Coordinating Infrastructure Projects with GIS
ESRI 2004 User Conference – Paper 1936

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Abstract:
Several departments in the City of Cleveland recently began using GIS to store information about current and future infrastructure projects. The project information came from utility, community development, economic development, and city planning departments. Before using the GIS, project data was stored in spreadsheets and shared to determine any conflicting locations. Now with GIS, queries can be run to instant identify these locations. Project managers can now take advantage of the time that a street is closed and excavated, hopefully reducing the number of times residents ask, "Didn't they just tear up the street last summer?"

Introduction

The City of Cleveland, Ohio serves a population of over 475,000. There are many departments within the City that provide services common to most large cities: street paving, community development, city planning, water pollution control, and the department that both authors work under, water treatment and distribution.

Sometimes the work that these departments perform requires street closures or an interruption of services that impact citizens. In these cases, the City works to minimize these inconveniences by alerting each department when such work is going to be performed. This way, other work planned for the same area may be scheduled to coincide with other work or be re-scheduled for a date far in the future. Occasionally a notice may slip through the cracks and not get out to the other departments. Or an emergency arises, and work must be done that was not originally scheduled. These situations can result in repeated interruptions to the residents that the City would like to avoid.

City Departments and Their Duties

Many City departments are involved with infrastructure projects. Those doing the most volume of work are the Division of Water, Division of Water Pollution Control, Engineering & Construction and the Division of Streets. Engineering & Construction handles road reconstruction projects and the Division of Streets performs the street paving work. The Division of Water handles water main cleaning and lining projects and new main installation or repairs of existing mains. Similarly, Water Pollution Control is in charge of new sewer installations or repairs of existing sewers.

Other departments performing work that impacts the City's infrastructure are Cleveland Public Power, Community Development, City Planning, Economic Development, and Parks and Recreation.

The roadway improvement departments (Engineering & Construction and Streets) are responsible for notifying all other departments of their projects and giving ample notice such that other related infrastructure improvements can be planned, designed, and constructed prior to the roadwork. They are also obligated to review project lists submitted by other infrastructure improvement departments to identify the impact on roadway improvement planning. They establish guidelines for typical life of pavement, so that other departments can plan work such that it will not be recently after a street has been paved.

The other infrastructure improvement departments, primarily Water, Water Pollution Control, and Public Power are responsible to review projects from the roadway divisions and assess the infrastructure work required. They must also prioritize their projects.

Prioritizing Projects Using GIS

Each department has their own method to prioritize projects. It is important not to excavate streets that are recently reconstructed or paved. 7-10 years is the guideline.

An example of how the Division of Water prioritizes projects is shown here. Figure 1 shows some of the information that the Division of Water uses to help decide which projects are most important:

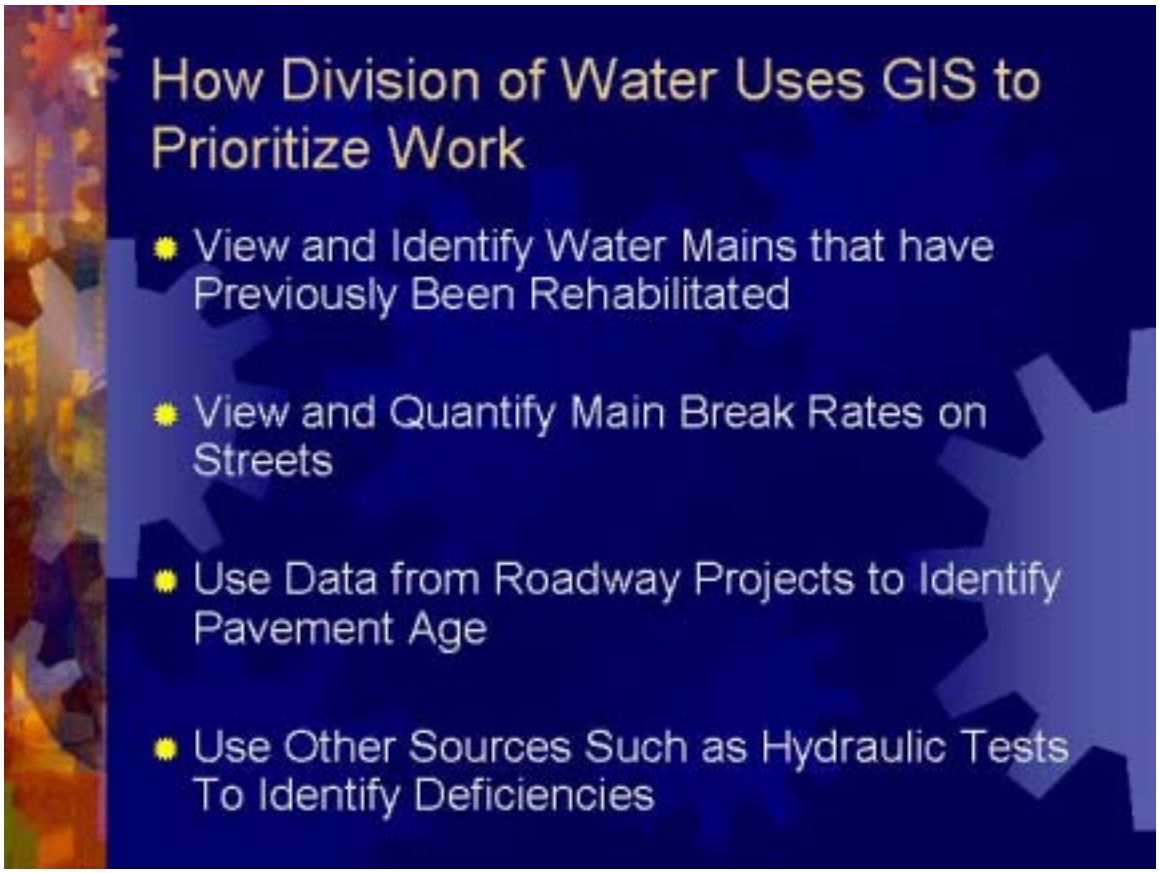

Figure 1. Division of Water Prioritization of Projects

Two of the most often used indicators of water main condition are resistance, or friction, that can be determined from a typical fire flow test of a hydrant, and the history of the water main breaks in the vicinity of the main. The following figure shows analysis of mains within the City of Cleveland and their break rate based on the database that has been kept since 1989.

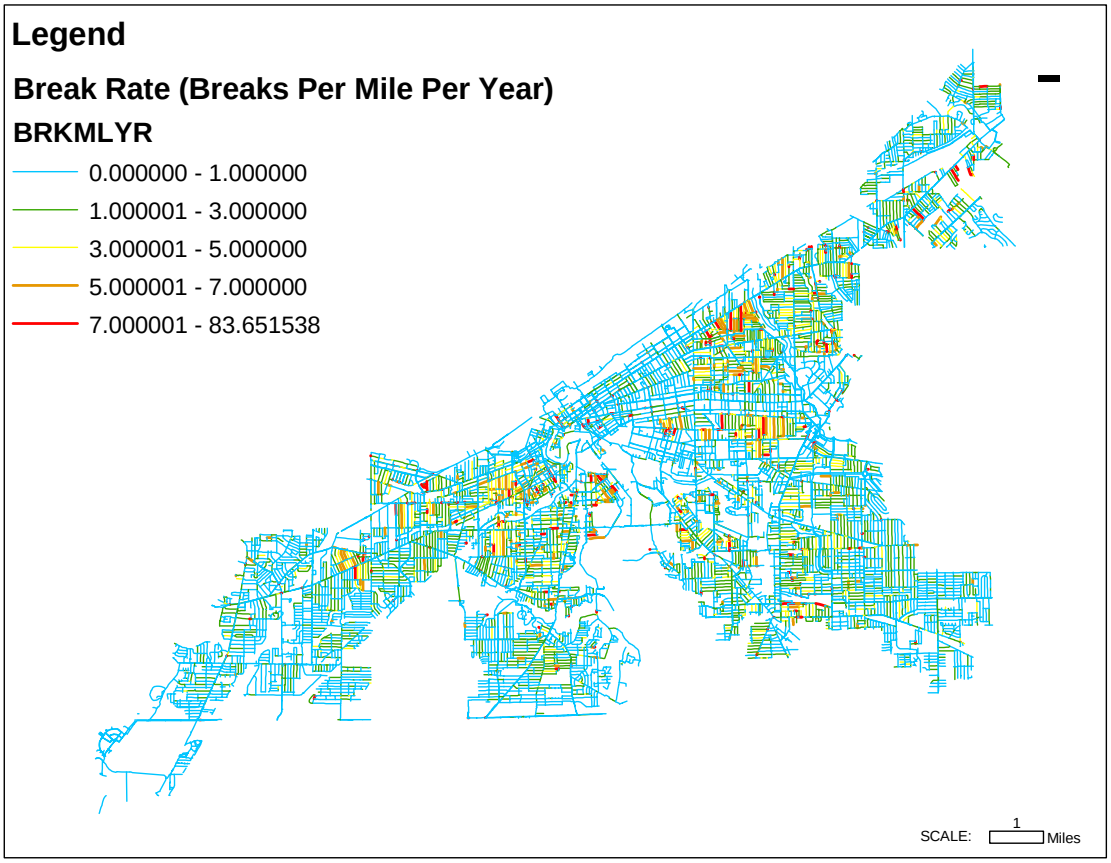

Figure 2. Map of Main Break Rate in Cleveland

The main break database was geocoded, and then a spatial join was performed to associate a PIPE_ID from the Division of Water's Hydraulic Model GIS with each break. Then, a summary table was created to contain the PIPE_ID in one column and the total number of breaks that is associated with that pipe in the second column. This was then joined to the Pipe table in the GIS. From there, using the SHAPE.Length field and knowing that the break database has been kept for 15 years, the Breaks Per Mile Per Year could be calculated. Mapping these values quickly identifies areas in the distribution system where main breaks are frequent and replacement or cleaning and lining should be considered (Figure 2).

The association of resistance to pipe was performed using the Fireflow Test layer that has been developed at the Division of Water over the past couple years. All fireflow tests on record were associated with a hydrant and the test information was associated with a point feature that is coincident with that hydrant. From there, fireflow test points were spatially joined to the Pipe layer so that all attributes from the fireflow test could be found in the pipe table. This is thematically mapped in Figure 3.

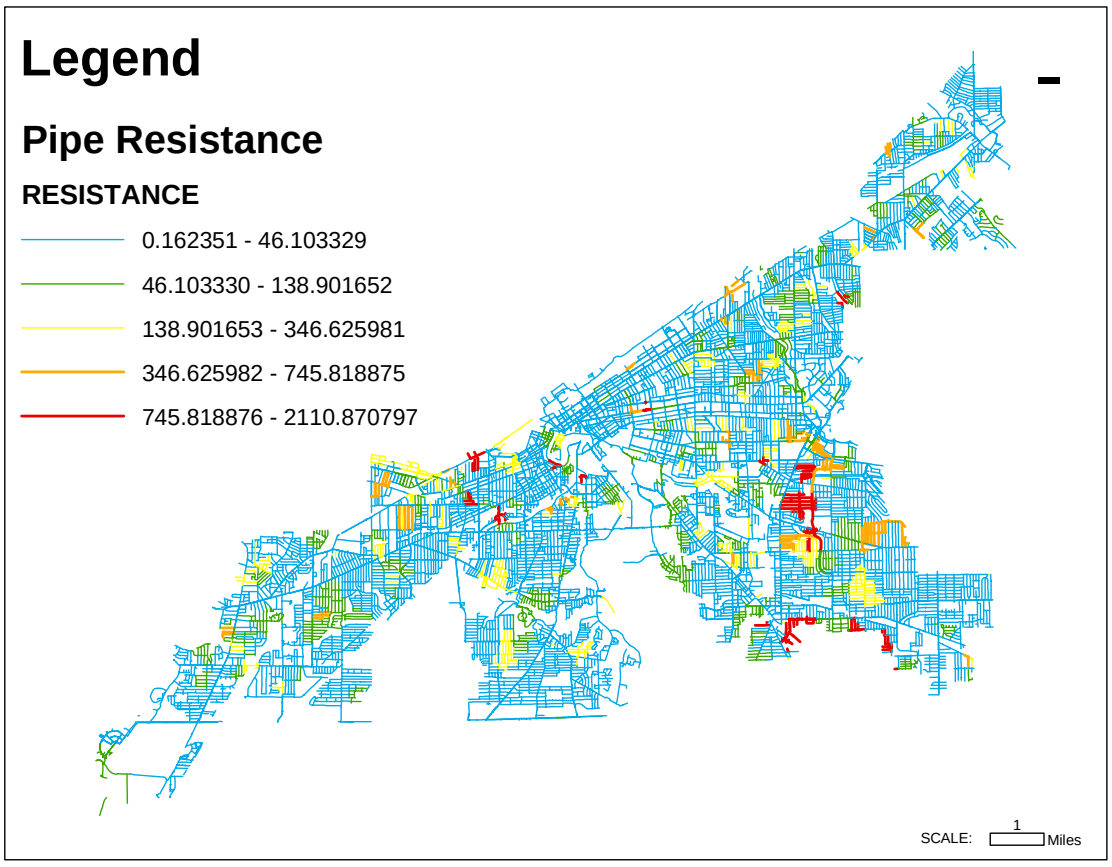

Figure 3. Pipe Resistance in Cleveland

These maps could then be combined to show one map that could be used to prioritize water main maintenance that factors in both break history and pipe resistance. Since resistance is on the order of 10 times a pipe's break rate, the formula of Break Rate x 10 + Resistance was used to the map in Figure 4. The areas in red are top priority for either repair work, the orange mains are secondary and so on.

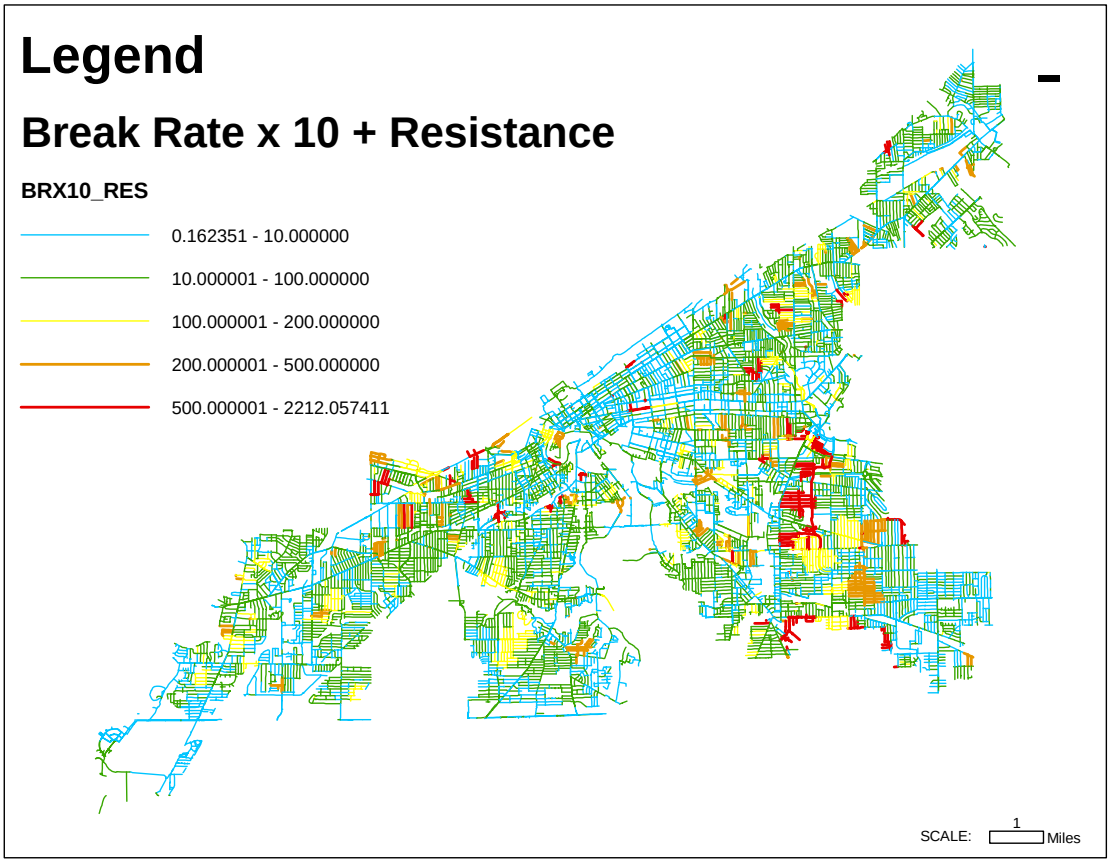

Figure 4. Map of Overall Pipe Condition Using Combined Factors

The Infrastructure Coordinating Committee (ICC)

With so many different divisions working at once throughout the City, the Infrastructure Coordinating Committee was formed to improve communication and coordination between departments and divisions within the City of Cleveland. During monthly meetings, representatives from each department are presented with new projects from developers and offer advice to the developer on how they will be able to get their project approved and any conflicts that may arise with planned City projects. At the first meeting of the year in January, all departments provide copies of spreadsheets to the others listing the location of projects that are planned for the coming year.

Development of the ICC GIS Database

Using the spreadsheets from the January ICC meeting in 2002, the ICC GIS Database was developed by manually entering the data as polygons where areas will be under construction and highlighting street centerlines where roadwork will be done. All

information listed in the project spreadsheets from each department were entered into the attribute tables for each layer. Each layer represented the proposed work for the upcoming construction season for each department. Once that was complete, newly proposed projects and road resurfacing jobs could be queried against planned projects for any conflicts. Figure 5 shows a typical area in Cleveland and the planned project layers in ArcMap.

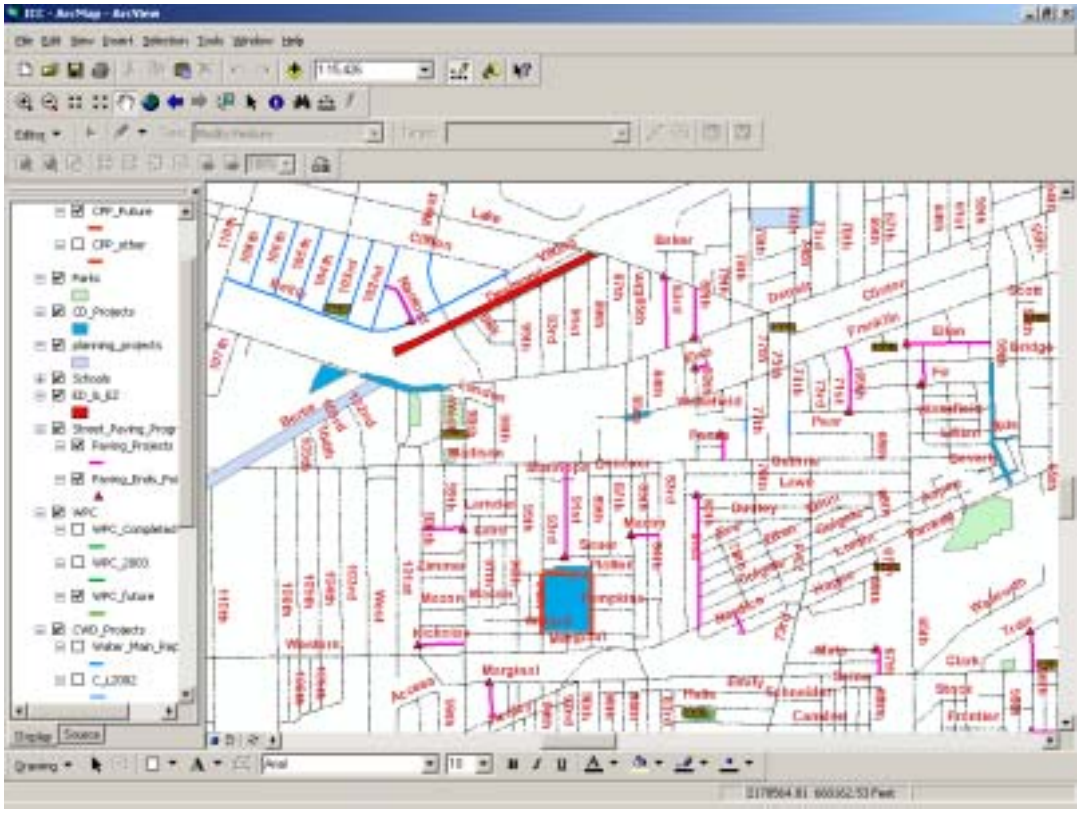

Figure 5. Example from ICC GIS

Resolution Process for Conflicts Between Projects

The ICC GIS can be queried to identify any projects that intersect one another. After reviewing the query results, and weeding out projects that are far in the future that will not be recently after other construction or roadway projects, a list of conflicts is generated.

Currently, the person who found the conflicts will contact the department by email or phone and let them know that there an adjustment to the project schedule will need to be made by one department or the other. After the discussion, the schedule that is more flexible is adjusted and work for that particular street may be put off for 7-10 years so that the new pavement is not torn up. If possible, the project may coincide so that all necessary work on a street in the short-term may be completed while the street is open.

The Future of the ICC GIS Database

Currently there are only a handful of ArcInfo and ArcView licenses available to City employees, so only a few people make edits to the ICC GIS Database. Fortunately, the City of Cleveland is currently developing a Citywide GIS system that will have all departments with geographic data needs using ArcMap or a browser based GIS application running from ArcIMS or ArcServer. One of the applications that will likely come from the project will be one that allows users in each department to add project data to the ICC database and send and receive alerts to all other departments when there are changes to the data. Once that application is in place, each department will be responsible for maintaining their data in the ICC database so that it is up to date.

Lessons Learned and Keys to Success

As one may expect, communication is key to avoiding project conflicts. As soon as a department is aware that they will be opening up a road, the location and date of that project needs to be sent to all other departments. Another critical aspect is that when conflicts are found in the planning stages, it is important that both departments work together early to decide when to reschedule a project or coordinate to make both projects happen while the road is under construction. Successful GIS implementation and training on the citywide level will minimize the possibility of project conflicts as well if all departments feel comfortable using the ICC GIS database and realize its benefits over the old method of circulating project information by spreadsheet.