

GIS Tools for a Small Groundwater District

Abstract

In Texas there has been a proliferation of small groundwater districts created to manage the groundwater resources of the state. One such district is the Lost Pines Groundwater Conservation District in central Texas. The district, with a staff of two with no GIS expertise and a budget of less than \$50,000, can now produce maps showing water levels, distribution of wells by type and use, information on wells in a given area and other permitting needs as needed. The paper will present some of the tools and concepts developed by the district and its consultants to aid in the management of the water resources in this small two county district. The paper will show how the use of buttons and specific views and projects eliminated the need to have a GIS expert on staff. The paper will also discuss future needs of the district and possible solution that would use GIS.

Introduction

The GIS tools enable the staff of Lost Pines Goundwater Conservation District (LPGCD) to evaluate permit applications for compliance with the rules of the district, inform the effected public of pending applications, enable the board of the district, communities and diversified people to examine the issue of water availability, usage and rights.

State prospective

Groundwater in the state of Texas falls under the right of capture rule unless regulated by a local Groundwater management district. Right of capture generally is considered as

"He who has the biggest pump gets the most water."

Tax relief request by high plains irrigation farmers in the 50's established the legislation where communities can create a Water District. Declines in water levels were valid federal tax write offs. Prior to the mid 60's, the Groundwater districts were chiefly created for income tax purposes. In the mid 60's or early 70's, that changed more to a regulatory function. Districts were created in the Houston area to control subsidence in Houston-Galveston area and in the San Antonio area for the protection of endangered species in the springs at New Braunfels and San Marcos.

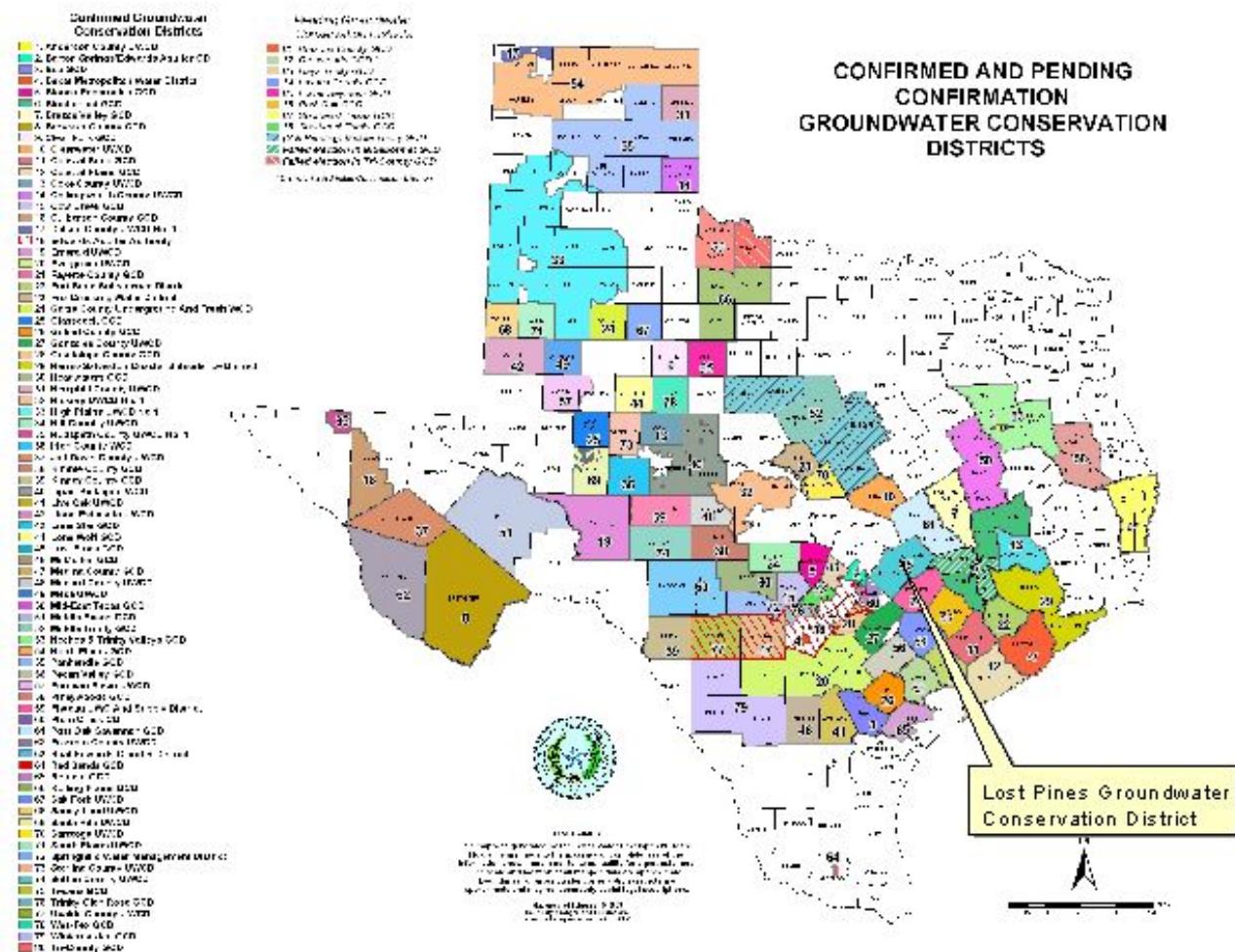
The 1990's saw the function change again. Drought in Texas created awareness of our limited water supply. As water in the drought stricken sections came more critical, endangered species and Texas Wild rice were used to force cities into water conservation programs and limiting of water use, cities looking for alternate water sources bought up tracts of land in rural areas for the water under the land. The practice is commonly called water ranching. Water ranching runs the gauntlet from business cartels buying up large tracts of land or obtaining leases to use water from many smaller tracts; to public utilities obtaining tracts of land in areas not considered as their service area.

Today, the concern for the validity and usage of water has moved from academia and state planning agencies to the general public. In rural areas people are asking the questions.

"Will I have water to drink and for my livestock?"

Groundwater management districts have been or are been formed throughout the state to try to prevent large municipalities or water suppliers from taking all of the local water. Over the last four legislative sessions the number of Groundwater districts has increased to 72. These districts are general one or two counties in size and are funded through a tax based or fee's collected. Groundwater Districts can make rules to mange the resources within the district within the legislative intent outline by chapter 36 of the Texas Water Code. **Map 1** shows the current Texas Groundwater Conservation Districts (TGCD) and the size of the districts vary from a small

geographical area to several thousand square miles. The Lost Pines Groundwater Conservation District is represented in Turquoise number 45.

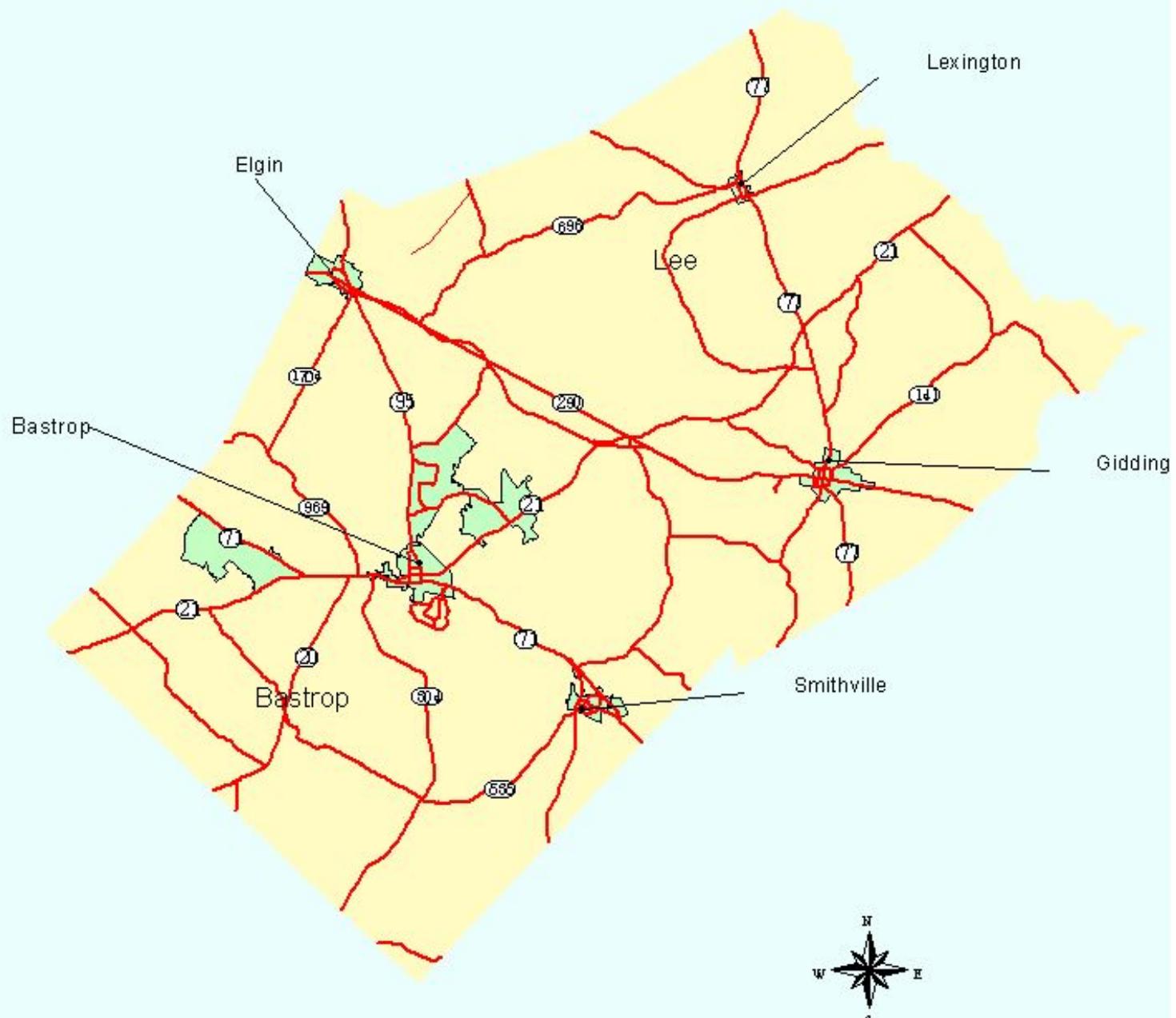


Map 1. Texas Groundwater Conservation Districts

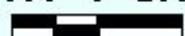
Lost Pines

The Lost Pines Groundwater Conservation District (LPGCD) is charged with protecting the groundwater resources under fourteen hundred square miles of land. The district has two river basins flowing through it, and is in two different regional planning groups and council's of government. In 1998, LPGCD was created by the 76th Legislature and approved by voters in Bastrop and Lee counties in November 2002. The high voter approval, 70%, shows the level of concern over water availability. The jurisdictional area, **Map 2** depicts Bastrop and Lee counties located in central Texas. They sit upon the Carrizo Wilcox aquifer. Basically a rural area, future population projects target a shift to a more urban area. Presently the population is over 73,000 and as people migrate from the population centers of Austin and central Texas it is expected to grow to over 265,000 in the next fifty years.

Lost Pines Groundwater Conservation District



20000 0 20000 Feet



Map 2. Lost Pines Groundwater Conservation District (LPGCD)

Managing with GIS

Using maps, databases, and handheld GPS systems, the Lost Pines Groundwater district locates new and existing water wells. The GIS technology provides businessmen, citizens and landowners an opportunity to participate in the water planning for their area.

It was determined that in the permitting and protection process that there was a number of requirements and decisions that staff were going to have to do that require the use of maps to accomplish the tasks. LPGCD hired a groundwater specialist to assist them in formulating a strategic plan. A specialized groundwater permit system was developed. This system enables the LPGCD to issue and tract various type of groundwater permits, track new well development, register wells, and collect registration and pumping fees. Also integrated into the system is the prior well data or historical data from the Texas Water Development Board. (TWDB). As the permit numbering system is based upon a geospatial grid and new well application is assigned by its location with the grid the next step in the strategic plan was to use integrate the Access database with geospatial coverages for the two counties.

Strategic plans requirements and problems

The LPGCD required the development of a system to be used by personnel with limited computer experience and no GIS experience. The process had to be simple enough for present staff to use, as no funds were available for addition staff. The process had to incorporate the already drilled wells, the newly permitted wells and the historical data from outside sources. The system needed to identify wells by various categories: agriculture, municipal, domestic as well as exempt and nonexempt classes. Existing wells location needed to be collected and documented. The system required the data to be entered as it happened and data had to be entered in only one place.

The grid system used to number the permits and the wells had to be made easier to use. The current process required that staff had to rummage through a ton of 7 1/2-minute quad sheets to find an applicant's location and determined the grid number. Additionally the permitting process required a 1000 feet buffer zone around wells. A new applicant cannot be with 1000 feet of another well or 50 feet of the property line. When a new application came in the staff had to locate the drilled wells on the seven and half minute quad sheets and check to see if new application was with 1000 feet of a drilled well. Currently the seven and half minute quad sheets did not have any historic well data recorded on them. The whole process was time consuming and not very accurate.

The system needed to speed up the permitting process. LPGCD rules required that all non-exempt new well applicants notify all property owners within a half-mile of the proposed well. The applicant for a new well permit had to go to the county's central appraisal district and obtain information about the owners within a half-mile of the proposed well. The LPGCD would like to simplify the process for the applicant by providing mailing labels of the property owners.

The system needed to produce board reports and educational material for the general public using maps. Educating the general public by providing maps, tables and information on the resources in the district was considered one of the keys to success of the district.

Strategic plans GIS tools developed

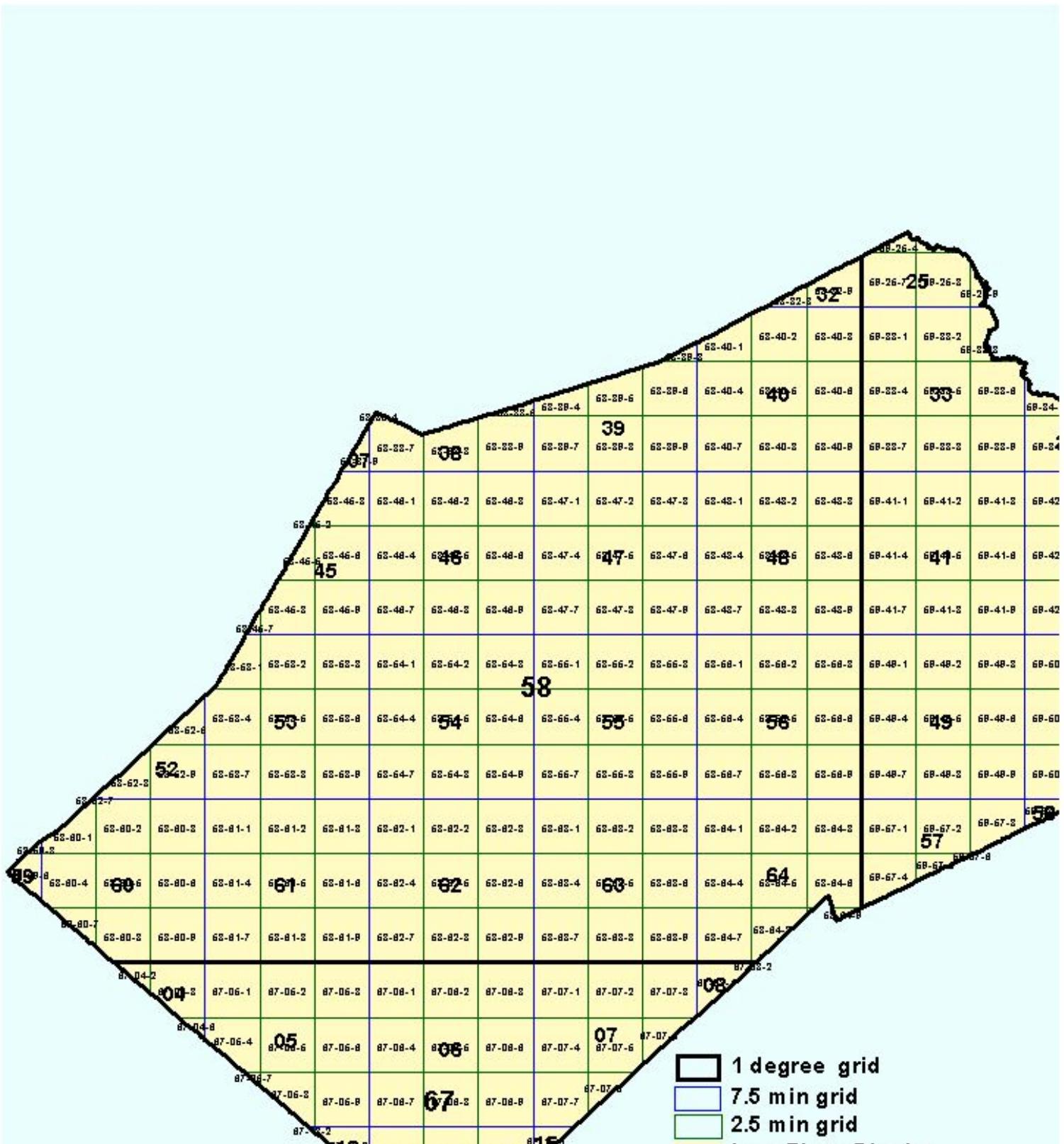
GIS tools were developed to meet the requirements above. The LPGCD GIS system facilitates the locating of new well, verifies the spatial sighting requirements, and the staff can produce adhoc maps for the board and general public. ArcView was used as the GIS component and connects to the LPGCD Access database system for the detail well information data. Avenue scripts were written to simply a set of procedures.

Geospatial data collected and integrated into the projects were base maps for the county, cities, and roads obtained as shape files from ESRI's geography network web site. A local project for the endangered species, "Houston Toad", provided geospatial data for the soils

and land use. Texas Natural Resources Information System (TNRIS) provided the topographical data; the TWDB provided the major and minor aquifer maps, the state grid system and well information for the historic wells. The Bastrop and Lee county Central Appraisal districts provided parcel and ownership maps.

Imposing the TWDB grid system on the base map of the LPGCD developed the LPGCD well grid system, **Map 3**.

Lost Pine Permit Numbering Grid

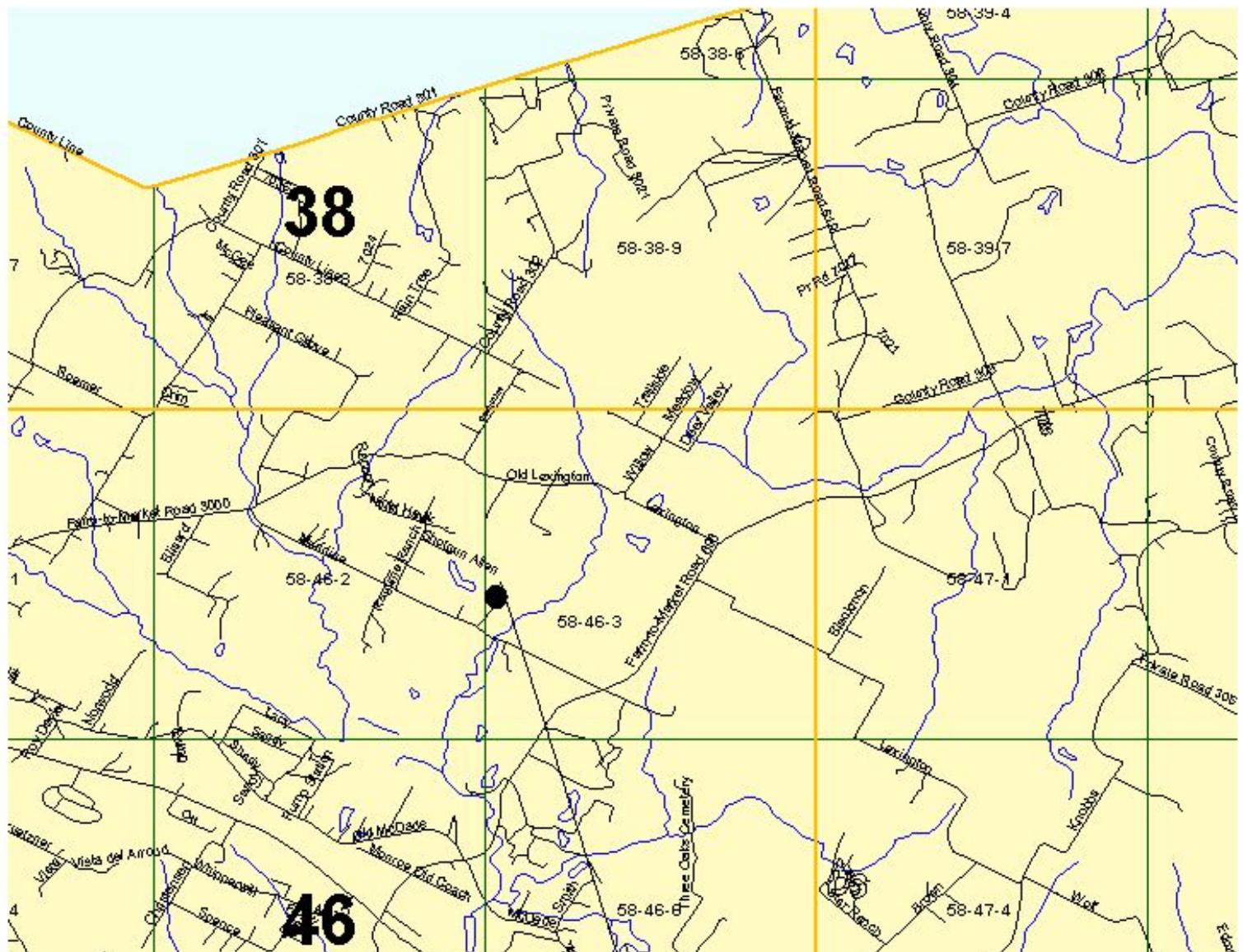


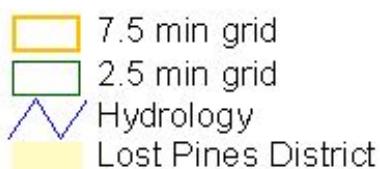
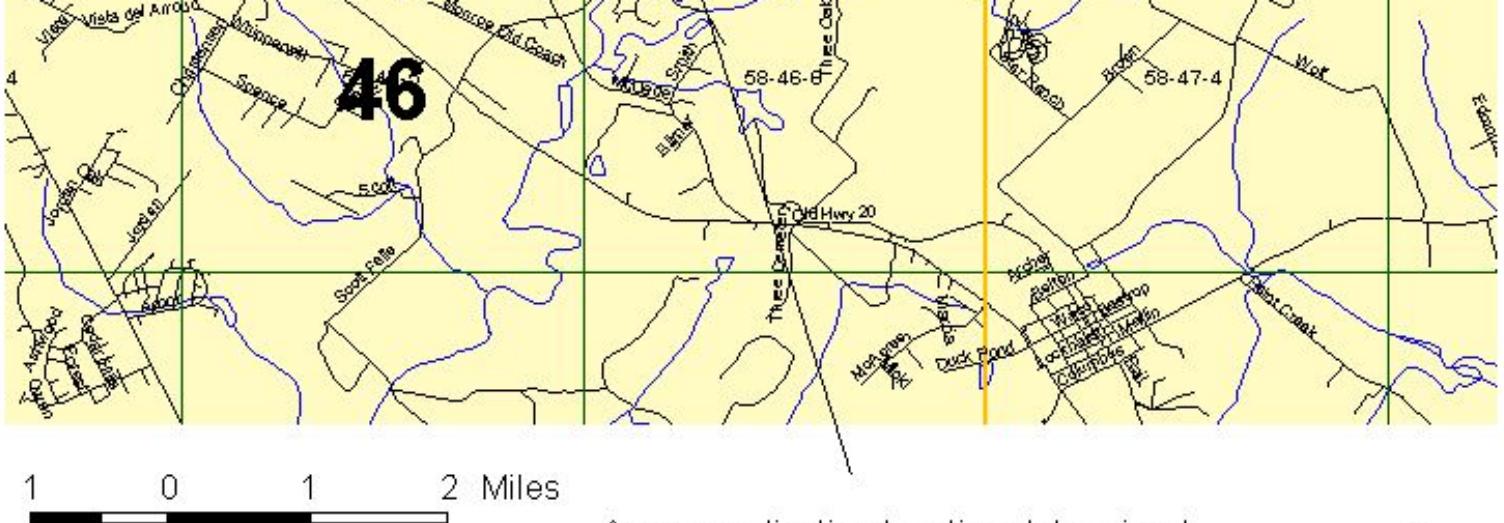


Map 3. Lost Pines Permit Numbering Grid

Upon implementation of the Access system and the ArcView projects, the staff uses the GIS system to locate the general area of the application and the grid coverage to determine the permit number. Staff with the aid of the applicant is able to zoom into the detail area where the applicant wishes to locate his well and easily assign a permit application number. An example of this feature is shown in **Map 4**. The new application was located and assigned application number 5846315 in less than 5 minutes. Using the GIS system and the Access database prohibits duplicate application and well numbers.

Determining the Application Number using the Grid System





A new application location determined, using the grid system found in grid 58-46-3 and upon checking database determined that it was the 15th application thus assigned application number 5846315

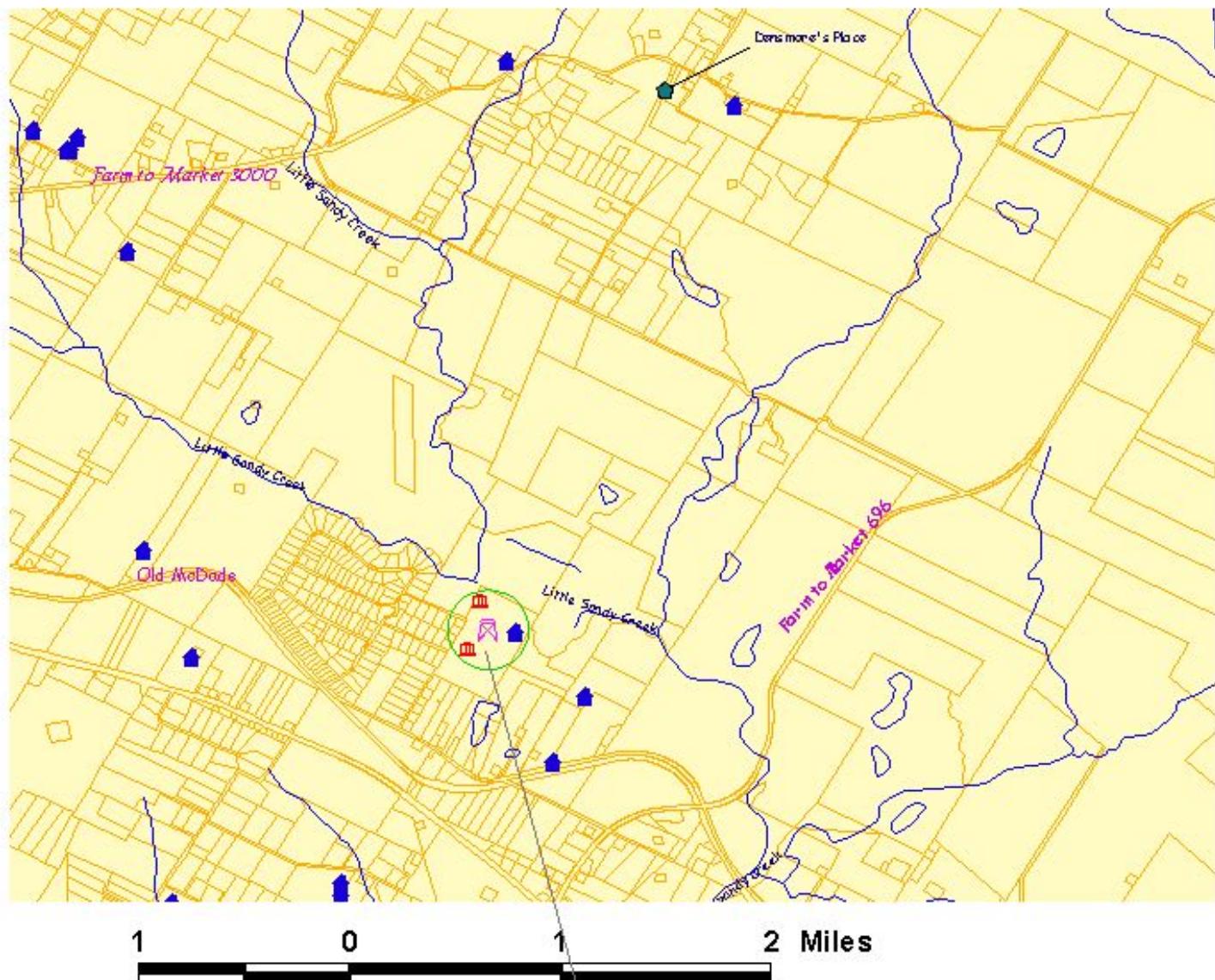


Map 4. Determining Application Number

By using the Access database and SQL connect features of Arc View the information on wells is up-to-date. By powering up in the morning the GIS system has access to all well information as of the previous day.

The staff also uses the GIS system to determine if the proposed well will be in conflict with other wells in the area by creating a 1000 foot buffer around the proposed site and checking for other wells within the buffer. **Map 5** depicts a new well application's buffer area. This well is in violation of the 1000-foot rule. The other wells shown were established prior to the LPGCD. Waivers can be issued depending on the types of wells in the buffer.

Locating a New Well



- Minimum Distance
- ▴ Proposed well
- Usage**
 - Municipal
 - ▲ Domestic
 - * Irrigation
 - Livestock
 - Industrial
 - Aqua-culture
 - △ None
- △ Hydrology
- Bastrop Parcels
- Lost Pines District

The proposed well violates the rule that each well must be 1000 feet from existing wells.



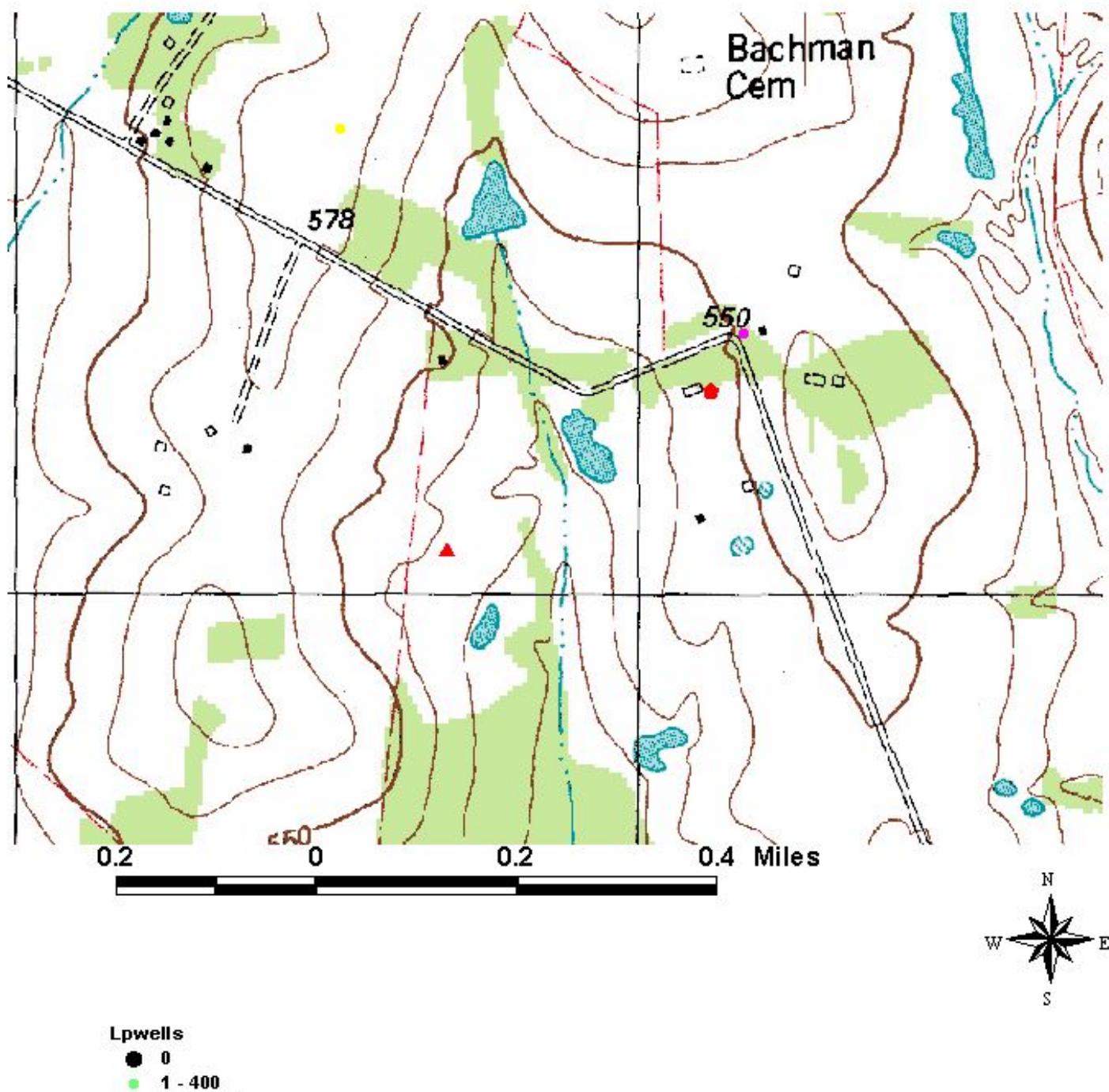
Source: LPGG GIS System

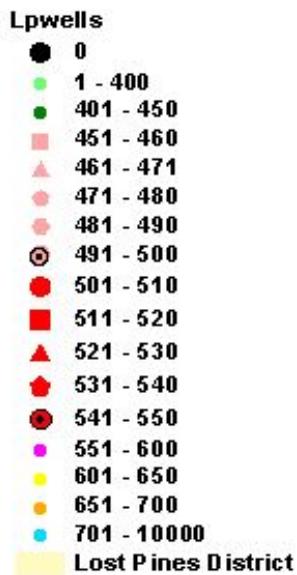
Software: ARView 3.2a

Map 5 Proposed Well Buffer Area

Once a well is drilled, LPGCD staff visits the well site and collects detail information on the well. Its latitude and longitude is collected along with an elevation using a GPS. A water level is also taken and if funding is available a water sample is collected. The collect information is then entered in the Access database. LPGCD's Access database tracks the new well and the historical wells. The staff can use the GIS system to produce various maps of the information in the well information sub-system of the database and check the validity of the data collected using the GPS. Staff has used the system to check land surface elevations as recorded in the well information sub-system. This is shown in **Map 6**.

Elevation Checker



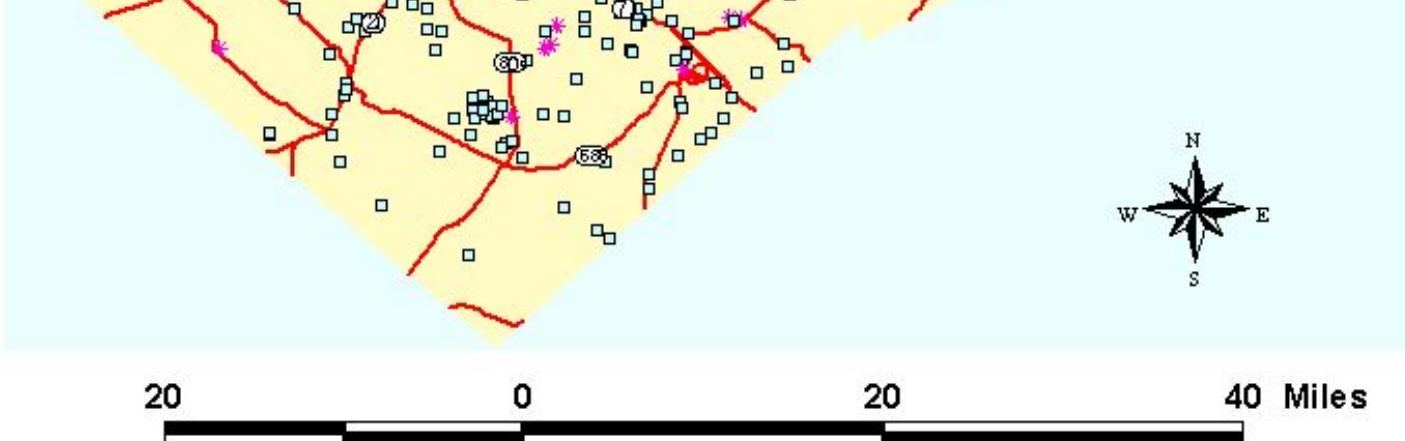


Map 6. Showing example of using the GIS system to check elevations in the database.

A number of map reports are provided to the LPGCD board and the press on a quarterly bases that provide information on the location, type and use of wells in the district. The staff prepares the maps using the Access database and the GIS system. One of the maps, **Map 7**, provided to the board show the number of exempt and no-exempt wells in the district.

Exempt and Non-exempt Wells in LPGCD





Permitted Wells

- * Non-exempt
- Exempt
- Major Roads
- Lost Pines District

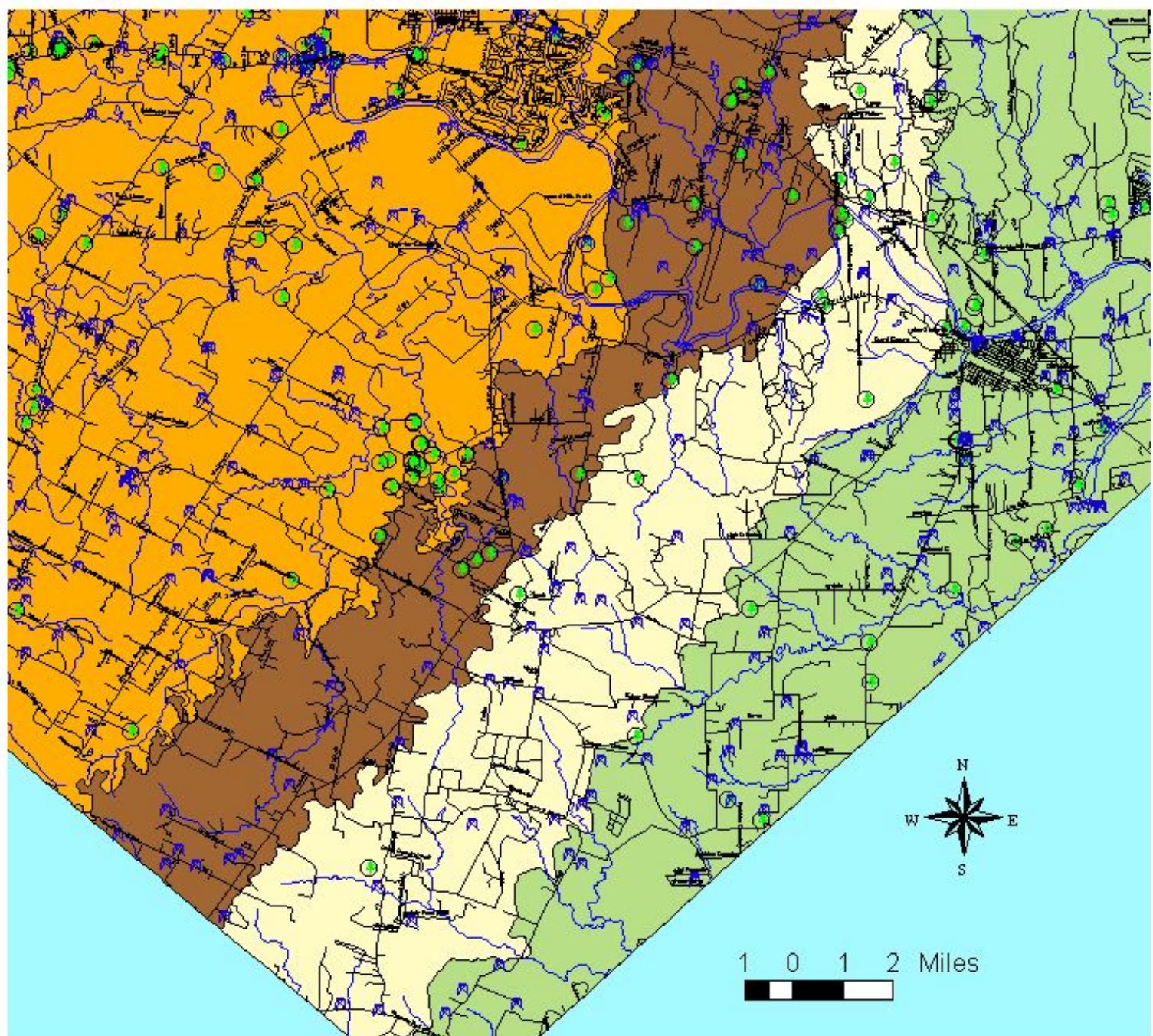
Prepared by:

Lost Pines Ground water Conservation District.

Map 7 LPGCD Exempt and Nonexempt wells.

One of the maps the district is able to produce shown the major and minor aquifers and the well locations. **Map 8** shows an example could be provided to a local paper when LPGCD is having a local town hall meeting in southeast Bastrop County.

Major and Minor Aquifer Outcrop and Wells in LPGCD database



■ TWDB Wells

● LPGCD Wells

Hydrology

Minor Aquifers

■ Yequa

■ Queen City

■ Sparta

Major Aquifers

■ Wilcox

■ Carrizo

■ Trinity



Map 8. Showing Major and Minor Aquifers in southeast Bastrop County.

Things learned

Even with a willing staff there was still a large learning curve. We had to allocate more time to training than was budgeted. Sometimes easy to understand buttons are more complex than they appear. They need to be in a progressive order across the control panel. You need the projection provided that the data is in. We were provided with some coverage's that had no Metadata and it took time to determine the projections.

Naming convention of the data and files were important. We created a data dictionary to facilitate the documentation of the project. Changing the name of data items was costly in manpower in the rewriting of scripts. We also periodically made copies of the databases and keep older versions at different points in time

Changing technology can delay can delay the implementation of the project. We are still trying to overcome this problem. We started development of the process in ArcView 3.2 and now we are converting to ArcGIS 8.3.

Future products desired

After the staff had used the product and had seen demonstrations of other systems they created a "to do" list. This includes incorporating images of all non-exempt wells into the system. This enables new employees to obtain a visual picture of the well site to assist them when they needed to visit the site. The general manager would like to be able to produce graphs of historical pumpage from a well by "clicking" on the well location. Another goal is to resolve issues on updates to the ownership maps and finish implementing the property owner notification mail-out system using Crystal Reports.

The board would like to incorporate information from the Texas state's Groundwater Availability model "GAM" into the GIS system. Simulation of various pumping schemes could be used both for management of Groundwater resources and for educational purposes of citizens. Other plans are to include the public water supply risk assessment model into the LPGCD GIS system.

Conclusion

A GIS system can be developed to aid small groundwater districts in the management of their local resources. It requires the development of special features and customized interface of specific views to enable the staff to use the system

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