.

The AutoCAD map could now be compared with both the photomosaic and USGS mylar composite. A series of overlays were prepared in ARC/INFO to identify any discrepancies between the locations of the features depicted in the two vector maps and the photomosaic. The source of the errors could not be determined because: (1) the aerial photographs and AutoCAD map were both registered to the USGS mylar composite, and (2) the USGS composites incorporate locational errors that are only quantified in general terms for individual USGS map products.

GPS Survey Coordinates

Global Positioning Systems (GPS) can be used to establish precise ground control networks and evaluate the error present in existing data products.[12] GPS coordinates were collected at 11 benchmarks that were strategically located throughout the city for this study. A static survey was conducted with a base station whose position was determined from GPS observations by two independent Order B stations located within 3 mi. of Montana State University's Leon Johnson Hall (the base station receiver is located on the top of this eight story building) and an Ashtec Dimension receiver. The use of a surveyed base station and one receiver meant that all 11 benchmarks were measured to within 3 ft. of their actual locations. The GPS coordinates were converted to a point coverage and used to assign real-world coordinates to the roads coverage and photomosaic in ARC/INFO. The USGS- and GPS-versions of these two base maps were then overlaid in ARC/INFO to determine the magnitude of the errors present in the USGS mylar composite.

The Final GIS Base Maps

The value of the roads and photomosaic base maps depends on their information content and accuracy. The roads coverage was prepared from quarter section maps and shows the street network in the City of Bozeman (Figure 3). This coverage could be used for transportation planning studies, network analyses (routing emergency vehicles, school buses, etc.) and infrastructure management applications. The number and variety of applications could be easily expanded if additional features and attributes (street names, traffic signals, traffic flows, address ranges, surface conditions, culverts, etc.) were added to this database.

The photomosaic reproduced in Figure 4 could serve these functions and more. A road centerline coverage could have been generated with the editing tools available in ARC/INFO directly from the digital photomosaic. Additional transportation features and attributes could have added to this coverage (similar to the ARC/INFO roads coverage derived from the AutoCAD drawing). The photomosaic might also be used to generate water and sewer line coverages and determine the locations of buildings, fences, trees, hedges, and creeks in relation to streets, administrative boundaries (zoning districts, special improvement districts, tree maintenance districts, etc.), and possibly property lines. Finally, the photomosaic can also be used to update those features in a GIS database (new streets, roads, buildings, land use changes, etc.) that are visible in the photographs:

Wednesday, September 12, 2007.max

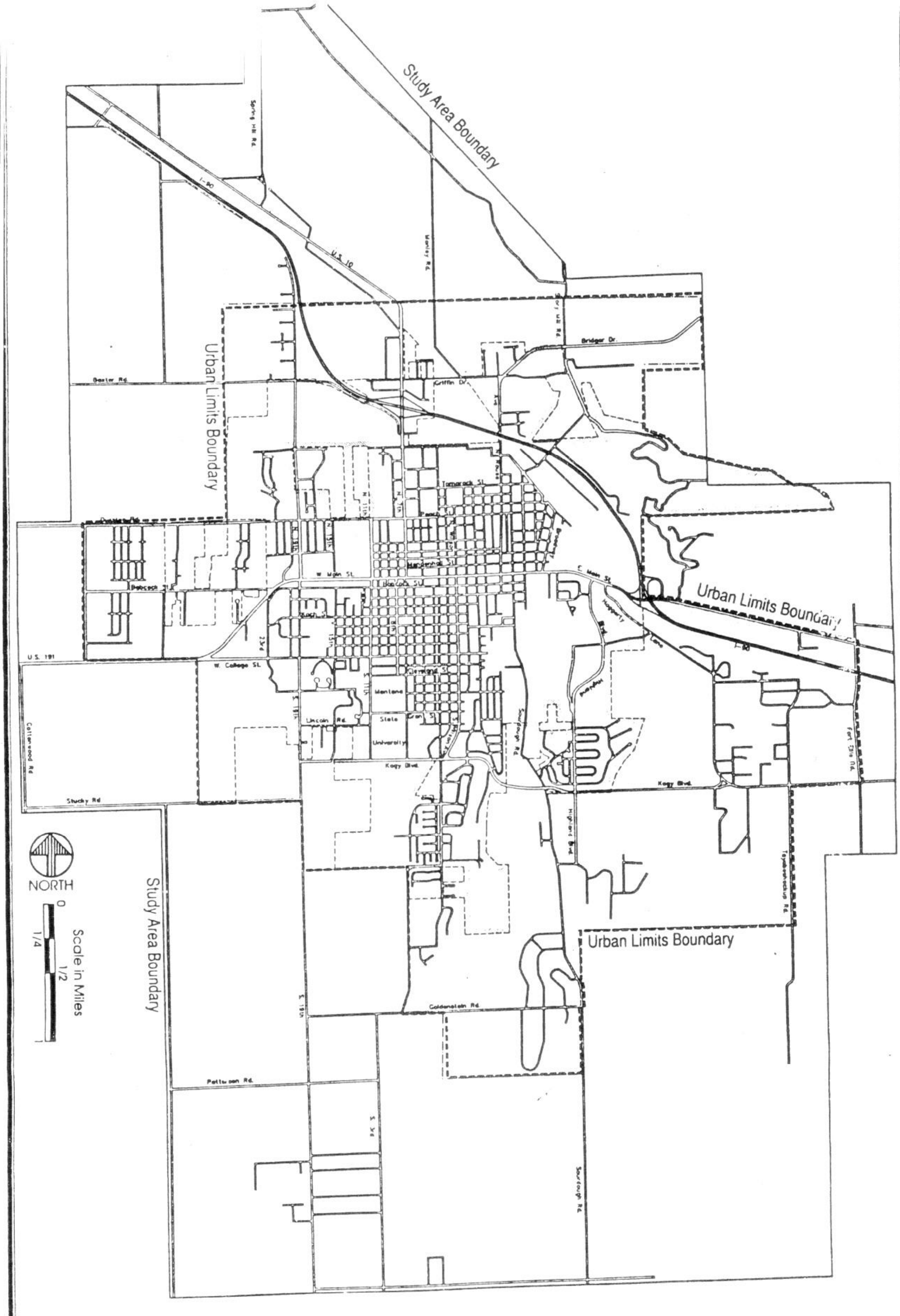


Figure 3: City of Bozeman roads coverage constructed from AutoCAD drawing file.

Wednesday, September 12, 2007.max

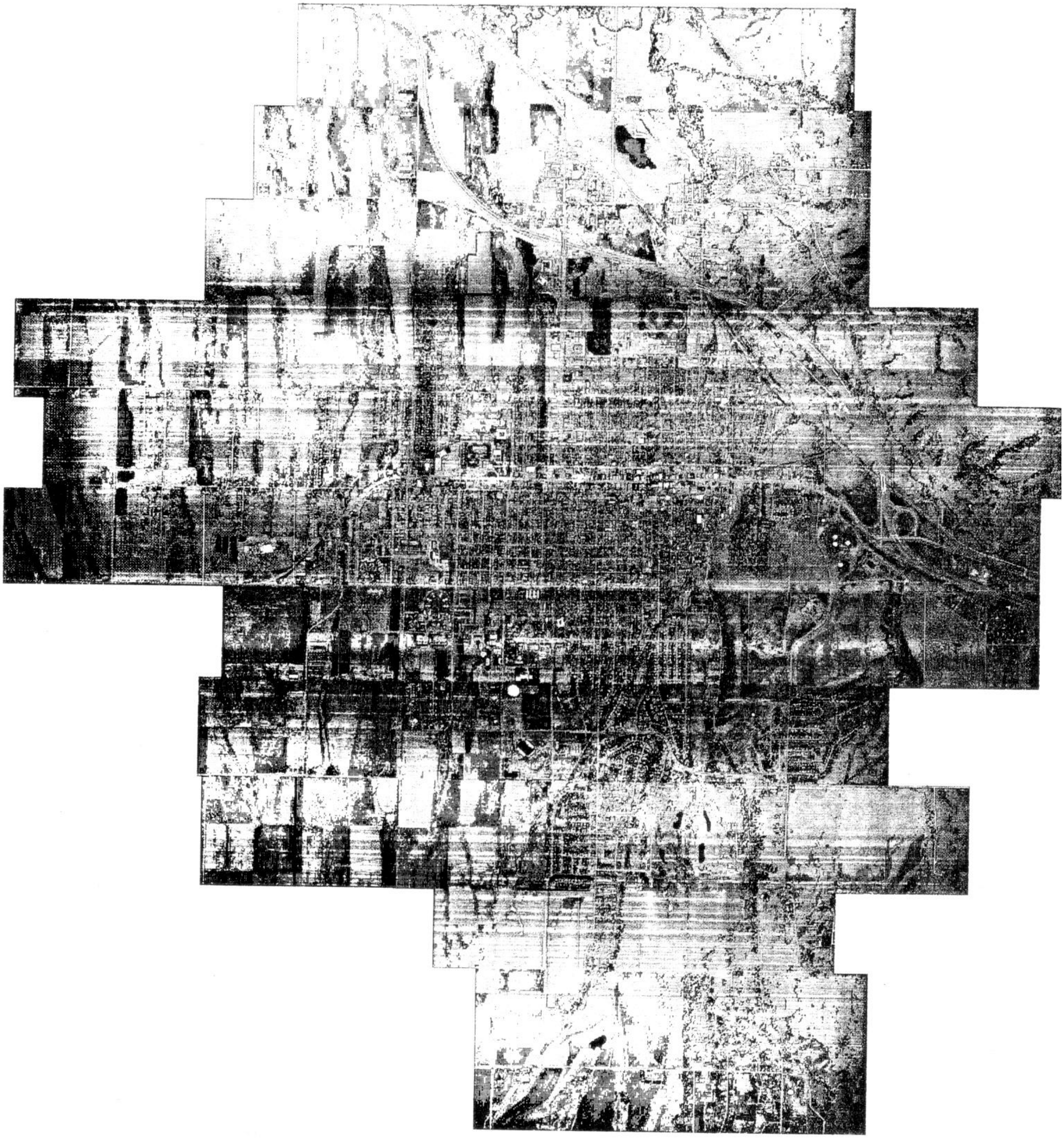


Figure 4: City of Bozeman photomosiac.

Wednesday, September 12, 2007.max

> Superimposition of the vectors on top of the stereo image in a stereoplotter has been possible for some years, but the hardware and software requirements have made it expensive and its usefulness and cost effectiveness for original map compilation is debatable. However, for map updating or revision, superimposition is essential as it affords the best means of viewing the old map superimposed upon the new photography, giving the technician a powerful tool in seeing what changes need to be made.[10]

The value of the two base maps reproduced in Figures 3 and 4 is also affected by the accuracy with which the real world locations of the features are represented in the base maps. The variation between the USGS and GPS latitude/longitude coordinates ranged from 20 to 60 ft. However, there were no consistent trends (north, south offsets, etc.) and the mean variation of 20ft is well within the ± 10 m published limits for 7.5 minute USGS map quadrangles noted by Colvocoresses.[10] There were numerous discrepancies between the locations of the roads represented in the AutoCAD coverage and those depicted in the photomosaic. The roads aligned in a north-south direction showed the greatest variation with respect to their locations on the two maps.

The spatial extent of the photomosaic prepared for this study (Figure 4) was constrained by: (1) the lack of features that were visible in the photos and the USGS mylar composite to the west and south of the city, and (2) the rolling topography of the [illegible] Hills and Bridger Range to the east and north of the city. The availability of GPS coordinates for the features visible in the aerial photographs and the use of an analytical stereoplotter (as advocated by Colvocoresses in the last quotation) could have reduced one or other or both of these problems.

Conclusions

This pilot project showed that: (1) the roads coverage and photomosaic could both be used for local government applications that do not require submeter accuracy, and (2) that USGS mylar composites can be used to assign real-world coordinates to these data layers (if necessary) and that this approach represents an excellent way to develop an initial base map which can be updated as GPS coordinates become available. In addition, the roads coverage could have been generated directly from the USGS transportation mylar separate instead of the city's quarter section maps. However, the quarter section maps are updated more frequently than the 7.5 minute USGS map series and roads coverages prepared from these local sources could therefore be expected to require less editing (to add new streets and other improvements) than those prepared from USGS mylar separates. The photomosaic may be superior to both of these sources given that: (1) they can support a larger number of applications and (2) sequential photographs offer numerous opportunities for updating GIS coverages over time.

Notes

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Wednesday, September 12, 2007.max

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[8] Registered trademark of AutoDesk, Inc., 2320 Marinship Way, Sausalito, CA 94965.

[9] Registered trademark of Environmental Systems Research Institute, Inc., 380 New York Street, Redlands, CA 92373.

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Wednesday, September 12, 2007.max

MONTANA
Policy Review

BUILDING A COUNTY GIS THROUGH INTER-GOVERNMENTAL COOPERATION

Rick Breckenridge
GIS Specialist, Flathead County, Kalispell, MT

The purpose of the Flathead County GIS is to provide a series of integrated software and database solutions to help manage growth. The association of the database to the parcel graphic is accomplished using GEO/SQL Version 4.02. GEO/SQL ties together a graphics package, Autocad, with a database, Oracle. Since we are managing two very different types of data, spatial and relational, GEO/SQL defines the links between the records in the relational database table and the spatial database objects. This renders the capability for these structures to work together to store, manage, and provide access to graphic and SQL data.

Starting a GIS is every county administrator's visionary tool when attempting to forecast the future needs of an ever-expanding population. Flathead County, which contains or borders Flathead Lake, Glacier National Park and the Bob Marshall Wilderness, is one of the fastest growing areas in the nation. This influx of new residents threatens to overwhelm the county's ability to provide infrastructure and services. Public officials need to be able to process a large number and variety of data to predict future needs and allocate resources.

Susan Haverfield, Clerk and Recorder for Flathead County, started taking a serious look at GIS technology when the county began an emergency evacuation notification exercise at Glacier International Airport. This effort required that the plat room look up each affected parcel in the land record books so that every owner within the evacuation area could be properly notified. This task took twenty person days to accomplish manually. Haverfield recognized that the land owners could have been identified in just a few hours with a GIS.

Realizing the enormous task at hand, Flathead County hired a consultant to: (1) conduct a needs assessment, (2) perform a pilot study, and (3) provide hardware/software recommendations. The county initially expected to be able to incorporate GIS information from Flathead National Forest and the National Park Service. This strategy was rejected after analyzing their information and realizing that the county needed a parcel-specific base map. This conclusion meant that the design of the Flathead County system would have to start from the ground up.

Positioning Geographic Features in Real World Coordinates

Flathead County was a remote, sparsely populated area (until recently) and as such, National Geodetic Survey (NGS) control stations are few and far between. This situation was identified as a serious problem in the GIS needs assessment, and six precise GPS control points were

Wednesday, September 12, 2007 (2).max

pilot project. These results showed that lack of control was an important problem whose solution would help to determine the success or failure of the county-wide GIS implementation.

Several options emerged as potential control solutions. One alternative involved the establishment of an initial grid that would place geodetic coordinates on every township corner in the county. This solution would have required the county to get into the surveying business either by itself or by hiring a contractor. Another option would have been to require all certificates of surveys to tie into an accepted control station. However, both of these solutions would have incurred expenses that the county could not afford at present.

Knowing that the Bureau of Land Management (BLM) faced a similar problem with its Geographic Coordinate Data Base (GCDB) project, the county contacted the Montana State Office to discuss the feasibility of the BLM considering this area for adjustment. Dan Mates, Branch Chief of Cadastral Survey, and Michael Brown, GCDB Section Chief, took our proposal a step further as they had already adjusted 35 townships, placing latitude and longitude on all corners of the Public Land Survey System (PLSS) down to the sixteenth corners. The BLM gave Flathead County this information along with a complimentary copy of the GMM adjustment program. GMM is a least squares adjustment and blunder detection package that allows an in-depth analysis of survey measurements. By assigning weights to returned bearings and distances, an adjustor can display and analytically resolve the inherent surveying measurement errors that errors.

The Geographic Coordinate Data Base project provided an inexpensive alternative which could reliably provide the required geographic positions in a relatively short period of time when weighed against the time and expense involved in establishing a static GPS control net.

After the latest survey record on lines of the PLSS are entered, analyzed, re-weighted, and adjusted, positional tolerances are then computed. The positional tolerance for each point is based upon a Chi-square distribution at 95%. The computed positions were compared with the six points established by GPS in our pilot area off the NGS "Supernet" control network. The positional tolerances off the GMM computed points identified the geographic positions within an elliptical axis of approximately 25 ft. Hence, a maximum variation of 17 ft. was obtained for the six points used in the pilot study.

These results demonstrated that GMM was an inexpensive alternative which could reliably provide the required geographic positions in a relatively short period of time when weighed against the time and expense involved in establishing a static GPS control net. Figure 1 shows some of the water features and the control network for a small portion of Flathead County. The county estimates an initial savings of approximately $300,000 if the county would had contracted for GPS services to design and monument a densified, county wide network.

Constructing a Parcel-Specific Base Map

The purpose of the Flathead County GIS is to provide a series of integrated software and database solutions to help manage growth. With this stated objective and the design criteria established, it was a matter of engineering a system in keeping with these parameters. As planning is the primary concern, the accuracy and precision derived from GMM computed coordinates give the GIS a statistical standard well within the design criteria. It does not give nor is it a panacea for circumventing the established professional channels for land boundary or elevation determinations. This caveat must be stressed because it is susceptible to being misused for other than its designed purpose.

With the establishment of geographic positions throughout the county, a parcel specific base map can be constructed. Plat maps are run through a

Wednesday, September 12, 2007 (2).max

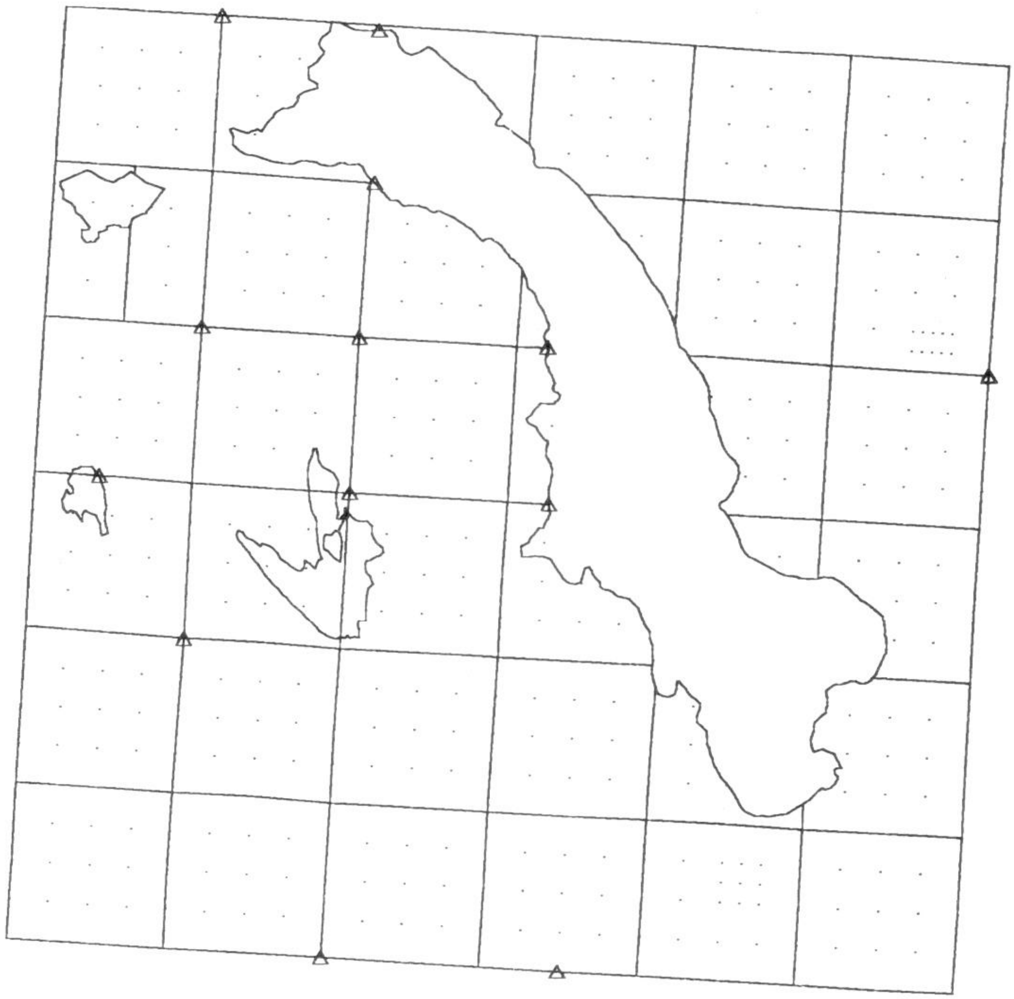

FIGURE 1: THE ADJUSTED FIGURE OF T31N, R22W. THE TRIANGLES DENOTE CONTROL LOCATIONS OF CORNERS OF THE PLSS DIGITIZED FROM USGS 7 1/2' QUADRANGLE MAPS. THESE POINTS PROVIDE THE NECESSARY GEOGRAPHIC POSITIONING FOR CONSTRUCTING THE COUNTY BASE MAP.

Calcomp scanner and then brought into a raster conversion program where the raster data is converted into a vector format. Digitizing of raster data is a simple and yet time consuming exercise because Flathead County has 1,776 plat maps. These maps show parcel breakdowns and the certificate of survey or subdivision with which the parcel was first delineated. Several staff are presently working to recreate the plat maps in the GIS with this process. Figure 2 shows the land parcel data for a portion of Flathead County. Any additional information that must be added to the map is appended within the GIS after the map is digitized. Regular maintenance will be required in the future to keep the spatial and tabular data current.

Wednesday, September 12, 2007 (2).max

ity control assurances posted, the graphics are ready to attach to the database. The county database on property specific information consists of four data sets. The Computer Services Department generates ASCII text files for townships upon request that are imported into EXCEL and parsed into fields. The common thread that runs through each of these data sets is the assessor number. Hence, the values in this unique assessor number column or field are used to join those records in the four initial data sets that relate to the same parcels.

One problem that surfaced during the pilot project was the need for a unique parcel identification system (MDR) has developed a geocode that is approximately 90% parcel specific. The adoption of this code offered Flathead County two advantages in addition to solving the parcel identification problem: (1) the data carried by MDR increased the information kept by Flathead County in certain fields, and (2) it provided greater quality control in other instances. The MDR data are also imported as an ASCII text file, converted to a dBase III format, and attached to the county database via a relational join. The final database is exported out into an Oracle table since Oracle serves as the relational database for the Flathead County GIS.

FIGURE 2: LAND PARCEL DATA FOR SECTION 31, T31N, R22W, P.M. IN FLATHEAD COUNTY

Wednesday, September 12, 2007 (2).max

ics is accomplished using GEO/SQL Version 4.02. GEO/SQL ties together a graphics package, Autocad, with a database, Oracle. Since we are managing two very different types of data, spatial and relational, GEO/SQL defines the links between the records in the relational database table and the spatial database objects. This renders the capability for these structures to work together to store, manage, and provide access to graphic and SQL data.

One reason a CAD-based approach was taken by Flathead County was the availability of local training through courses offered at Flathead Valley Community College. Training key personnel will be a major undertaking and a commitment by public officials to that training is one of the essential ingredients for the successful implementation of GIS in Flathead County.

GIS Data Utilization and Access

The county is also in the process of networking all departments together with some selected municipal governments via a fiber optic backbone. An agreement was reached with a local cable company to lash fiber optic cable on their pole space to an existing cable line. This fiber optic backbone gives all potential users the capability to work with the large graphics files that are associated with many GIS applications. Looking down the road, it also lends the county the ability to migrate to more powerful machines when that opportunity arrives.

Flathead County is also looking at making GIS information available publicly to users via computer modem. Realtors, appraisers, and land surveyors have already expressed an interest in using this service. This development would alleviate some of the pressure on the plat room staff since a majority of the records traffic comes from this sector. It will also cut our costs as updates could be sent out by electronic mail rather than by the conventional paper copy method.

Many factors, both intrinsic and extrinsic, lead to success or failure on a GIS project. Poor planning, misdirected emphasis, and occasionally even overplanning has led to high mortality rates among systems, especially in smaller municipalities where budgetary constraints are always a factor. The Flathead County GIS program has adopted a unique approach in building the county wide (5,137 sq. miles) base map. Incorporating elements from all strata of government has helped us to minimize duplication and make the best use of limited available resources. The Geographic Coordinate Data Base Measurement Management programs developed by the Bureau of Land Management and the University of Maine and parcel data maintained by the Montana Department of Revenue has helped to move this project from theory into a useable and expanding operation with immediate results and applications.

Training key personnel will be a major undertaking and a commitment by public officials to that training is one of the essential ingredients for the successful implementation of GIS in Flathead County.

We have to be careful to avoid extending the capabilities of a system beyond its designed use. Flathead County is developing its GIS to assist with the planning process. Precise points with survey grade tolerances are not of paramount importance at this juncture. Positional tolerances are accepted based upon current survey conditions and statistical analysis of those data. As with any adjustment process, the more control you have the better the results. This is an area in which Flathead County expects to be able to increase the geodetic control as well as the number and variety of applications as time, money, and opportunity allow. This technology should help Flathead County to improve the delivery of infrastructure and services in the immediate and longer term future.

Wednesday, September 12, 2007 (2).max

MONTANA
Policy Review

GIS/GPS IN A SMALL RURAL MONTANA COUNTY

Susan M. Parrott: Assistant Coordinator, Central Montana Resource Conservation and Development Area, Inc.
Monty L. Sealey: Executive Director, Central Montana Resource Conservation and Development Area, Inc.

The ability of GIS to be queried and have data displayed graphically has added a great deal of flexibility to the planning process. Issues are easier to conceptualize by public officials and citizens, which increases the odds of achieving consensus and making informed decisions. The Musselshell County GIS, with added GPS capability has proven to be a very effective tool for rural local governments, even though the full potential for applications in a small rural setting have not yet been tapped.

Imagine that you live in a rural, western county that is 1,900 square miles in size and home to 4,100 people. There are only two small incorporated towns and they contain about 50% of your total population. Nothing has really changed in the last 10 years; the population has stayed about the same.

You have just been elected County Commissioner. You are experienced at running a medium sized ranching operation. You are elected with the impression that you will primarily have to deal with the 700+ miles of County road, control noxious weeds and try to hold down mill levies for the citizens.

Suddenly, a major mining project is proposed in your county. It could increase your population by 15% in one year. Three separate new subdivisions also are being planned. A small manufacturing plant moves into town. Demands for additional services are already increasing. New roads and other improvements, additional bus routes and law enforcement capability, housing shortages, increased workloads in the courts and social services programs, shortages of sewer and water infrastructure suddenly emerge as items in need of attention. Few funds are available for these projects because of the initiative recently passed by the citizens to limit mill levies.

Several months before this scenario actually happened in Musselshell County, there was a regular meeting of a small group of citizens from a local development corporation.[1] That night's not too unusual conversation centered around a request to the group for a site to locate a development project, with specific required attributes to that site. At that meeting, along with countless other meetings in the past, a large research effort had to be conducted before any site could be recommended. Typical questions included:

Wednesday, September 12, 2007 (2).max

of land?

- Who owns it/can it be acquired?
- How much electrical power is available?
- Where? From Whom?
- What is the proximity to public water and sewers?
- What is the proximity to transportation facilities?
- Is the land surface (topography) conducive to development and drainage?
- In what taxation district is the parcel located?
- What is the availability of emergency services and communications?

The local development corporation, as with most organizations in a small rural community, is operated almost exclusively by volunteers. Each time a project or idea had to be researched we seemed to use up a lot of volunteer time. The availability of this time is very limited and we were often dissatisfied with the lack of progress. Multiple agencies and services had to be contacted time and again for information. We were using up our people resources with this redundant process and we lacked an effective mechanism with which to store and retrieve the data that we often had to deal with.

Because of that single meeting, the Musselshell County Planning Board was approached to see if they could find or create (1) a process to speed up the research phase of issues, or (2) a system to make basic information more readily available to decision makers.

The Planning Board took the charge and initially visualized a set of maps in book form, with mylar overlays for flexibility and additional narrative information about each map. The maps were intended to display existing situations and occurrences of resources and infrastructure in Musselshell County. Further efforts to define an acceptable format led to the discovery of automated GIS technologies that had existed, though in limited applications, for several years.

hardware and software, terminology, limitations, applications, cost, etc., followed next. The more that was learned about technical capabilities and options, the more local discussions focused on additional ways the GIS could be used: how accessible it could be and to whom; which activities could benefit from such a system in the next five years; and finally, what funding opportunities existed to pay for this technology. Additional questions focused on the data and sources that could be tapped; who could help get the project together; and how the database would be maintained? A major portion of project planning centered around software capabilities; how could it be used to add or change coverages; could it support queries; could tabulater databases be integrated with coverages; how steep was the learning curve; how well would it perform in a personal computer (PC) environment; what products can be produced.

To our knowledge, no GIS technical capability existed in Musselshell County. None of the Planning Board members had any experience with GIS applications, software options or system needs. The Planning Board made the decision to acquire software, hardware, base mapping and appropriate coverages and data by contracting the whole project through an RFP process. The "crash course" described above, along with discussions with local groups about needs and applications, set the stage for the development of the Request for Proposals. The RFP centered around a flexible, automated environment which would house all the information about natural resource occurrences and infrastructure in Musselshell County.

The GIS was to be based on existing information from existing sources, so that a significant portion of the Scope of Work for the endeavor centered around identifying and accessing sources of relevant information. Hardware and software recommendations were also solicited in the RFP process. All through the project development process, methods to make the whole system accessible to a wide segment of the local citizenry were discussed. ArcView, for example, was acquired late in this project to expand accessibility.

Wednesday, September 12, 2007 (2).max

The Musselshell County GIS was funded through a grant from the Montana Coal Board in 1991. The project was officially completed in February, 1993. It is apparent to Musselshell County that the GIS, if used to any degree of its potential, will never be complete because it is dynamic and has countless applications at the local government level.

Hardware and Software Resources

Musselshell County currently has two separate locations with PCs dedicated to GIS; one in the Roundup City Offices and one in the Courthouse. Both PCs have a set of licensed ARC/INFO[2] software disks, etc. The PC ARC/INFO modules include the Starter Kit, Data Conversion, Overlay, ArcPlot, ArcEdit, and ArcShell. The ArcView[3] data query and display software is also available on these machines, along with licensed copies of MSDOS 5.0, Microsoft Windows 3.0, and DBase IV 1.1. One set of licensed GeoLink software 2.0 exists at the City Office location, including GeoLink Data Collector 3.1 and Data Manager 3.1. Other associated software at both sites include Microsoft mouse, EZ Tape 2.2 and PC Shareware. The hardware used to support these software products is summarized in Table 1.

Table 1: Mussellshell County Computer Hardware

Hardware at the Courthouse PC Site:
- AST Premium II 386/33 CPU
- 200 MB Hard drive, 8 MB Ram
- SVGA Monitor
- AST Keyboard
- ACCUtrak 120 MB Internal tape drive
- Toshiba Floppy Disk Drive
- Accessories: Math CoProcessor, Intel

Hardware at the City Office PC site:
- AST Premia 486/66d CPU
- 540 MB Hard drive, 16 MB Ram
- SVGA Monitor
- AST Keyboard
- Conners Internal 250 MB Tape Drive
- Toshiba Floppy disc drive 1.2 MB
- Calcomp Pacesetter Plotter 36"
- Digitizer Drawing Board II

Additional Hardware:
- Motorola LGT 1000 GPS receiver
- 256 KB SRam card
- Antenna (remote)
- Portable terminal charger
- Batteries and charger 12V

Other Equipment and Supplies
- Stacom 12-place Map Rack
- Realistic 19" Color TV
- Realistic VCR
- Furniture
- Plotter Media
- Plotter Pens

Wednesday, September 12, 2007 (2).max

Coverage Acquisition and Maintenance

Once Musselshell County determined their GIS should contain data about natural resource occurrences and local infrastructure, the process of selecting types of information began. Coverage types and categories were articulated in the RFP. Searching out sources of coverage data was part of the Scope of Work required of the contractor. Substantial collaboration between the contractor and sponsor was necessary to select preferred sources and in particular cases, to access data.

Data was available in many different formats. Conversion methods as well as the age and accuracy of the data had to be considered during the selection process. In particular instances, cost was a factor. Negotiation by the project sponsor was used when sources were uncooperative or information was considered proprietary. In other instances, delays in obtaining data or the need for updates (i.e. yearly, weekly, often, occasionally) were considered important. For instance, CAMAS[4] data will be updated annually. Rural addressing may be updated weekly. Geological data may be reviewed only as new techniques or data become available. The Musselshell GIS project acquired hard copies of all source materials and indexed and archived all those copies for further use, verification and maintenance. A list of agencies and contact persons was compiled and indexed to facilitate future database activities.

The Musselshell County GIS includes 110 infrastructure coverages, 77 natural resource coverages and 4 housekeeping coverages (See Appendix 1). Associated data files vary substantially. Some coverages have little or no attribute data, such as boundary coverages. Some coverages have large data files attached, such as the bridge coverage.

The final GIS product from the contract included a Plot Directory with 61 Plot Files. The GIS hard-copy map inventory includes 108 maps, representing in excess of 900 hours of actual plotter time, excluding prep time and set-up. A total of 57 SMLs were also developed by the contractor. All these plots, files, etc., resulted from literally dozens of contacts with public and private sources.

Table 2 summarizes part of the layout of one coverage in the Musselshell County GIS. This particular coverage, Mineral Resources-Commercial Oil, is part of the natural resources category. Coverages of oil producing fields and oil and gas wells were created from data collected at the Bureau of Land Management (BLM), Montana Board of Oil and Gas, United States Geological Survey (USGS), and Montana Geological Society. Commercial Oil Fields-Oil Field delineations were taken from the map provided by BLM entitled "API Well Locations" and the Oil and Gas Symposium publication provided by the Montana Geological Society. Data about field production were appended from the "Statement of Crude Oil Production and Valuation-All Montana Fields" published with the 1990 Annual Review of Montana Oil and Gas Production.

Table 2: Mineral Resources-Commercial Oil Coverage

Oil and gas wells located with the county were located by matching locational data from the oilgas.dbf data base to a map of Api wells. Each well was digitized and labeled with its Api well number and joined to the database.

Items:	API	Api well identification number (permit number)
	A	Locational data given in database (before digitized x,y coordinates were established).
	B	"
	TD	"
	D	"
	RD	"
	Q3	"
	Q2	"

Wednesday, September 12, 2007 (2).max

Table 2 cont.

Q1	"	WS	Well Status
NS	"	WT	Well Type
EW	"	R	Depth
CTY	County code (Musselshell is 65)	DATE	Date permit was granted
		FLD	Field number
COMP	Company drilling	FM	Producing formation name
WELL	Well name	MBS	Internal code (stripped out)
LEASE	Oilfield leased to		

Well Status Codes

Y	Permitted
Z	Spudded
C	Complete
P	Producing
S	Shut in
T	Temporarily abandoned
A	Abandoned
X	Plugged and abandoned
I	Incomplete
E	Expired permit
R	Release for water well
F	Domestic Gas
U	Unknown

Well Type Codes

O	Oil
G	Gas
B	Both Oil and Gas
H	Dry Hole
I	Injection
S	Salt water disp.
W	Water source
T	Stratigraphic
L	Observation
X	Expired Permit
A	Gas storage
U	Unknown

Sources: Montana Geological Society, Montana Oil and Gas Fields Symposium, Vol. I & II, 1985. Maps of API wells were obtained from the BLM and all updates or corrections were made using the individual well reports (IWR's) located in the stacks on the 3rd floor.
Bill Hansen, Geologist
Bureau of Land Management
Granite Building
Billings, Montana

Plot: Commercial oil wells are plotted on the map entitled "Coal and Petroleum Resources of Musselshell County". The wells are represented by status and type, drilling or location, plugged and abandoned, oil well, gas well, shut-in gas well. The plot may be edited or re-run again using the Resour.sml and related keys.

The spatial location of oilfields and accompanying data about field production is given in the coverage called "Oilfield" (Table 3). Data joined to this coverage include field production measured in barrels, value, and average price per barrel. Both cumulative and 1990 estimates are included.

Wednesday, September 12, 2007 (2).max

Table 3: Oilfield Coverage

Oil field delineations and annotation of field names.

Items:	BAR1990	Number of barrels produced in 1990
	VAL1990	Value of produced barrels in 1990
	AVG1990	Average price per barrel in 1990
	BARCUM	Cumulative number of barrels produced to end of 1990
	VALCUM	Value of cumulative barrels produced to end of 1990
	FIELDNM	Field name

Source: Bureau of Land Management
Montana Geological Society
Granite Building
Billings, Montana

Oilfields are represented in the map "Coal and Petroleum Resources of Musselshell County." This plot is generated by an SML called Resour.sml.

Coverage selection was dictated by the purpose and proposed use of the GIS. Coverage mix and source selection were two very prominent determinants of the financial costs of the GIS and will impact set-up and maintenance cost over the long run. Musselshell County elected not to include their manual rural addressing system in the original contract because a substantial amount of digitizing would have been required to incorporate 51 townships of addresses into the GIS. We thought that the digitizing could be accomplished in-house at a future time for less cost. Parcel data from CAMAS is also very time consuming and costly to incorporate under a contracted project, though it appears to be one of the more useful and important coverages for local government applications.

Current Status of Database

Most coverages in the Musselshell County GIS require no significant amount or only limited amounts of maintenance effort. Wildlife populations will only be updated as new data becomes available every two or three years. Township, range, political boundaries, districts, etc. only occasionally change. New districts may appear periodically. Road systems are static and show very little change, except in areas of subdivision. However road maintenance data, including conditions, gravel, culverts, cattle guards, plowing schedules, etc., are constantly changing. Cumulatively these changes may only need to be incorporated into the GIS on an annual basis, primarily for annual reports and budget purposes. Maintenance of most city and county infrastructure data is similar to road systems. Updates are scheduled annually and any changes or improvements are incorporated into the GIS through that project's Scope of Work.

Schedules are being discussed with utilities to acquire changes to their systems on an annual basis. Oil, coal and other mineral resource data modifications will be solicited annually from appropriate sources. A major project management initiative begun since the completion of the original GIS Scope of Work is the preparation of a complete indexed checklist of maintenance needs, including sources, times and methods. With the completion of the checklist, the periodic evaluation of coverages will become a semi-annual agenda item of the Musselshell County Planning Board.

Wednesday, September 12, 2007 (2).max

The coverage requiring most attention for maintenance purposes is the parcel coverage reflecting ownership of land. In 1992 alone, Musselshell County experienced over 1,000 land ownership changes. Since the current data base includes land parcel ownerships, it is imperative to incorporate these transactions in the GIS, so CAMAS data can be accepted annually. The parcel coverage is very much in demand from a variety of groups including planning agencies, sales companies, outdoor recreationalists, agricultural producers, and mineral lease personnel.

Although rural addressing was not originally added to the GIS as a coverage, it has long been recognized that addressing plays a major role in many local government activities and functions. Since the completion of the GIS, approximately one third of the rural addressing maps for Musselshell County have been digitized and incorporated into the GIS. Maintenance of rural addressing data requires significant amounts of time. Musselshell County manually makes 2-3 addressing changes and additions per week. The address changes will be incorporated quarterly into the GIS in the immediate future, and weekly once the digitizing is completed and maintenance procedures can be standardized.

How quickly other changes or updates are put into the GIS depends upon user needs. Some of those changes may need to be incorporated sooner than others. Many requests come into the city office to change zoning, lot boundaries, etc. Those changes, when passed by the Council, need to be incorporated into the data base as they occur, to avoid mistakes and confusion in future transactions. As subdivision activities create new neighborhood roads and means of access, coverage adjustments are necessary on a timely basis for emergency services, UPS, etc.

There is at least one example in Musselshell County where the GIS came too late to (1) track a particular resource, and (2) help with the management of the impacts to local government created by the harvesting of that resource. The County tried to find data to establish a coverage layer which accurately reflected the quantity, type and value of the timber resource when the original GIS was constructed. Essentially all of the timber resource existed on private land, so no inventory had been conducted by state or federal agencies. Musselshell County fully intended to conduct a timber inventory within the next few years and incorporate the coverage in the GIS. Major structural changes in management practices of public timber resources in the West suddenly created a demand for privately held timber in Central Montana that was not anticipated and 1992 and 1993 have seen up to one dozen companies purchasing and harvesting the private timber. The harvestable timber resource is estimated to last 2-4 years at the current rate of harvest. Pre- and post-harvest mapping and typing could have been added to the GIS, except for the fact that the trees have now been removed before the pre-harvest mapping could be completed.

The significance of local ability to vision and plan will become even more obvious as we begin to deal with the Clean Water Act, a revised Endangered Species Act, watershed management, wetlands delineations, etc. GIS is a tool that will contribute in a major way to how these actions and policies are applied locally, because of the ability to display information geographically with associated tabular information.

As resource management, both nationally and within Montana, moves toward a more holistic approach, Musselshell County has recognized that their GIS can play a significant role in several areas that have to be implemented at the local level. In many cases local governments will be responsible to enforce or monitor certain aspects of some of these major initiatives. The significance of local ability to vision and plan will become even more obvious as we begin to deal with the Clean Water Act, a revised Endangered Species Act, watershed management, wetlands delineations, etc. GIS is a tool that will contribute in a major way to how these actions and policies are applied locally, because of the ability to display information geographically with associated tabular information.

Wednesday, September 12, 2007 (2).max

Far and away the coverages most in demand by local government offices, boards and the general public involve roads, land ownership, parcel coverages, rural addressing and zoning. Most of the demand is for various plots of these coverages. To put the requested coverages in perspective, other "coverages" must be included. So, when a county road map was requested by the Roads Superintendent, he requested township, range, sections, highways, impoundments, perennial streams, secondary roads, as well as labels and legends. After seeing the plot as ordered, he decided he also wanted a plot that included parcel boundaries and neighborhood roads in addition to the above items, so the relationship between subdivided sections (Musselshell County has approximately 50 subdivided rural sections) and transportation routes would be easier to visualize. For good measure, the Roads Superintendent requested that a color code for state and federally owned parcels be included on the plot.

Approximately one month later personnel from the Roads Department requested a plot of a portion of the county south of Roundup that showed subdivisions and a series of railroad spur routes for a proposed major underground coal mine in that area of the County. This same plot, on a countywide basis, has been used for presentations to several potential grant funding sources by Musselshell County.

These examples illustrate the great flexibility provided by the GIS. Demand for GIS products has grown in leaps and bounds since the turnkey system was delivered by the contractor.

With rural addressing being added as a coverage, the Roads Department has requested a list of people living within 300 feet of the proposed haul road from the Coal Mine project. Because many utility companies now install utility lines underground along county right-of-ways, the Roads Department has requested plots reflecting general locations of utility lines within those areas where the County is responsible for road maintenance.

These examples illustrate the great flexibility provided by the GIS. Demand for GIS products has grown in leaps and bounds since the turnkey system was delivered by the contractor. Most of the coverages requested by the Roads Department have also been requested for the offices at the Courthouse. The Clerk and Recorder has ordered plots depicting district boundaries and voting districts. Parcel ownership changes will eventually be made at the point of filing and at the time documents are accepted and filed at the Clerk and Recorder's Office. Currently all rural addressing changes are being manually made at the Clerk and Recorder's Office. This will be done on the GIS as addresses are assigned, sometime within the next year. All divisions of land that fall under the Montana Subdivision Act will provide a plat to the Clerk and Recorder. That plat will be incorporated into the County GIS as a parcel ownership change, by digitizing the new parcels into the RCPAR coverage (Appendix 1).

The City of Roundup is currently developing a master plan for their water, sanitary sewer and storm drain systems. As a component of that process, existing GIS coverages from the County system are being utilized. Future scenarios and projections are being provided in digital form by the engineering firm who originally worked on the County GIS. Alternatives can be overlaid and displayed as coverages with the existing base maps. The City believes this capability will more fully demonstrate possible cause and effect relationships from infrastructure changes. The City also believes that the changes will be far easier to conceptualize and present to the public.

Musselshell County began a cooperative effort with the local USDA/SCS office to digitize soils data from the soil survey currently being conducted in Musselshell County. This arrangement accomplished about 15% of the required digitizing before personnel changes halted the effort. The soil survey is an important tool in subdivision enforcement and natural resource planning efforts and the county hopes to negotiate a new cooperative agreement to finish the data conversion effort in the immediate future. Similar efforts are being evaluated for tracking of annual noxious weed control programs through

Wednesday, September 12, 2007 (2).max

Because the Musselshell County GIS was based upon existing data from multiple sources, many of which were local, methods to allow changes and corrections were incorporated into the GIS effort. One of those methods was the acquisition of hardware, software and training to allow in-house digitizing of information from additional sources as discussed above. Additionally, equipment, software and training were acquired to utilize Global Positioning Satellite (GPS) technology and integrate it with the GIS. This capability greatly expands the applications of the GIS, because relatively accurate ground-truthing, tracking and inventorying activities can be conducted by local government personnel.

The major limiting factor to Musselshell County in increasing the use of their GIS/GPS system is cost of staff. Both private and public special projects are being considered to enhance the staffing capabilities for this small rural County. Additional grant sources and creative fee structures are viewed as potential financing methods.

One of the more promising applications of this capability includes negotiations with a private agriculture producer who wants to GPS map his entire operation, including grazing cells, pastures, water resources, pipelines, buildings, etc. He has indicated possibly including existing GIS layers into the final product such as electrical lines, private roads, soil types, adjacent land owners, and wildlife occurrences. As the GPS mapping is completed and integrated into the GIS, approximate area calculations, distances and other queries will be possible. This producer believes the information will greatly expand his management capabilities, and perhaps lead to conservation strategies that he has not yet attempted.

Applications of GIS/GPS are too numerous to describe in such a short article. The practicality of those applications varies greatly. The major limiting factor to Musselshell County in increasing the use of

and public special projects are being considered to enhance the staffing capabilities for this small rural County. Additional grant sources and creative fee structures are viewed as potential financing methods. Public/private partnerships, such as the ag producer project, will also help with the maintenance of the system.

What Did We Expect?

Probably the biggest differences between what was anticipated of this project and what it turned out to be occurred because of a lack of understanding of the terminology surrounding GIS/GPS. Definitions are hard to make any sense of when you are dealing with persons who have little or no computer literacy. Even though we were aware that the software choices we made had a fairly steep learning curve, the lack of constant use, perhaps one or two days per month, makes proficiency almost unattainable. Very simple things can be confusing and frustrating when you are in the driver's seat, with only a learner's permit, and you are expected to perform in a Formula I Racer.

Most clients come into the GIS room and request maps or data which serve their interests. We all underestimated what would be involved with that type of request. After all, we knew that with these new computers, all you have to do is "push a button" and there it is! Most requests have been quite within the capability of the GIS system, it just takes a bit more time and planning to produce a good product, partly because of limited people resources.

One moment of increased apprehension occurred during the waning days of the GIS project. Staff from the Central Montana RC&D, Roundup office, had provided project management services under contract with the Musselshell County Planning Board for almost 2 years. The Contractor and Project Managers were checking the list of plots (maps) which had been produced by the Contractor, as required in the Scope of Work in the original proposal. Double copies of each plot were required in the contract. The Contractor noted that the first set of plots took in excess of 900 hours on a plotter. That did not in-

[illegible] Language programs (SMLs) or plan the map layout. Were we getting the SMLs for all these plots along with the plots? The answer was no! That was not a requirement in the Scope of Work. In other words, each time we wanted to produce a plot in-house, we could only produce those plots for which we already had copies. Any changes, additions or deletions would require the preparation of an SML for that plot. This would have been possible with the software resources that we purchased but for the time and effort involved in learning this component from scratch. This omission was potentially a major blunder in the project. The amount of computer time, i.e. people time required to write all of these SMLs, along with the learning curve, would have exhausted the available resources in Musselshell County. A solution was negotiated with the Contractor by trading additional plot time for SML's.

Musselshell County is very fortunate that this GIS/GPS capability is now in place, because the mining scenario described earlier in the paper is reality (See Figure 1 for map of past, present, and proposed commercial coal mining). With so many changes occurring in a short time, planning new public management strategies to maintain some sort of order has been a big challenge for public officials. The ability of GIS to be queried and have data displayed graphically has added a great deal of flexibility to the planning process. Issues are easier to conceptualize by public officials and citizens, which increases the odds of achieving consensus and making informed decisions. The Musselshell County GIS, with added GPS capability has proven to be a very effective tool for rural local governments, even though the full potential for applications in a small rural setting have not yet been tapped.

Our experience to date has taught us some valuable lessons with respect to space, cartographic skills, supplies, systems management and public access as well.

The shear size of maps, digitizing boards, plotters and other related GIS equipment, does take a reasonably large area. To save set up time and save wear and tear on equipment, a room dedicated to the GIS, though not a requirement, is preferable. Storage space for supplies is also needed. Supplies for plotting are expensive yet many times we are able to recover the cost of supplies by charging for plots as they are ordered. That is not true of supplies used during learning and experimentation.

Cartographic training could be an asset for composing maps and visualizing final products prior to the actual plotting. The appropriate plot size, the size of this line compared to that one, color combinations, scale of plot, lettering sizes and the location of legends, all become issues that someone in-house has to learn how to deal with. ArcView was purchased so that we could make the data available to Courthouse officials and even to the general public. ArcView is quite powerful and simple to learn; however, our first attempt to create a very user friendly, quick step manual to use ArcView was only a limited success. Even printing screens to a printer in ArcView requires some prior knowledge of cartography and artistic talent.

Our experiences to date demonstrate that a total commitment to on-going project management is required if issues such as those above are to be effectively dealt with and the system is to be utilized to any level near its capacity. That commitment is going to put a strain on the resources of an individual local government in a small rural county like Musselshell. Joint efforts involving several adjacent counties may be needed to enhance the availability of this powerful, practical technology in other small local government settings.

Notes

[1] Central Montana Resource Conservation and Development Area, Inc. (RC&D) is a non-profit agency funded by the Montana Department of Natural Resources and Conservation and the USDA Soil Conservation Service.

[2] Registered trademark of Environmental Systems Research Institute, Inc., Redlands, CA 92373.

[3] Registered trademark of Environmental Systems Research Institute, Inc., Redlands, CA 92373.

[4] CAMAS (Computer Assisted Mass Appraisal System) data is available from the Property Assessment Division of the Montana Department of Revenue.

Wednesday, September 12, 2007 (2).max

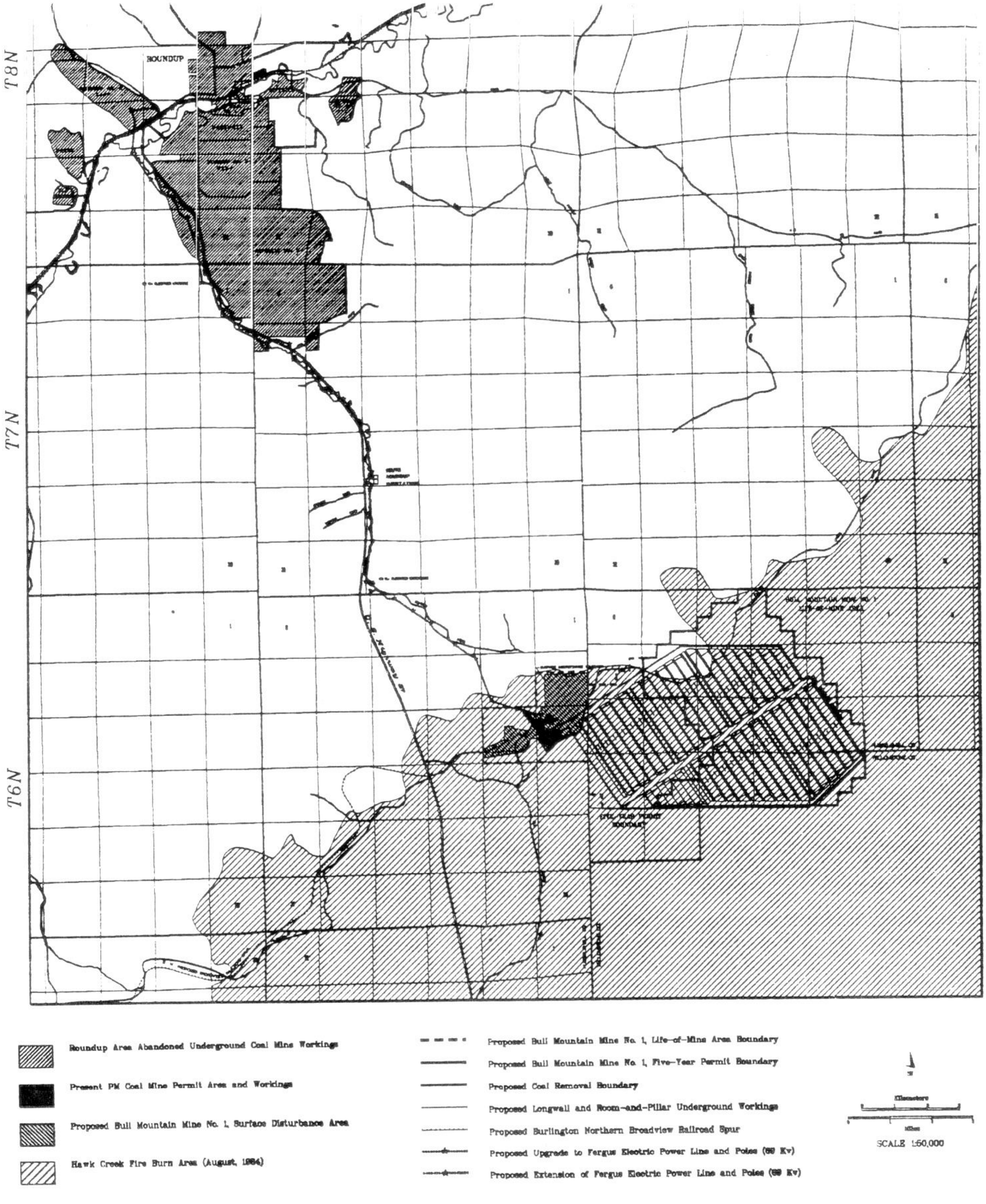

Figure 1. Sample plot: Past, present, and proposed commercial coal mining in Musselshell County

LIST OF MUSSELSHELL COUNTY GIS COVERAGES

Address	Rural Addressing
Afirg	Stock Pond Locations (Irrigated Lands)
Airports	Air Trans. Facilities - Public, Private or Restricted
Antl1983	Antelope Population Distribution, 1983
Antl1984	Antelope Population Distribution, 1984
Antl1985	Antelope Population Distribution, 1985
Antl1986	Antelope Population Distribution, 1986
Antl1987	Antelope Population Distribution, 1987
Antl1988	Antelope Population Distribution, 1988
Antl1989	Antelope Population Distribution, 1989
Antl1990	Antelope Population Distribution, 1990
Antdist	Hunting Districts and Subunits, Antelope 1991
Antenna	Radio Towers and Antennae
Apiwell	Oil and Gas wells, location & status
Arable	Arable Lands, Classes 1,2,& 3
Arrow	North Arrow
Artesian	Locations of Artesian Wells
Barscale	Barscale, Kilometers and Miles
Basin	Basin Designations and Codes, Irrigated Lands
Beaver	Beaver Habitat Zone
Bridge	Bridges Spanning Streams & Roads
Bulksupp	Bulk Supply Facilities for Gas, Fuel Oil and Coal
Bullcoal	Fort Union Coal Region, Bull Mountain Coal Field and Roundup Mine Area Delineations
Bulminel	Proposed Site of Meridian Minerals Mine No. 1 with Life-of-Mine and Five Year Permit Boundaries
Chipmnk	Least Chipmunk Population Distribution 1976
Cityedu	Roundup Condition, Desirability, Utility Zones
Citylv	Roundup Land Value Zones
CntySch	County coded School Districts
Coalbnd	Mammoth Coal Bed Outcrop Boundary
Comcity	Roundup Commissioners Districts
Comcnty	Musselshell County Commissioners Districts
County	Musselshell County Boundary
Countylv	County Land Value Zones
Coyote	Coyote Population Distribution
Deerdist	Hunting District, Deer 1991
Deermous	Deer Mouse Population Distribution 1976
Dem	Surface Elevation Contours from USGS DEM data
Disaster	Emergency Routing, County-wide
Disklein	Klein Emergency Shelters and Evacuation Routes
Dismal	Melstone's Emergency Facilities and Routes
Dismus	Musselshell's Emergency Facilities and Routes
Disrnd	Roundup's City Map of Emergency Shelters and Routes
Dissol	Total Dissolved Solids - Miligrams/Liter
Duck	Duck Population Distribution - 1978
Feci5	Fergus County Electric Coop., Inc.
Fgrouse	Forest Grouse Population Areas - 1978
Firm	Flood Insurance Rate Map, Roundup
Fldpln	Flood Plain Zones and 100 yr. Hazard Areas
Fox	Red Fox Population Distribution 1976
Gagefld	Gage Petrol. Field Delineation

Gagepts	Gage Petrol. Field Well Locations
Gas_stat	Gas Stations and Diesel Fuel Distributors (County Wide)
Gauging	Gauging Stations, Irrigated Lands
Geese	Population Distribution of Geese, 1978
Geol	General Geology (County Wide)
Geotherm	Abandoned Underground Mine Sites, Musselshell County
Grsquirl	Thirteen-lined Ground Squirrel Pop. Dist. 1976
Hawkfire	Bull Mountain Burn Perimeter Map - Aug. 1984
Histsect	Historical District Boundary, Roundup
House	Roundup Housing Situations Including Subdivisions
Hsmouse	House Mouse Habitat Zone
Hungpart	Hungarian Partridge Pop. District 1976
Hydrant	Fire Hydrant digitized for Marker Symbol
Impless	Intermit. Impounds (<2 acres), Marsh, Backwater
Impound	Permanent Impounds (Lakes > 2 acres)
Int_strm	Intermittent Streams and Rivers
Irgnet	Irrigation Network
Irrigate	Irrigated Lands
Isolower	Isopachs of Lower Mammoth Coal Formation
Isoupper	Isopachs of Upper Mammoth Coal Formation
Jackrab	White-tailed Jackrabbit Pop. Dist. 1976
Kangrat	Ord's Kangaroo Rat Habitat Zone
Landfil	Solid Landfill Sites and Transfer Stations
Landuse	County-wide Landuse
Lifework	Life-of-Mine Underground Working, Bull Mountain Room-and-Pillar, Longwall Areas, and Coal Removal, Boundary, Meridian Minerals (proposed)
Location	Timber Stand Sample Locations
Logo	GeoResearch, Inc. Logo
Lots	Lot Boundaries and Use - Roundup
Lstrike	1990 Lightning Strike Locations, date, time
Marmot	Yellow-Bellied Marmot Habitat Zone
MCD	Tiger MCD Boundaries and Demographic Data
Meadvole	Meadow Vole Population Distribution 1976
Medical	Medical Facilities, Address, telephone
Melsewer	Melstone Sewer Network
Melstone	Survey Map, City of Melstone
Melwater	Melstone Water Network
Merbnd	Meridian Minerals Map Extent Boundary
Mink	Mink Population Distribution, 1976
Min_roy	Mineral, Oil & Gas Royalties or Ownership
MM1	Isopachs, Mammoth Coal Split Area 1
MM12	Isopachs, Mammoth Coal Split Area 1 2
MM123	Isopachs, Mammoth Coal Split Area 1 2 3
MM2	Isopachs, Mammoth Coal Split Area 2
MM23	Isopachs, Mammoth Coal Split Area 2 3
MM3	Isopachs, Mammoth Coal Split Area 3
Montana	State Boundary
Msbasin	River Basin Boundaries within Musselshell County
Mssgr430	Roundup GPS Control Points
Msstoret	Climate Monitoring Locations and Water Monitoring Locations in Musselshell County
Mpc4	Montana Power Company Lines and Stations
Muledeer	Mule Deer Population Distribution, 1978
Munic2	Municipal Boundaries (Roundup, Musselshell, Melstone)
Musriver	Musselshell River (polygon) for purposes of Roundup City Mapping
Muss	Survey Map, Musselshell
Musswtr	Musselshell Water System
Oilfield	Oil or Gas Field Delineations, County

Pdifeb	Palmer Drought Severity Index Values in Feb 1992, County
Pdimarch	PDSI Values in Musselshell County, March, 1992
Pdiapril	PDSI Values in April, 1992 - Musselshell County
Pdimay	PDSI Values in May, 1992 - County-wide
Per_strm	Perennial Streams
Pheasant	Pheasant Population Distribution - 1978
Pipeline	Oil Pipeline Network
Pipestat	Pipeline Injection and Pump Stations; and Storage
Piptics	Tic File for Registration and Edits to Pipeline
Plss	Section Grid lines and Numbering Scheme, County
Plstics	Master Tic File Based on Pub. Land Survey
Pmcoal	PM Coal Mine Site with Underground and Surface Workings
Potwat	Potentiometric Surface Water Contours
Prairdog	Black Tailed Prairie Dog Habitat Area
Prairvol	Prairie Vole Habitat Zone
Preccity	Roundup City Precincts and Polling Places
Preccnty	County Precincts and Polling Places
Primroad	Primary Roads including Traffic Counts
Proad	Proposed MDOT Road Construction Projects
Propelec	Fergus Electric Service to proposed Meridian Minerals, Bull Mountain Mine No. 1 Site (Wires, Posts, and Station)
Proprail	Burlington Northern Rail Spur proposed for Meridian Minerals, Bull Mountain Mine No. 1 Site
Raccoon	Raccoon Population Distribution, 1976
Railrd	Railroad Network
Rcpar	Parcels coverage with Residential and Commercial Data Joined from CAMAS (Computer Assisted Mass Appraisal System) and the County Assessor's Office
Republic	Room and Pillar Structure of Rep. Coal Mine
Richsqr	Richardson's Ground Squirrel Habitat Zone
Rivbasin	Montana State River Basin Designations
Rndbnd	City of Roundup Boundary
Rndhaz	Hazardous Waste Producing Sites and Product
Rndhist	Historical Sites and Walking Tour, Roundup
Rndlts	Electric Network & Street Lights, Roundup
Rndrail	Railroad (as historically mapped by early surveys)
Rndsdr	Storm Sewer Network, Roundup
Rndsewer	Roundup Waste Sewer System
Rndtv	Roundup Cable Television System
Rnduptr	Survey Map, City of Roundup
Rndwtr	Water System Network, Roundup
Roads	State and County Coded Roads Network
Road1	Primary Roads
Road2	Secondary Roads
Road3	Neighborhood Roads
Road4	Class 5 Roads (Jeep trails)
Rustwest	U.S. West Telecommunications Trunk Lines, Roundup
Sagevole	Sagebrush Vole Population Distribution 1976
Sdptch	Ratio of Sodium, Potassium and Chloride
Seismic	Seismic fault locations, Musselshell County
Services	Roundup Community Facilities (Services)
Sgouse	Sage Grouse Population Distribution, 1978
Sharptl	Sharp Tailed Grouse Pop. Distribution, 1978
Shrew	Merriam's Shrew Population Distribution, 1976
Siren	Location of Siren in Roundup
Slicense	Surface Mine Leases, Permits and Licenses
Splitbnd	Coal Split Boundaries, Mammoth
Ssurgo	SSURGO (SCS) Soil Classification (current status)

Statsgo1	STATSGO (SCS) Soil Classification
Statsgo2	STATSGO (SCS) Soil Classification (cont.)
StSch	State coded Levy and School Districts
Sulfate	Ratio of Sulfate to Total Anions in Water
Surdist	Surface Disturbance Boundary, Bull Mountain Mine No. 1, Meridian Minerals (proposed)
Surfmine	Surface Mine Sites, Musselshell County
Sw_gauge	Surface Water Gauging Stations
Tnrng	Township/Range Grid
Tree	USFS Timber Sample Data-Timber Inventory
Trparcel	Annotation for Town/Range Codes (CAMAS)
Trtic	Master Tic File, County - Based on PLS
Turkey	Turkey Population Distribution - 1978
Ulicense	Underground Mine Leases, Permits and Licenses
Ustcnty	Underground Storage Tank Locations, County
Ustmel	Underground Storage Tank Locations, Melstone
Usw_midr	U.S. West and Mid Rivers Telecommunication Lines
Valve	Valve Marker Digitized for Symbol Library
Veg	Vegetation (county wide)
Veg1	Understory Vegetation Inventory and Classification
Veg2	Understory Vegetation Inventory and Classification
W_wells	Ground Water Monitoring Wells and Private Wells
Weed87	1987 Weed Distribution, County
Weed91	1991 Weed Distribution, County
Wildfr	Wildfire Data for BLM Lands in Musselshell County
Woodrat	Bushy Tailed Wood Rat Habitat Zone
Wpmouse	Wyoming Pocket Mouse Habitat Zone
Zoning	City of Roundup Zoning Classifications

Wednesday, September 12, 2007 (2).max

LOCAL GOVERNMENT NEWS

MONTANA'S LOCAL GOVERNMENT REVIEW

Judy Mathre
Local Government Center

The idea that it's a good thing to examine local government is not new. Many states provide various methods allowing such review. However, no other state does it in the sweeping way that it is done in Montana.

The authors of the 1972 Montana Constitution wrote in their own method of local government review, not matched by any other state. Article XI, Section 9, provides for a review of local government every ten years, beginning in 1974. They decided that periodic self examination of local government was a healthy idea. In fact, they decided that it was such a good idea that they required it of all units of county and municipal government.

The first voter review process began in 1974 with the election of unpaid, non-partisan study commissions comprised of 3 - 9 members. They had two years to complete their work and were required to put a proposal on the ballot for citizen consideration. The voters could choose between the existing form of local government or the proposal of the study commission. For two years (1974-76) a study commission examined the organization and structure of its local government, interviewed members of the government, held hearings for the public to acquire and share perceptions of the representativeness, responsiveness, and general capacity of their government to deliver services efficiently and to provide for the health and safety of their community.

As a result of the first local government review process, four units of county government and 27 municipal governments were changed by a vote of their citizens.

The Constitution was amended in 1978 to change the review process. This change made the process permissive in that the voters were given the opportunity to decide whether or not they wished to review their government every ten years. At the primary election in 1984, 25 counties and 73 municipalities voted to review their governments yet again. Study commissions were then elected at the general election in November, 1984, and once again had two years to study their governments and write a report.

Wednesday, September 12, 2007 (2).max

In contrast with the first review, these study commissions were not required to put a proposal for change on the ballot. They could decide, after examining their local governments, that there was no need for change, they could make certain recommendations directly to their local government, or they could put a proposal for structural change on the ballot. This time 13 county proposals and 24 municipal proposals were put on the ballot of which 16 (2 county and 14 municipal) were approved by the voters at the general elections of 1986.

Round three of local government review began with the June 7, 1994, primary election. Voters were asked whether they wished to review their local government or not. Citizens living within municipalities voted on reviewing both their county government and their municipal government. Those living outside a municipal jurisdiction voted only on reviewing their county government. As a result of that vote study commissions will be elected in 33 counties and 79 municipalities at the November 8, 1994, general election.

LOCAL GOVERNMENT REVIEW ELECTION ANALYSIS

The rate of electoral approval for both city and county jurisdictions was examined and the rate of approval can be demonstrated to increase with size of population. Counties and cities were divided into quintiles based on their populations. The tables below indicate the quintile, the number of jurisdictions approving and disapproving review and the percent approving. The first quintile has the highest population, the fifth, the lowest.

COUNTY

Quintile	Number Approved	Number Disapproved	Total Number	Per Cent Approved
1	11	1	12	91.7
2	9	2	11	81.8
3	8	3	11	72.7
4	5	6	11	45.5
5	0	11	11	0
Total	33	23	56	58.9

CITY/TOWN

Quintile	Number Approved	Number Disapproved	Total Number	Per Cent Approved
1 *	22	2	24	91.7
2	21	3	24	87.5
3	16	10	26	61.5
4 **	13	12	25	52.0
5	7	19	26	26.9
Total	79	46	125	63.2

* Anaconda/Deer Lodge and Butte/Silver Bow are both counted as county jurisdictions only.
** Townsend is not counted as there was no election on the question of local government review.

Wednesday, September 12, 2007 (2).max

Those jurisdictions approving local government review are as follows:

Counties

Beaverhead
Big Horn
Blaine
Broadwater
Carbon
Cascade
Custer
Dawson
Deer Lodge
Fergus
Flathead
Gallatin
Glacier
Granite
Hill
Jefferson
Lake
Lewis & Clark
Lincoln
Madison
Mineral
Musselshell
Park
Pondera
Powell
Ravalli
Richland
Rosebud
Silver Bow
Stillwater
Teton
Toole
Yellowstone

Cities and Towns

Alberton
Bainville
Baker
Belt
Billings
Boulder
Bozeman
Bridger
Brockton
Browning
Cascade
Chinook
Choteau
Circle
Clyde Park
Columbus
Conrad
Cut Bank
Darby
Deer Lodge
Dillon
Drummond
East Helena
Ennis
Fairfield
Fairview
Forsyth
Fort Benton
Fromberg
Geraldine
Glasgow
Glendive
Great Falls
Hamilton
Hardin
Harlem
Harlowton
Havre
Helena
Hysham
Joliet
Judith Gap
Kalispell
Kevin
Laurel
Lewistown
Libby
Livingston
Lodge Grass
Malta
Miles City
Missoula
Pinesdale
Polson
Poplar
Red Lodge
Rexford
Richey
Ronan
Roundup
St. Ignatius
Scobey
Shelby
Sidney
Stevensville
Sunburst
Superior
Terry
Thompson Falls
Three Forks
Twin Bridges
Valier
Virginia City
Walkerville
West Yellowstone
Whitefish
Wibaux
Winnett
Wolf Point