

# Statewide Addressing for Enhanced 9-1-1 Lessons Learned in New Mexico

By  
Keith W. Cunningham, PhD

## Abstract

Since 1998, the State of New Mexico has been funding the assignment of physical addresses in all Counties with the goal of an E9-1-1 database with at least 96% completeness. This paper presents the methods used in New Mexico to establish statewide GIS/GPS addressing as well as the management and technical lessons learned on a project of this scale.

## Introduction

The physical address is not only important in the dispatch of emergency services to the location of an emergency; it also plays a role in the routing of the call for 9-1-1 service to the appropriate public safety answering point (PSAP). There are more than 70 PSAPs in the State of New Mexico, all of which have the necessary telephone networking and equipment to provide Enhanced 9-1-1, but the databases are incomplete in the rural portions of the state.

Physical or city-style addressing along with another 9-1-1 database called the Master Street Address Guide (MSAG) are required to have an operational E9-1-1 system. These databases were only operational in the larger metropolitan areas, which account for about two-thirds of the 800,000 telephone records throughout the State.

The other third of the 9-1-1 records in the State had no city-style addressing and without addressing, the MSAG could not be developed. The State concluded in 1996 that most rural counties could not provide E9-1-1 addressing without State assistance, thus the database for E9-1-1 would remain incomplete.

In 1997, the State amended its emergency telecommunications regulations. This legislative revision required PSAPs to obtain a database completeness of at least 96% to continue to receive E9-1-1 financial assistance from the State. This meant assigning addresses and ensuring a match of all telephone records against the MSAG for a minimum of 96% of the Automatic Location Information (ALI) database records served at that PSAP.

Simply put, the rural counties had to address.

## Funding

To support this mandate, the State dedicated 9-1-1 surcharge monies to assist the counties in completing the addressing. In New Mexico, the 9-1-1 telephone surcharge monies are collected by the State, and this pool of \$7 million is managed by the Department of Finance and Administration. These funds were used to fund the addressing and database work and would be distributed via grants.

All 33 counties and other municipalities were invited to apply for the addressing grant. In June of 1988, the State Board of Finance awarded 52 grants to all counties and some municipalities. The grant amounts varied for Counties from \$55,000 to \$274,000 based on the number of addresses to assign, road mileage, and the completeness of their 9-1-1 databases. Nearly all communities who applied for the grant were recipients.

A condition of the grant was to complete all 9-1-1 database work by December 2001. Additionally, the grant recipient was responsible for preparing a geographic information system (GIS) of all roads and houses, preparation of the MSAG, as well as address data sharing with utilities and other government agencies.

Most importantly, each grant recipient was responsible for maintenance of the addressing system after the grant was completed.

It was also envisioned that the resulting GIS databases would be used in a variety of other functions, thus jumpstarting GIS in each County. The desired uses included PSAP dispatch mapping, parcel mapping, voters' registration, redistricting, etc.

## Approach

Assisting the State in formulating the required E9-1-1 database tasks were staff from other State agencies, universities, consultants, telephone companies, and PSAP managers.

Their input resulted in a 68-page addressing manual prepared to guide communities in the addressing process. This manual described a standard methodology for implementing road mapping, road naming, addressing standards, 9-1-1 database standards, and methods of quality assurance.

### The Project Manager

The first step required from the grant recipient was the assignment of a project manager. The project manager was tasked with these eight points:

- 1) Assigning physical addresses;
- 2) Participating in required training;
- 3) GPS/GIS all roads – public & private;
- 4) GPS/GIS address data collection;
- 5) Quality assurance;
- 6) Developing the MSAG;
- 7) Managing hardware and software purchases;
- 8) Supervising all employees and contractors.

The 9-1-1 grant could be terminated by the State if the project manager did not complete any of the above steps. By the same token, failure to provide any of the deliverables listed below could result in suspension of the grant.

A summary of the minimal deliverables for each grant recipient included:

- A) Hard copy maps of all roads and addresses to the PSAP, emergency services, county government agencies, telephone companies, the USPS and local utilities;
- B) Minimum GIS/map content with, road centerlines, road names, symbolized points for addresses and other features, i.e. house, business, hydrants, pay phones, gate, parks, etc. Ancillary data including emergency service zones (ESZ), fire, ambulance, law, and ZIP codes for MSAG creation;
- C) Provide all GIS data and metadata to the State for quality assurance, and inclusion in the statewide GIS data warehouse;
- D) Build all GIS data with goals of PSAP dispatch mapping and parcel mapping;

- E) Conform to State and USPS standards for addressing and road naming and generate MSAG to telephone company specifications;
- F) Deliver data to the State in an ESRI shape file with all GIS data in NAD-83, New Mexico State Plane Coordinates;
- G) Manage all confidential USPS and telephone company information and provide address conversion databases back to USPS and telephone companies.

### State Price Agreements

The State also received advice from a number of vendors who provided guidance on GIS, GPS and Enhanced 9-1-1 databases. Based on what the State learned, two RFPs were issued to create two state price agreements to assist the grant recipients in selecting qualified 9-1-1 addressing software vendors and addressing consultants.

The first state price agreement identified two vendors who develop and maintain GIS software specifically for E9-1-1 addressing and MSAG construction. Both of these software systems operate as an “extension” to ArcView. The State desired that all GIS data be created in an ArcView Shape file format.

The second RFP was for addressing consultants. It resulted in the selection of five addressing consultants from about a dozen interested vendors. These consultants were vetted by the State for their experience with addressing as well as experience with GIS and GPS consulting. Of the five vendors selected for the price agreement, three were dedicated addressing consultants and the other two were photogrammetric engineers with good GIS and GPS credentials.

One vendor provided software and addressing on both state price agreements.

With the grants monies available and the state price agreements established, the grant recipients were ready to select software and consultants to begin their addressing. It should be noted that the Counties were not required to use the software or services of the vendors on the price agreements. They could still bid their own projects, however the State would more closely scrutinize their decisions and use of the grant monies.

Of the 33 counties, 4 decided to use addressing vendors not on the State’s price agreement. A few municipalities also decided to hire other engineering

firms. In about 8 cases, software other than ArcView was used for the GIS construction.

## Lessons Learned

The State encountered many problems with data, software, hardware, the grant recipients, and with the vendors. Generally there have been two types of lessons learned: Managerial and Technical. The managerial issues relate to the people and institutions implementing the grants. The second issue of technology largely stems from the technology being applied incorrectly or inefficiently, specifically the proper use of the GIS and GPS technologies in constructing the E9-1-1 telecommunications databases.

### Managerial Lessons

#### *Project Complexity & Uniqueness*

Changing an address affects the identity of the citizen. Address conversion is not just making a map, but a public relations campaign promoting the new road naming and educating the public about the need for new addressing. In some communities there is strong public involvement in the naming of roads and committees established only to preserve historic road names. In other communities these processes occur behind closed doors, which may impact politics later. One County may have few road naming issues, while the next county may have significant work required to name their roads, possibly being politicized.

A consultant will find what worked technically in one county or community is not transferable to the next. Issues related to existing data, road naming, politics, and geography affect how data are collected and processed. In some counties, GPS works well and the satellite imagery is clear and easily interpreted, while the next county has different circumstances due to terrain and tree canopy.

The State also learned that each county had different organizational approaches to addressing. There was no set county department, which had the 9-1-1 project manager. Addressing was found in the assessor's office, road department, community development, planning, and public safety. In two counties, the county manager was actively involved. Only a few counties actually had a GIS department.

Another issue creating differences in each county was the status of their addressing and 9-1-1 databases. Those counties who already had some addressing

were forced to consider how to include and preserve this addressing while creating new addressing in the remainder of the county. If addressing already existed, the ALI and MSAG databases were also likely to be operational and implementing additional addressing would adversely affect the accuracy of these existing 9-1-1 records until the project was complete. This required special consideration and skill on the part of the vendor.

The State also had to exercise flexibility with the use of the grant monies in each county. Some counties were so poor that the State approved grant monies for salaries, vehicles, and departmental cross-use of the data and equipment.

#### *PSAP Coordination*

Many counties did not realize that the addressing and 9-1-1 databases had to be shared in real-time with their PSAP. This meant that dispatchers often did not utilize the products created for addressing.

For example, a 9-1-1 dispatch center may have been unaware of a road name change, or addressing corrections, and never received a map of the community. Revisions to the MSAG could occur at the PSAP without the addressing staff being informed.

This problem was identified later in the grant process, and communities with remaining grant monies were directed to work on this form of data sharing. Some communities have already deployed the GIS data at the PSAP.

#### *Technical Requirement of the Community*

Managing addressing turns out to be very complicated: Numerous entities including the US Postal Service, telephone companies, municipalities, and county government agencies all need to cooperate. This cooperation extends to schedule, road naming, data sharing and maintenance. The good consultants realized they had to forge this team while the poor consultants relied on the County to provide this organization.

Some consultants also expected too much technical expertise from their customers, including an in-depth knowledge of product deliverables and GIS/GPS expertise. When the customer could not provide the consultant with organization or deliverables, the consultant blamed the customer and the project failed.

The skill of the county's project manager varied considerably. Project management turnover was a problem with some counties having as many as four different project managers over the grant period. Perhaps the complexities of the GIS/GPS/911 activities were too much for the project managers, and if they did learn all of the technical details, that knowledge was lost if the project manager was lost. GPS and GIS were not solutions. Instead, reliable people trained to use the technology were the solution.

#### *USPS Coordination*

Unlike addressing projects in other states where the US Postal Service strongly supports the 9-1-1 addressing process, the USPS in New Mexico had to involve themselves differently because there simply was no volume of rural deliveries for them to justify their full support.

A few counties followed the envisioned procedures for cooperating with the USPS for address conversion. These counties had large rural delivery routes. Other counties, whose mail delivery was almost exclusively Post Office Box and General Delivery did not have direct USPS participation.

#### *State Supervision*

The State of New Mexico believes that the size and scope of the project should have justified a state-level official monitoring the grants. This would have identified problems earlier with the various consultants and bolstered the local management of the 9-1-1 grant. In a few cases, wasteful use of the monies could have been avoided.

#### *Database Creation Versus Maintenance*

Vendors and communities have often failed to understand that there is a difference between building these addressing databases and maintaining them. The tools for database creation are different from the tools used for database maintenance.

The State has also observed that database maintenance, which occurs forever after the 9-1-1 databases are created, must be an integrated process of using the 9-1-1 data in real-time from the field. This means the traditional GIS and GPS workflows must be changed and integrated, with their technical functions placed inferior to 9-1-1-database maintenance. The vendor that integrated this process, making the GPS and GIS transparent to the user, had a vastly better method of maintaining the 9-1-1 data.

#### *Not a GIS/GPS Project*

The majority of the companies responding to the State's RFP for addressing consulting services were surveyors and photogrammetric engineers. All steps in the RFP identifying the construction of the road centerline, addressing, 9-1-1 database creation and data sharing were well defined. Those vendors selected for the price agreement responded well to all the points in the RFP and appeared to be qualified.

However, this project proved that book learning and research to respond to the RFP is no substitute for real experience. The consulting firms who failed on the project did not fully understand the 9-1-1 database process and how it relates to the GIS/GPS mapping process. They also could not adapt their learning and experience to the special circumstances of addressing in New Mexico, which were always different from county to county.

In short, addressing for 9-1-1 is not a GIS or GPS project, it is an emergency telecommunications-consulting project – which only happens to use GIS and GPS as tools.

#### **Technical Lessons**

The technology was not a solution to any of the problems encountered in the addressing project. However, in the hands of qualified people and if the technology is used appropriately, it could be used to complete the addressing economically and with few errors.

#### *Satellite Imagery*

IRS satellite imagery for the entire state was acquired for the 9-1-1 project. It was assumed that the imagery was necessary for quality assurance to locate roads and addressable structures missed by the grant recipients. However, the 5-meter resolution was too coarse to adequately identify many homes and was of little use in forested areas.

Besides delays in receiving the imagery, the horizontal accuracy was often much worse than the specified 40 foot. The black and white panchromatic imagery was also difficult to use in locating paved roads due to the lack of contrast between the roads and surrounding vegetation.

The DOQ data was available during the period of the grant and was superior to the IRS data. However, complete state coverage is still lacking today. A better approach may have been to partner with the

USGS to accelerate the development of the DOQs, rather than purchase the IRS imagery.

#### *Quality Assurance*

The IRS imagery was used to examine the spatial accuracy of the roads and addressing in each county. From this QA process, one consultant was found to be using recreational GPS receivers without differential corrections to remove the earlier effects of the Air Force's intentional positioning scrambling called Selective Availability. The problems of this vendor were identified using the satellite imagery, though it was not uncommon for the imagery to not match accurate differential GPS locations.

Besides the quality assurance for the spatial component, quality assurance was implemented for the attribute data. This included examining the attribute data in the road centerline files for missing road names and address ranges, as well as examining the addressing data for missing or bogus data.

As the quality assurance methods evolved based on feedback of counties submitting their GIS data, consultants whose methodologies were not as refined and detailed often complained of the revisions to the QA/QC standards.

#### *Field Data Collection & Methodologies*

While consultants used GIS and GPS technology for the mapping, the industry-accepted techniques were not appropriate for 9-1-1. Most consultants treated the use of the GPS as a distinct step in their whole, multi-step process. The most successful consultant integrated the GPS passively with their 9-1-1 data collection, reducing the total steps in the process.

This consultant with this different approach spoke of the GPS position being collected as a passive or background process while their staff focused almost entirely on building the 9-1-1 records. Their different approach turned out to reduce errors and keep their projects on schedule. It also avoided a disconnection between the GPS locations and the 9-1-1 records.

An example of the differences in GPS data collection techniques is Sandoval County, with suburbs of Albuquerque. They reported a 200% improvement in their productivity and a dramatic reduction in data collection errors after transitioning from the traditional GIS/GPS methods learned from the GIS and GPS vendors, and then using the integrated GIS/GPS methods designed specifically for 9-1-1 databases.

#### *MSAG Complications*

At the very end of the statewide process, the specifications for the MSAG were changed. The change affected the definition of community database field in the MSAG. At the beginning of the project, the community designation was based on actual corporate limits, with addresses outside of an incorporated community having a designation in the MSAG with the County's name. Midway through the project, the community definition was revised to include place names for communities which were not incorporated, adding significantly richer information to the MSAG and bettering the understanding of the 9-1-1 dispatcher about where an address is located. Finally, the MSAG community definition was revised again, this time based on ZIP Codes, thereby eliminating many of the small communities and other useful dispatch coding. Some counties have only two or three major ZIP Codes and of course many ZIP Codes cross county lines.

To help remedy the loss of the dispatch information, the telephone companies agreed to allow more detailed Emergency Service Zone (ESZ) mapping, even allowing single agencies like sheriff's departments to define multiple dispatch regions.

#### *Telephone Data Loading*

A major delay encountered with the address conversion process is the requirement of the telephone company to have a completed MSAG prior to loading any address corrections. With the MSAG changes occurring up to the last moment, the update and correction of addressing data at the telephone companies was also delayed.

Another factor affecting the address conversion process at the telephone companies was the sale of GTE franchise to Valor Telecommunications. This resulted in several counties experiencing delays in acquiring telephone customer service records and then the telephone companies lacking the corporate infrastructure to manage the loading of the new addressing. The delay experienced by three counties was more than 18 months.

#### *Map Coordinates*

New Mexico has three state plane coordinate zones and counties from one zone do not "tile" against the counties in the adjacent zone. This results in the State lacking a uniform coordinate system that can be used in a seamless statewide 9-1-1 GIS.

Perhaps using UTM Zone 13 and extending zone 13 into the small sliver of zone 12 found in western New Mexico would have been a better choice for GIS map coordinates used by 9-1-1.

Additionally, using UTM in the addressing process would have likely resulted in an addressing system that is then compatible with the inexpensive GPS receivers often used by search and rescue and local fire departments.

## Summary

While the final results of the addressing in New Mexico were satisfactory, there were many complications.

One vendor was up to the task and two went out of business. Surveyors, engineers and product vendors are not addressors. Too many consultants thought it was a GPS/GIS mapping project.

GIS and GPS are necessary technologies for the completion of a 9-1-1 addressing project, but if the technology is used incorrectly, the results are less than satisfactory.

The single largest factor affecting 9-1-1 database construction in New Mexico is “data decay” where portions of the 9-1-1 database change very quickly. In some communities, the names and telephone numbers of the persons receiving a new 9-1-1 address may change by as much as 50% in a year. Very quickly the 9-1-1 data collected for addressing becomes stale and even useless.

Unless a maintenance process is integrated from the beginning to update the 9-1-1 databases, the number of errors in the system will prevent its reliable use.

The goal of Enhanced 9-1-1 is to save time in providing emergency services and if the data driving the system is inaccurate or incomplete, the public’s confidence will suffer.

### About the Author

Keith Cunningham founded Spatial Data Research in 1993. While semi-retired, Keith still advises SDR and its customers on issues of project management, software engineering, and continues his own research with GPS and GIS integration. Spatial Data Research continues to work with the State of New Mexico and numerous other counties, assisting with their GIS and addressing implementations for enhanced and wireless 9-1-1.

Keith received a PhD in Geography from the University of Kansas in 1997, with an emphasis in artificial neural networks for GIS data processing. Prior to founding SDR, he served as a GIS/addressing consultant for GTE, and prior to that was a statistician/geographer with the US Census Bureau building TIGER Line Files.