

Improving Multi-Use Recreational Trail Safety through a Coordinated 911 Sign Project

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ABSTRACT

The objective of the Cedar Valley Trails 911 Signs Project (911 Signs) is the design and implementation of a comprehensive method to georeference trail locations for emergency response and asset management purposes. The Cedar Valley Trail System and the Cedar Valley Nature Trail encompass 95 miles of paved trail within Black Hawk County Iowa. This recreational trail system serves over 200,000 trail users annually. Using GIS software and local GIS data, a new map grid system was devised to communicate a location to within one-tenth of one square mile. This scheme of two numbers, one letter, and two numbers (e.g., 22 C 99) provides a short identification number that is meaningful on both computer and printed maps. A GPS trail survey was conducted by Iowa Northland Regional Council of Governments (November 2004) to collect locations, attributes, and photographs of benches, signs, and other trailside features. A new 911 sign, with "911" clearly visible, was designed and approved. The new 911 signs, with the specific ID number for location reference, are attached to the georeferenced trail features. The 911 sign location data is integrated into the Black Hawk Consolidated Public Safety Dispatch Center's system to enable dispatchers to "see" the location on the Dispatch Center's GIS computer map. Thus, the 911 Signs Project provides a practical solution to location communication in emergency situations and serves as an asset inventory of all features along this transportation corridor.

Key words: alternate transportation—recreation trail—safety

PROBLEM STATEMENT

The metropolitan Cedar Valley Trail System and the rural Cedar Valley Nature Trail (collectively referred to as the Trail) encompass nearly 95 miles of paved trail within Black Hawk County (BHC), Iowa. This recreational trail system serves over 200,000 trail users annually. Trail use includes bicycle, in-line skating, and pedestrian traffic; charity walks and rides; Trail festivals; and other events. As Trail usage increased and the Trail length was extended over time, it became apparent that an improved means of communicating trail location information was needed for both public safety and asset management purposes. Since Trail expansion plans are in place, any location communication improvements must fit both the current Trail and future extensions. An added benefit is an inventory of all assets along this transportation corridor.

Public Safety

The original Trail location project, known as the Trail Emergency Access System (TEAS), was developed in 1999. The TEAS was designed to assist emergency responders in locating Trail users in need of help. The TEAS included 130 signs that were placed along the then-existing Trail. The signs, made of a material that degrades in the sunlight, were not permanently fixed in the ground. Some have been destroyed, others moved, and some are hidden in trail-side vegetation (see Figure 1).

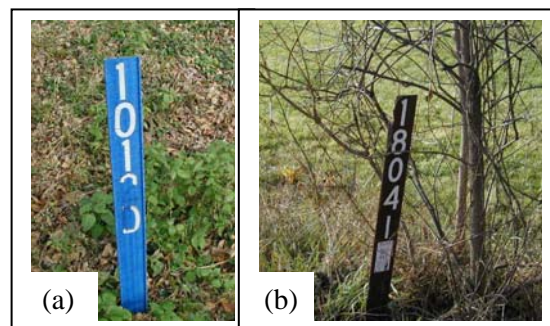


Figure 1. Two of the 79 remaining TEAS signs. (a) deterioration of the decals; (b) a sign that will be hidden when the shrub leafs out

Of the original signs, only 79 remain today. Decals on each sign provide a unique location ID code. The purpose of the signs, however, is not clearly indicated. The TEAS code is composed of numbers and a letter. The first two to three numbers were derived from the east-west street address range, with the following two to three numbers coming from the north-south street address range. The east-west street address ranges start at 00 in the center of BHC and again in the center of each city, as do the north-south street address ranges. The address range numbers increase to the east and west and to the north and south of the city or county center. Thus, the number on a TEAS sign gives no apparent clue as to location. The letter designates a particular jurisdiction or area within a jurisdiction. TEAS signs along the Trail in southeastern BHC have as many as seven characters. For bicyclists and other trail users, a seven-character sign that may be partially hidden in grass is difficult to read, let alone to recall if the sign is no longer in view. With the TEAS, all of the numbers and the letter need to be communicated to describe even the general area of the location. At the Black Hawk Consolidated Public Safety Dispatch Center, the TEAS sign locations are related to the street or the Trail access point nearest to the sign, rather than to the sign location on the Trail. The post-1999 trail segments lack TEAS signs. Thus, the TEAS is no longer adequate to meet present public safety needs related to location communication and emergency dispatch.

Asset Management

Today there are over 1700 trailside features, including signs, benches, and shelters. The Trail crosses through many jurisdictions (Cedar Falls, Evansdale, Hudson, Waterloo, BHC, and the State of Iowa). The Iowa Northland Regional Council of Governments (INRCOG) coordinates transportation planning, grant writing, and Trail mapping. Thus, rather than each jurisdiction devising an approach to Trail asset data collection, a common method useful to all the jurisdictions to provide uniformity is needed. The resulting method must facilitate annual asset condition reporting and maintenance, be useful for Trail planning, and accommodate future addition of new assets.

PROJECT OBJECTIVES

The main objective of the Cedar Valley Trails-911 Signs Project (911 Signs) is the design and implementation of an up-to-date, comprehensive method to georeference trail locations. Specific objectives are to do the following:

- Develop a location identification system that is consistent across all jurisdictions in the county
- Use a location identification code that is meaningful to emergency responders even if only part of the identification code is communicated
- Design signs that are easy to see, read, remember, and maintain
- Use GPS for initial and future Trail-related field data collection and for future asset condition assessment
- Use GIS software for data management, sharing, viewing, and updating
- Install 911 signs on existing permanent trail-side features so that there is at least one 911 sign every one-quarter mile along the entire length of the Trail in BHC
- Incorporate the 911 sign location data into the local computer-aided dispatch system
- Replicate the 911 Signs Project in other counties that have multi-use recreation trails

The 911 Signs Project is the first such project implemented in Iowa.

PROJECT DEVELOPMENT

The 911 Signs Project is a cooperative project involving multiple agencies. Meetings began in August 2004 to discuss needs and initiate the design of the 911 Signs Project. County and city parks departments, the State of Iowa Department of Natural Resources, city engineers, the BHC Emergency Management Agency, public safety offices, the Black Hawk Consolidated Public Safety Communications Center, INRCOG, and BHC Information Technology were represented at this and subsequent meetings.

911 Sign Location Identification Code

Representatives agreed that using a number-letter-number format would be easier to remember than an entirely numeric sequence and that the code should be as short as possible. A new 911 sign location identification code with a maximum of five alpha-numeric characters was chosen from among a variety of possibilities presented to the group. Using GIS software and local GIS data layers as a base, a new map grid system was devised. The location code is based on a new map grid system that breaks BHC into one-square-mile blocks, assigning numerals 1–25 to the X-axis (west-east) and letters A–X to the Y-axis (north-south) of the grid (see Figure 2). Thus, the X value and the Y value alone designate a particular square mile (see Figure 3). Each one-square-mile block is further broken into 100 blocks one-tenth of a square mile. The one-tenth square mile blocks are sequentially numbered 00–99 from left to right (i.e., 00–09, 10–19, 20–29, etc.). The final two digits identify a location to within one-tenth of a square mile.

This scheme of two numbers, one letter, and two numbers (e.g., 22 C 99) provides a short identification code that is meaningful on both computers and printed maps.

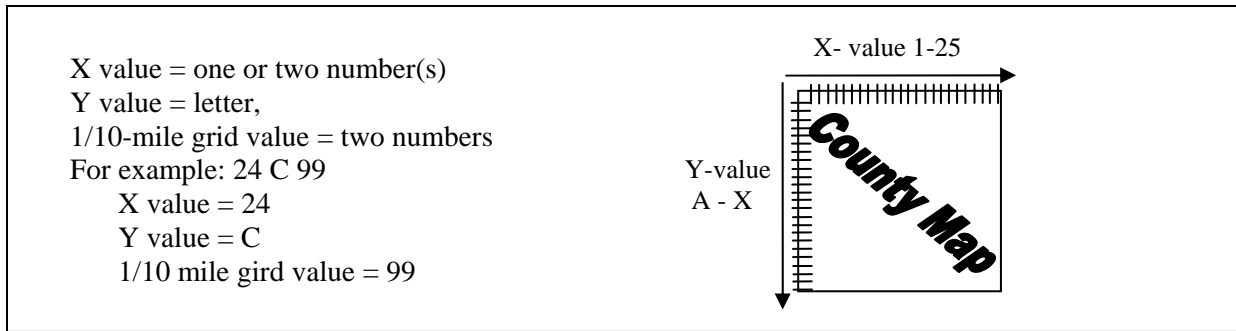


Figure 2. Overview of identification code

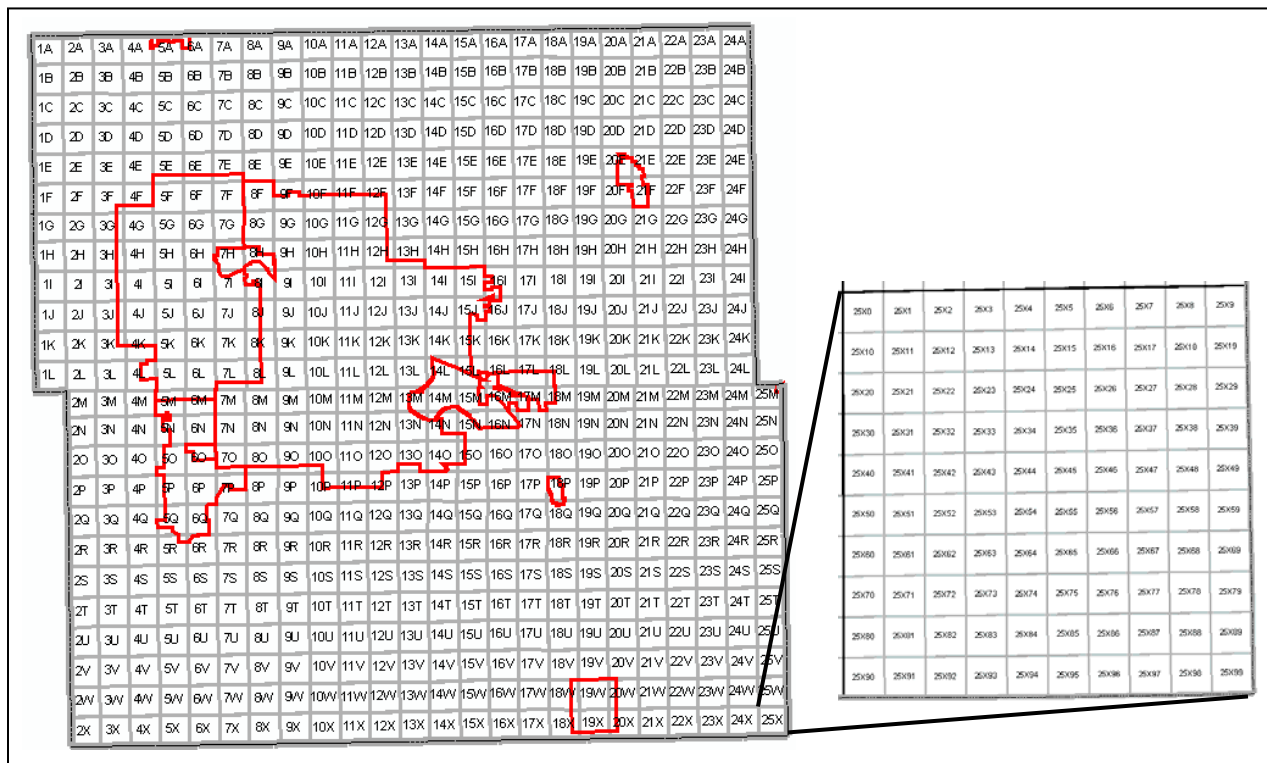


Figure 3. One-mile grid with code, marked county boundary and corporate boundaries, and an expanded (25X) area to illustrate the 1/10 mile grid

Sign Design

Following approval of the new identification code and location grid system, a new 911 sign with “911” clearly visible was designed and approved (see Figure 4). The signs are made of metal. Identification code decals are attached to the sign. The feature that a sign is attached to dictates sign shape and orientation (horizontal, vertical, or square). The horizontal and vertical signs measure 18 inches by 4 inches. The square sign measures 12 inches by 12 inches.



Figure 4. 911 sign design

Trail Survey

INRCOG staff conducted a GPS trail survey to capture location and attribute information for each trail feature, including benches, shelters, drinking fountains, bridges, and transportation signs. This was done in late fall in leaf-off conditions. A Trimble GeoXT GPS receiver was used for field data collection. The data dictionary included an auto-filled date and time entry. Field data was differentially corrected post-process to improve spatial accuracy, using Pathfinder Office software and the files downloaded from the North Liberty CORS GPS base station. The differentially corrected trail feature files were exported as shapefiles for use in ESRI® ArcGIS9 (ArcView) software. Using ArcGIS 9, the trail feature shapefiles were overlaid on BHC's high-resolution orthophotography to compare spatial accuracy. Many of the trail features are more recent than the orthophotography, but those that did correspond to visible features in the orthophotography were on the feature or within five feet of it. This level of accuracy is suitable for the purposes of this project. A photograph of each feature was also taken for quality control and asset management purposes. Each photograph was time-stamped.

911 Signs Project Maps and Attributes in GIS

A GIS project was set up for asset mapping and attribute management purposes (see Figure 5). The Trail-related data sets (shapefiles) were symbolized. Layer (.lyr) files were created to preserve the symbology for ease of use in other GIS projects. A hyperlink attribute field was included in each of the point data sets so that the photograph of a particular feature could be linked to the point representing the feature. The time stamps of the photo and the date/time from the GPS data dictionary were used to ensure that each photograph is properly assigned to its corresponding feature (see Figure 6). The photographs served as a quality control and quality assurance measure initially to verify that feature attributes were correct. The photographs also provided a baseline against which future feature conditions and 911 sign condition will be gauged. Mapping the features provides a visual overview of the location of 249 benches. The attributes reveal the material the bench is composed of, the memorial name on the bench, the side of the trail the bench is on, and the sign identification code that would apply to the bench.

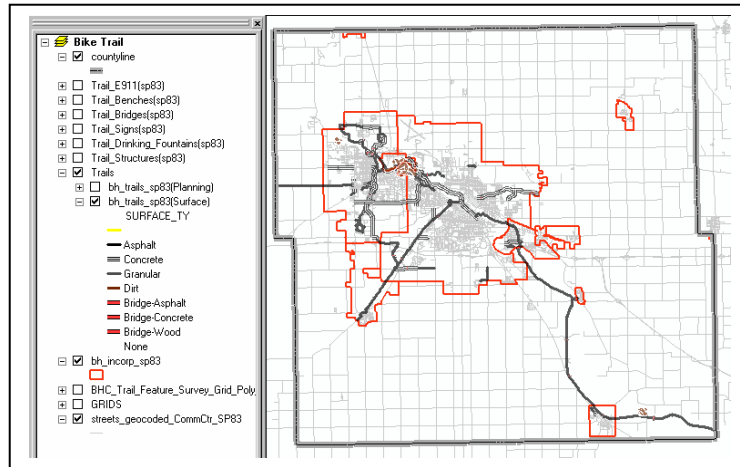


Figure 5. Trail Survey 2004 Project in ArcMap, illustrating Trail location and Trail surface type (1:300,000 scale)

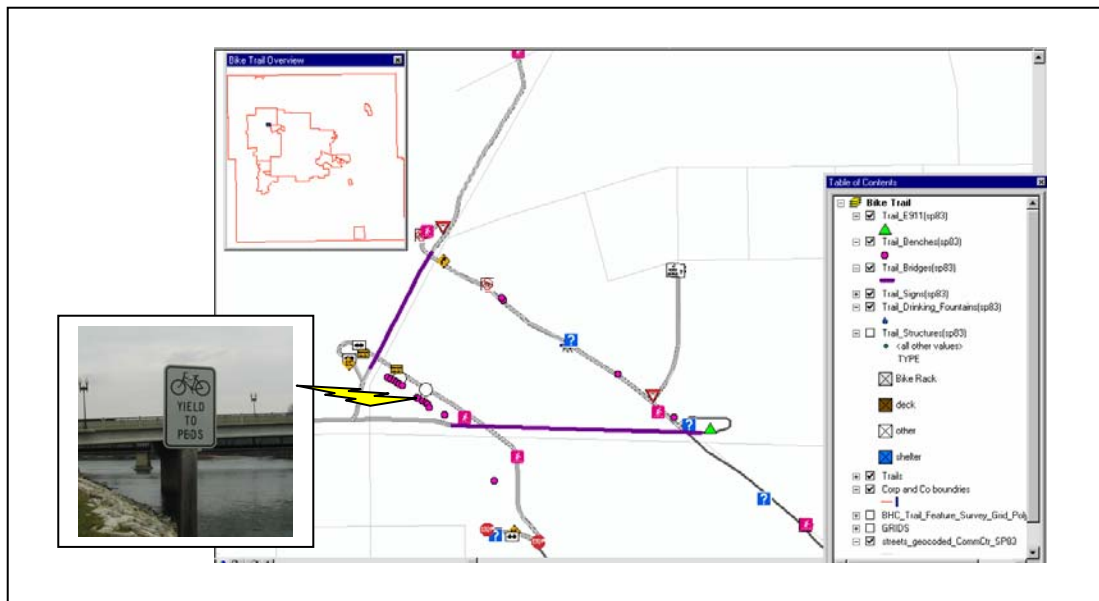


Figure 6. Trail Survey 2004 Project in ArcMap, illustrating variety of Trail features and a photograph linked to a particular feature (1:3,500 scale)

Other Trail assets include bridges, structures, drinking fountains, and existing TEAS signs. There are 1,363 trail signs providing information to Trail users. These include the typical caution, warning, yield, stop, and bike trail signs, as well as signs designating Trail names, funding sources and partnerships, other named places, boundaries lines, information marquees, local area maps, and directions. Table 1 illustrates the wide variety of signs along the Trail. These signs are valuable assets. Knowing Trail sign location, type, and jurisdiction aids in accounting for and tracking these government assets. The photograph of each asset also ensures that missing signs are replaced with the correct sign type.

Table 1. Partial list of sign types along the trail

All unauthorized vehicles and horses prohibited	House address markers	Roadside prairie restoration area
Begin one way	Lawcon funding sign	Rough trail
Bike symbol	Memorial marker	RR X-ing
Bike X-ing	Mile marker	Sharp left curve
Bikeway narrows	Names of trail segments	Sharp right curve
Bird house	Names places (cities, parks, wildlife area, lakes, etc.)	Side road - left
Bird observation blind / no bicycles	Narrow bridge	Side road - right
Bird sanctuary	No bicycles	Sidewalk users walk bikes
Bulletin board	No drugs zone increased penalties	Slip when wet
Campground	No dumping	Slow
Campground direction	No dumping \$500 Fine	Soft trail
Caution	No horses on recreation trail	Steep grade
City map	No hunting	Stop
Cross country skiing	No hunting wildlife refuge	Stop ahead
Curve 90	No minibikes motorcycles snowmobiles	Street or road name
Curve left	No motor vehicle	T intersection
Curve right	No parking beyond here	Trail begins
Curve S	No snowmobiling	Trail courtesy
Cyclist warn pedestrians when passing	No swimming	Trail end
Danger water	No target shooting	Trail ends 200 feet
Dead end	Park closing time	Tree plantings
Directional sign	Park or preserve boundaries	Two way traffic
Dismount walk	Park preserve - no dumping	Unauthorized vehicles and horses prohibited on dike
Do not enter	Park rules	Use ped signal
End one way	Ped X-ing	Warning orange diamond
Entering <named place>	Please place trash in receptacles	Warning walk bike across cattle guards
Exit only / directional sign	Prairie trail	Watchable wildlife
Funded by REAP	Public hunting area	Wildlife refuge
Hiking trail	Rec trail	Wrong way
Hiking trail / cross country skiing	Residential address sign	Y intersection
Hiking trail / no snowmobile	Restroom direction	Yield
Hiking, no smoking, dogs on a leash	Riverview recreation area/ rules and regulations	Yield to pedestrians
Hospital direction	Road closed	

When the 911 Signs GIS project was completed, the locations of the various trailside features were assessed in the GIS mapping to determine the features to which to attach the new 911 signs. Benches were the primary targets for the new signs. In a few situations, the 911 sign was attached to a vertical sign post or to a structure. To meet the criteria of having a 911 sign every one-quarter mile, new permanent posts were installed in a few locations to support the 911 sign. Once the final determination was made, a new data set consisting of 267 points illustrating features with new 911 signs was derived (see Figure 7). This data set is used in the dispatch center’s mapping system.

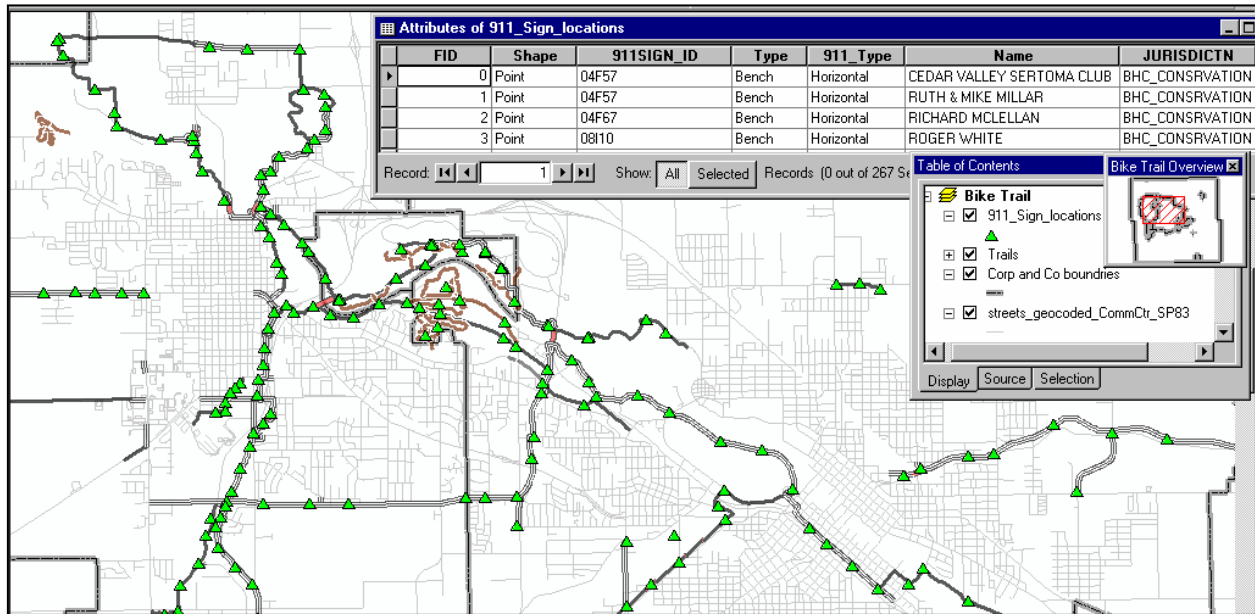


Figure 7. ArcGIS map view illustrating the location of new 911 signs, an attribute table for the 911_Sign_locations data set, and an overview map showing portion of county in the map view

Incorporation of 911 Signs Project Data into the Computer-Aided Dispatch System

Integrating the Trails and 911_Sign_locations data sets into the dispatch center's computer-aided dispatch (CAD) system enables 911 dispatchers to “see” the location communicated by a trail user on the center's CAD map, which is an ESRI® MapObjects application. This visualization helps dispatchers guide the appropriate responders to the emergency site. For the Trail data to work within the CAD system, the line data set representing the Trail was incorporated into the dispatch center’s geocoded street centerline shapefile using ArcGIS tools. The first step was to merge all of the individual features representing Trail segments from the original bh_trails_sp83(Surface) shapefile into one line feature, and then output this as a new shapefile named “merged_trail” using the merge tool in the edit tool set. Next, this single feature representing the entire trail system in the county was broken into segments by intersecting the one-square-mile map grid shapefile with the merged_trail shapefile and joining the attributes of the map grid shapefile with the merged_trail attributes in the process. The single merged_trail was broken into 83 line features representing trail segments, and then output as another new shapefile, “intersected_trail.” Due to the attribute joining, the intersected_trail shapefile included the X-number and the Y-letter attribute fields inherited from the map grid shapefile. Each of the 83 line features in intersected_trail corresponds spatially to and is located within a particular one-mile grid map area. Any attribute fields not needed for incorporation into the CAD system were deleted. Next, one road from the geocoded street centerline shapefile was selected and exported as a new shapefile (biketrail_geocoded_XY_SP83) to use as a

centerline attribute template. An editing session was begun with the biketrail_geocoded_XY_SP83 shapefile set as the target. All of the 83 line features of the intersected_trail shapefile were copied and pasted to the biketrail_geocoded_XY_SP83 shapefile, resulting in 84 records. The record representing the road, that is, the only record with an actual street name, was deleted, leaving only the 83 line features with the same exact attribute table structure, albeit not populated with data, as used in the dispatch center's geocoded street centerline file.

The next step was to populate the 83 records of the biketrail_geocoded_XY_SP83 shapefile via calculations, addition and deletion of fields, and a join. The NAME field was calculated equal to BIKE, and the TYPE field was calculated equal to TRL. Then, the intersected_trail shapefile was spatially joined to the biketrail_geocoded_XY_SP83 shapefile in order to append the X_Number and Y_Letter fields of the intersected_trail shapefile to the biketrail_geocoded_XY_SP83 attribute table (see Figure 8). The PRE_TYPE field was populated by calculation (X_Number and Y_Letter) to preserve the information for the CAD system. A Y_Number field was added as a text field. An X_Y_Number field was also added as a text field. All fields right of PRE_TYPE were eventually deleted. Since the CAD system uses standard LEFTFROM and LEFTTO fields for address numbers, the Y-letter was converted to a number corresponding to the letter position in the alphabet. Then the X_Y_Number field was calculated (X_Number and Y_Number). A zero was appended to the end of the X_Y_Number field. Thus, for example, 406 became 4060, 506 became 5060, and so on.

ST_TIP	ST_LABEL	PRE_TYPE	X_Number	Y_Letter	Y_Number	X_Y_Number
		4F	4	F	06	406
		5F	5	F	06	506
		6F	6	F	06	606
		7F	7	F	06	706
		5G	5	G	07	507
		6G	6	G	07	607
		7G	7	G	07	707
		4H	4	H	08	408
		5H	5	H	08	508

Figure 8. Portion of biketrail_geocode_XY_SP83 attribute table with X_Number, Y_Letter fields from the join and two fields added for calculations

After appending "0" to the X_Y_Number field, the LEFTFROM field, which is a numeric field, was set equal to the X_Y_Number field. The other three address range fields were derived from the LEFTFROM field (see Figure 9). Unnecessary fields were then deleted.

LEFTFROM	LEFTTO	RIGHTFROM	RIGHTTO	PREDIR	NAME
25240	25249	25241	25249		BIKE
4060	4069	4061	4069		BIKE
4080	4089	4081	4089		BIKE
5060	5069	5061	5069		BIKE
5070	5079	5071	5079		BIKE

Figure 9. Portion of biketrail_geocode_XY_SP83 attribute table illustrating address fields used in geocoding

Once the biketrail_geocode_XY_SP83 attribute table was populated and in the same format as the geocoded street centerline file, an editing session was started with the centerline file as the target. The 83 features in the biketrail_geocode_XY_SP83 file were copied and pasted to the geocoded street centerline file. The CAD system recognized a street named BIKE TRL, and an address range related to a section of that street (see Figure 10). No direct data entry was done to incorporate the trails into the centerline file.

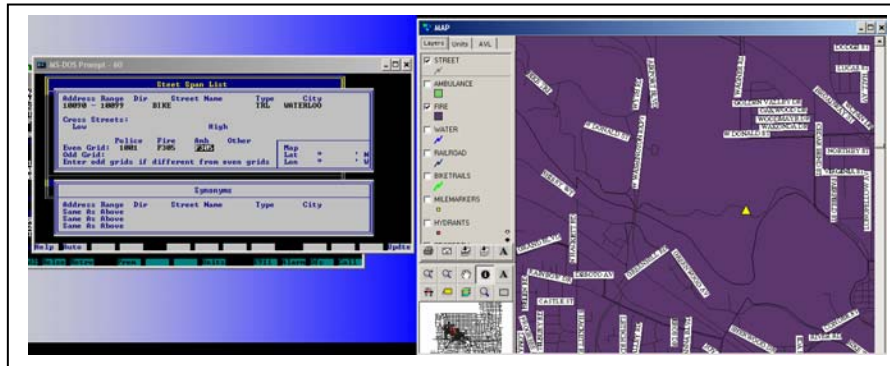


Figure 10. CAD screen showing BIKE TRL address range and a triangle on CAD Map representing the center of that street segment.

Fortunately, the CAD systems allows for the use of alias names. For example, if a caller in need of assistance identifies his or her location as Waterloo Wal-Mart, the dispatcher can enter that information because it is cross-referenced to the Wal-Mart address, and thus to the appropriate address range in the CAD system. That is exactly how the sign identification code is used. The sign identification codes are entered as aliases and are related to the appropriate address range. So, each of the 267 features that will have a 911 sign attached to it, with its particular sign identification code, will be related to 1 of the 83 BIKE TRL street segments. At present, the CAD system allows for only three alias entries. The use of the alias will bring the view on the CAD map to the appropriate BIKE TRL street segment. The 911_sign_locations point shapefile is used in the CAD map to identify the feature with a specific sign identification code.

KEY FINDINGS

While the 911 Signs Project does improve location communications, future updates of the CAD system software will remove some present limitations. The data fields for address numbers (as LEFTFROM and LEFTTO) can hold up to 12 digits in the ArcObjects application. However, the address fields in the CAD database are currently limited to five digits. This issue will be resolved within the next year by the CAD software developer. In some cases, there are more than three 911 signs within a square mile area of the map grid, so allowing more than three alias entries would also be beneficial. However, when a Trail user dials calls 911 and communicates a sign identification code, the dispatcher enters the identification code into the CAD system, which triggers the CAD map to center a particular BIKE TRL segment in the CAD map view. The 911_Sign_location shapefile, with the map tip set to the 911_SignID field, allows the dispatcher to visualize the location of the feature quickly in relation to the nearest Trail access point. Overall, the project has met the intended goals. Cooperative input from different viewpoints proved to be helpful in generating ideas and protocols. The ease of annual review to assess sign condition and readability will be beneficial. The project was accomplished at a very low cost.

CONCLUSIONS

This project provides a practical solution for georeferencing multi-use recreational transportation routes and related assets. The use of GPS and GIS technologies greatly simplified the task of assembling the data needed for improved trail location communication for both public safety, and asset management. Using a Trimble GeoXT GPS receiver, collecting location and attribute information for over 1,700 permanent trailside features, along with related digital photographs for each feature along the 100-plus miles of paved and dirt trail in BHC, was accomplished in less than three weeks. Incorporating these georeferenced point features into a GIS project provides easy and quick access to the information needed for location communication and asset management. A map grid system designed with GIS software provides a means to assign an identification code to selected features, primarily benches, along the Trail. The first three characters of the five-character alphanumeric identification code on the newly designed 911 sign locate a feature to within a particular square mile on the map grid. The last two characters define the location to a particular one-tenth square mile area. With all data in digital format, any additional trails and trail features can be incorporated easily into the existing data sets. Basic computational and analysis tools in ArcGIS (ArcView) made processing the shapefiles for incorporation into the dispatch center's CAD system an easy task. Annual review of asset conditions will be accomplished efficiently by loading the GIS data back into the GPS receiver. Cooperation between numerous agencies involved in this project, along with grant funding and in-kind contributions, enabled speedy completion of this project. The entire project, including sign installation and location communication testing, was completed within one year of its original conception.

ACKNOWLEDGMENTS

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