CAGIS Enterprise
County Wide
Construction
Coordination System

Cincinnati Area Geographical Information Systems -CAGIS
Application for 2011 URISA ESIG™
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Application for 2011 URISA ESIG™

A. System

1. Name of the System and ESIG™ Award Categories:
   CAGIS Enterprise County Wide Construction Coordination System
   Enterprise Systems

2. Executive administrator letter:
   See Attachment A

3. Summary:
   The County Wide Construction Coordination system (CWCC) allows road and utility agencies in Hamilton County, Ohio, to communicate, collaborate and coordinate construction projects within a shared, integrated framework. The system, developed by the Cincinnati Area GIS (CAGIS), functions across multi-jurisdictional and multi-departmental boundaries to identify opportunities to coordinate development activities. The CWCC exemplifies the use of geospatial technologies to integrate business systems and provide a common platform for collaboration and coordination, leading to cost savings and significant process improvements within participating agencies and improved service to communities by minimizing disruption.

   CAGIS is a public-private partnership organization established 20 years ago with the vision of multi-jurisdictional and inter-departmental sharing of information through GIS-integrated, enterprise systems that enable coordination and collaboration toward effective service delivery. All CAGIS systems seek to institutionalize the use of GIS in the day-to-day business operations of the various agencies.

   Current stakeholders include three regional utilities and two government road agencies. The Greater Cincinnati Water Works, Metropolitan Sewer District of Greater Cincinnati and Duke Energy each have service delivery areas that include Hamilton County and other surrounding counties. The Office of the Hamilton County Engineer and the City of Cincinnati Department of Transportation and Engineering manage Hamilton County- and City-owned street assets. In the near future the system will be made available to all right-of-way management agencies in the county’s 48 jurisdictions through a phased expansion.

   The system is unique in that it provides a single, shared system for agencies to coordinate projects throughout their entire lifecycles, from concept planning through permitting and construction. The projects in the system range from concepts/studies to funded capital improvements from various planning and design sections of the participating agencies, routine maintenance and repair projects, emergency works as well as permits issuance on all. CWCC is both a daily-operation business application as well as a long-term planning and collaboration tool.

   The following key features make CWCC system truly enterprise and exemplary:
1. A collaborative system designed to function across multi-jurisdictional and multi-departmental boundaries for detecting opportunities to coordinate. The system radically improves access to key information in an accurate and close-to-real-time manner and enhances effective service delivery and cost savings for its participants.

2. A cradle-to-grave business workflow design that tracks projects and flags opportunities for collaboration from concept to permitting within the same system that we believe is unique in its comprehensiveness and complexity.

3. Institutionalize the use of geospatial technologies within day-to-day operation of business users through business workflow focused design that makes it simple and easy to use.

4. Enables the visualization of project collaboration opportunities very easily. A single click on a map also reveals roadway condition, past projects, current ongoing projects and planned projects as far as 9 or more years out.

5. Seamlessly integrate with multiple business systems of business partners to create a shared framework for collaboration using geospatial technologies exposed through project-specific Application Programming Interfaces (APIs). This eliminates manual entry and upkeep of fluid project planning scenarios.

6. Use advanced geospatial and services oriented architecture (SOA) technologies to automate and integrate key processes to eliminate redundant data entries and synchronization of systems.

7. Drive innovation in other areas that led to the creation of the unique pavement asset model and the calibrated address range model that underpin CWCC as well as currently leading to the starting of a shared countywide Road Pavement Management application for transportation agencies tightly integrated with CWCC.

4. User testimonials:
   See all the user testimonials in Attachment B

B. Jurisdiction

1. Name of jurisdiction:
   City of Cincinnati and Hamilton County, Ohio

2. Population served by the organization:
   According to the 2010 census the population of Cincinnati, OH is 296,943 and the total population of Hamilton County including Cincinnati is 802,374.

3. Annual total budget for jurisdiction:
   The City of Cincinnati and Hamilton County have a combined budget of $2.12 billion
4. Chief elected officials:
   - **Cincinnati Mayor**
     Mark Mallory
   - **Cincinnati City Council**
     Roxanne Qualls
     Cecil Thomas
     Chris Bortz
     Leslie Ghiz
     Wayne Lippert
     Amy Murray
     Laure Quinlivan
     Charlie Winburn
     Wendell Young
   - **Hamilton County Board of Commissioners**
     Greg Hartmann
     Chris Monzel
     Todd Portune

5. System Contact:
   - Raj Chundur, CAGIS Administrator
   - CAGIS - Cincinnati Area Geographic Information System
   - 138 East Court Street, Suite 1000
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C. System Design

1. What motivated the system development?

CAGIS and the Metropolitan Sewer District of Greater Cincinnati initiated a prototype for improved management of the sewer repair system that took into consideration street rehabs and other planned capital projects. This evolved into a broader request and seed financing by MSD to develop the comprehensive CWCC. In addition, Hamilton County is experiencing an astonishing growth in construction in the public right-of-way, and the coordination of these projects has become more demanding and complex. First, Hamilton County, through the Metropolitan Sewer District of Greater Cincinnati, has embarked on one of the largest public works projects in its 200-plus year history to reduce or eliminate sewage overflows into local rivers and streams and sewage backups into basements. In 1999, engineers at Greater Cincinnati Water Works created a ‘Master Plan’ to identify water mains needing to be installed or replaced in order to maintain the integrity of the water system, and resulting projects are ongoing throughout the county. In addition, Duke Energy has launched its Accelerated Main Replacement Program (AMRP) to replace all 12" and smaller cast iron and bare steel gas mains in Hamilton County and the surrounding area over the next 15 years.
Hamilton County commissioners and the City of Cincinnati administration recognized the need to coordinate road and utility agencies’ projects and activities that ultimately result in road reconstruction or repaving. A study prepared by CAGIS in 2007 showed that approximately 40% of newly paved road segments were paved again within 5 years due to planned utility projects, emergencies and other capital improvements. The extrapolated cost to the community over the five-year study period was approximately $90 million in investment. In each case, the residents and businesses of Hamilton County paid for these repairs, either as tax payers or as rate payers. The goals were not only to encourage coordination but to provide the administration with a clear view of when and how tax dollars were being spent.

Before the CWCC system was developed, projects such as these were managed in information “silos.” Collaboration, when it occurred, was ad-hoc, relying on interpersonal contacts between agencies and jurisdictions on a case-by-case basis. There was no common repository and no traceable record of attempts to coordinate activities was available. Instances of detours in one jurisdiction impacting detours in neighboring jurisdictions were becoming commonplace. The CWCC system is a comprehensive system that is used for planning purposes as well as daily operations.

2. What specific service or services was the system intended to improve?

The project is intended improve the integrity and pavement life of city of Cincinnati and Hamilton County roads and minimize disruptions to businesses and citizens through the reduction of street openings and repaving. To that end, the system facilitates communication and collaboration between agencies, whose projects impact the right-of-way, and provides tools to the road agencies and utilities to coordinate the scheduling of that work. The intention also was to improve all internal business processes in multiple agencies to be in-line with the vision and goals of the CWCC system.

3. What, if any, unexpected benefits did you achieve?

CAGIS has a track history of over 20 years of successfully applying geospatial technology in business solutions and the value of GIS is recognized among the business staff and upper management of all participating agencies. The goal of CAGIS continues to be continual improvement of business processes and service delivery through adoption of new effective technologies, refining models and analytical capabilities for its users. With the emergence of lot of new technologies in the geospatial industry, CAGIS decided to use this project as a test bed to explore several options for technology migration. As part of a major system migration CAGIS leveraged the development of CWCC to test these technologies and these have since become part of the organization’s overall technology strategy. Developing a system as ambitious as the Construction Coordination system inevitably led to the development of new models and solutions. It is the extent to which CAGIS has utilized and benefited from the processes developed for this project that was unexpected.

- Adoption of a new pavement asset model (see section C, question 4) and associated road features asset model (sidewalks, guardrails, etc) opened the door for a broad range of other uses.
- Creation of a calibrated address model integrating the pavement asset model with addresses (see section C, question 4) expanded the ability to use addressing as an accurate location tool for other broad uses.
Enhancements to the street-centerline model and QA/QC of the data in that model enabling its use in a broader class of needs beyond CWCC.

- Implementation of Service Oriented Architecture (SOA) Core services that are used throughout CAGIS business solution applications
- Development of reusable web map solutions that integrate with new and existing web and desktop applications
- Creation of reusable components, services and user interfaces that can be used in the development of new focused business applications on a shared technology platform
- Afforded a test bed for the migration of both the GIS environment and the existing workflow systems
- Encouraged the utilities to re-examine their internal processes and make improvements resulting in more efficient and effective service.
- Significant reduction in development time and cost for new applications.
- Provided the foundation to track work and cost for future predictive models and for enabling fast on-going and accurate GASB reporting

4. What system design problems were encountered?

The fundamental system design concept of a county-wide business process focused application for non-GIS users with all the technological complexity of coordinating between multiple agencies systems raised numerous design problems. CWCC solved many of these problems through innovative optimizations and mix of technologies.

- **Building Consensus:** Initially some agencies were reluctant to openly share planning data for capital project concern that their utility alignment in the right-of-way may be lost to another agency that may accelerate their project to take up the desirable alignment. All the participating agencies worked through a charter process and developed ground rules for data accuracy, common project status definitions and frequency of project updates. This provided a high degree of reassurance the all players had a level playing field for sharing of information and in the interpretation of the shared project information.

- **Simple, cost effective user interface design for non-GIS users:** To accommodate users across the county with varying degree of skills levels, CWCC adopted a consistent wizard driven approach irrespective of the project type by creating a consistent data model across multiple agency requirements. This enables CWCC to be installed in any agency and train staff easily. Adopting a web based Rich Interface Application (RIA) model, the CWCC application can be distributed to anyone in the region at no cost.

- **Major business process reconfiguration and standardization:** Significant reconfigurations and optimizations to existing business workflows were implemented to meet demands of CWCC. This led to a consistent data models and business process design templates across multiple project types and agencies.

- **Accommodate spatial project boundary definition differences among agencies:** Participating agencies had their own methods for defining project boundaries spatially. CWCC developed various spatial algorithms to accommodate these methods and automated the synchronization and integration of these processes.

- **Design Spatial Models closer to how work is actually done:**
Street Centerline is traditionally the base for many of the activities related to the right-of-way. However, the street center line model does not meet the actual requirements of how pavement assets are managed. CAGIS developed an innovative Pavement Asset Model and a Calibrated Address Range model to meet the demand of the CWCC system.

**Pavement Asset Model:** The entire county street network was polygonized to clearly and graphically identify pavement and intersection assets. This model formalizes the design based on how work is performed and tracked. Further the model incorporated ownership, maintenance responsibility and responsible permitting agency to these assets. This was needed due to the fact that an asset could be owned by one jurisdiction and maintained by another by contract and some roads were sometimes split in the middle by jurisdictional boundaries. It also provided the base model for associating any other road or transportation related assets such as sidewalks, guardrails, signs, poles, etc.

**Calibrated Address Range Model:** CAGIS developed an innovative way of segmenting addresses ranges along the street using recorded parcel based addresses as calibrating points along the street. This significantly improved locating the various street assets by address that ties it closer to the actual posted street addresses.

- **Spatial and data Processing Optimization:**
  Since CWCC is a web based application and is geared toward non-GIS business users, it was important to optimize the spatial algorithm that identified opportunities for coordination from a range of project types distributed across the entire county region. CAGIS developed a variety of techniques to optimize for speed using a mix of technologies including Spatial SQL and geo-encoding in data models.

- **Visualization of Projects:**
  With projects from multiple agencies spanning multiple jurisdictions and long time frames, effective visualization is a challenge due to spatially coincident or overlapping projects. CAGIS developed different view models and offers choices to users based on their need. One such visualization technique is the **Street Impact View.** This view allows users to view the effect of projects on the street at a bird’s eye view level.

- **Security:**
  Managing security in a shared enterprise system with participants in multiple agencies collaborating and coordinating on project groups presented significant challenges. CAGIS developed a role based security model that also takes into account asset ownership, maintenance and permitting responsibilities using the pavement asset model.

5. **What differentiates this system from other similar systems?**

The Countywide Construction Coordination System is unique in many aspects of its vision, design and implementation.

**The difference in Vision & Design**

1. **Designed to work across business lines:** CWCC is a collaborative system designed to function across multi-jurisdictional and multi-departmental boundaries for detecting opportunities to coordinate. The system radically improves access to key information in an accurate and close-to-real-time manner and enhances effective service delivery and cost savings for its participants.

2. **Cradle-to-grave business workflow design:** There is no single COTS (Commercial Off The Shelf) application that meets the vision and goals of CWCC. The unique aspect of the system originated from the system’s most crucial requirement: complete integration with
the existing city and county business workflow/permitting system, GIS and participating agencies project planning systems. Any activity or project registered in the system either through the interface or through project planning applications synchronization initializes a registration in the CWCC system. These registrations are used as the baseline for identification of opportunities and for all collaboration and coordination. These registrations are also subsequently processed through the CWCC and CAGIS business workflow application for the issuance of permits. No commercial product provides the level of integration with CAGIS shared business workflow system and GIS.

3. **Institutionalize the use of geospatial technologies:** CWCC is designed to be used in the day-to-day business operations by staff in various agencies. This is achieved through a business workflow focused design that is tightly integrated with GIS and complex geospatial tasks automatically handled behind the scenes. This makes the application simple and easy to use for a broad range of users. CWCC is both an operational application as well as a planning tool.

The difference in technology integration

4. **Seamlessly integrate with multiple business systems for efficiency:** CAGIS developed advanced geospatial and services oriented architecture (SOA) technologies to automate and integrate key processes to eliminate redundant data entries and synchronization of systems. This eliminated manual entry and upkeep of fluid project planning scenarios. CAGIS developed this CWCC Application Programming Interface (API) to be accessible through .NET Web-services and can be used by any other agencies for other integration needs. This API makes it possible for proprietary work-order systems and enterprise spatial databases to synchronize project data with the CWCC system and retrieve data from the system. Because of the differences in how agencies manage their project data and the potential for expansion throughout the county, it is important to provide a solution that is flexible and scalable.
5. **Easy to use consistent interface for non-GIS users:** Clear and crisp user interfaces are provided for viewing, processing, searching, collaborating & coordinating and data entry that remains consistent no matter which agency the applications is used in. At the same time based on a user’s role, the view of the information and the ability to perform various functions are tailored to the specific business line of the agency.

   a. **Viewing & Processing:** Agency Specific work dashboards provide workflow based tools to identify projects for coordination and processing specific to their line of business.

      ![Spatially related projects displayed for selected project. These identify opportunities for collaboration](image)

   b. **Searching:** Interactive search tools allow users to search freely across multiple criteria and filter results including narrowing projects using agency specific data fields.
c. **Collaboration:** The Construction Coordination system provides tools to record collaboration and coordination tasks and scheduling of utility and road agencies’ right-of-way projects in conjunction with the Street pavement programs of the various municipalities and townships within Hamilton County. Project managers are alerted through email if one of their projects has a potential opportunity for coordination. Users can then review the schedules of spatially related projects, group the projects into a larger project, propose new start times and accept or decline suggested schedule changes.
The Coordination Group Manager Dialog provides tools to review and array construction schedules for spatially related projects.

d. **Manual Data Entry:** CAGIS has developed processes for automation, integration & synchronization of agency project data. However, projects, such as operational and emergency street openings, that are not synchronized with an agency’s project planning or work-order systems are registered in CWCC through a simple wizard driven process. This is designed specifically for non-GIS users to be able to select project extents and allows them to create a project boundary automatically based on either a selected address or a street with from and to intersections.
Enable easy visualization of complex data: The application also enables the visualization of project collaboration opportunities very easily through an interactive map. One such visualization technique developed by CAGIS is the Street Impact View. This view allows users to view the effect of project on the streets at a bird’s eye view level. The map interface also displays project boundaries and project points symbolized by facility type. A single click on a map reveals roadway condition including, Pavement Condition Index rating, planned paved date and restrictions as well as pavement ownership and maintenance responsibility, past projects, current ongoing projects and planned projects as far as 9 or more years out.
Innovative design of Spatial & data models reflecting closely how work is actually done: Pavement Asset Model: Another unique aspect of the CWCC system is in how the project data is related to the base GIS layers. Projects and activities participating in the system are associated with a pavement asset polygon layer in the CAGIS enterprise geodatabase. The relationship between project and asset persists beyond the lifecycle of the project as a related table of work history for each section of pavement enhancing the usefulness of the GIS layer. This data, which includes pavement condition, past work history and current...
and proposed work, is available to CAGIS users in departments and organizations throughout the city and county.

The entire county street network was polygonized to clearly and graphically identify pavement and intersection assets that reflect how work is actually performed and tracked.

8. **Calibrated Address Range Model**: CAGIS developed an innovative way of segmenting addresses ranges along the street using recorded parcel based addresses as calibrating points. This method significantly improves upon the accuracy of the traditional interpolated street address model by locating unassigned addresses relative to known addresses.

The diagram shows the effects of calibration on assignment of range addresses that closely aligns with real-world locations.

9. **Unified Workflow Design Template Model**: To accommodate the various projects types from multiple agencies and jurisdictions, CAGIS developed a consistent data model to capture baseline data that would enable identification of opportunities for coordination and move the project through the life cycle right to the issuance of permits for construction. This model led to the creation of just a handful of workflow design
templates that can be repeatedly applied across any agency or jurisdictional permit issuance process with minimal modifications.

Registrations are based on worktypes customized to each department’s business needs. Valid registration types are presented to the user based on login roles. These graphics show the differences in project types available to a MSD Collections user and a GCWW Distributions user.

D. Implementation

1. What phases did you go through in developing the system?

   Phase I – Technology, Data Model designs and Application development. CWCC system was used as a test bed for migration of CAGIS GIS systems to new technologies. CAGIS performed extensive testing of various technologies including spatial geometries, spatial SQL, ESRI ArcGIS Server and OpenLayers in the geospatial areas. Various Rich Internet Application (RIA) frameworks were also tested and CAGIS adopted the TIBCO GI JavaScript framework for web-based application UI development. Extensive workflow analysis was conducted based on existing designs and project types. New requirements were identified working with users in a joint application development (JAD) methodology. Based on these testing and analysis, various models were developed to meet the demands of the CWCC system. Using the JAD methodology, CWCC user interfaces as well as all the internal components and services were built and deployed at Hamilton County Engineer’s office and the City of Cincinnati Department of Transportation & Engineering as part of their day-to-day business operation application. Subsequently DUKE Energy Emergency Operations, Greater Cincinnati Water Works distribution section (handling routine maintenance and emergencies) unit was bought online.
Phase II - This phase focused on the capital improvement projects of Greater Cincinnati Water Works, Metropolitan Sewer District of Greater Cincinnati, Duke Energy, Hamilton County Engineer’s Office and the City of Cincinnati Department of Transportation and Engineering. The goal here was to automate the integration of the agencies respective project planning systems and project boundary definition methodologies with CWCC so that there is no data entry redundancy and make CWCC system accurate and as close to real-time as possible.

Phase III will focus on the incorporation of events and detour planning into the Construction Coordination System. With this all varied activities that impact the street will be incorporated in the Construction Coordination program providing a comprehensive view. Simultaneously, efforts to enable all road management agencies in other forty nine municipalities and townships to participate and share their planned capital project programs will begin.

2. Were there any modifications to the original system design? Why? What?
As a shared services and user-driven organization, CAGIS has always adopted the Joint Application Development (JAD) methodology in all its projects. The actual business users are actively engaged in the design process from start to finish. This iterative approach enables significant buy-in and major changes to the system are rare. CWCC follows this model and as with any complex project with multiple agency participants there are continual user involvement and requests for enhancements as the system is used daily and more agencies and staff are bought online.

E. Organizational Impact

1. What user community does the system serve and how?
Currently the system serves three utilities and two road agencies. These include the Metropolitan Sewer District of Greater Cincinnati, Greater Cincinnati Water Works, Duke Energy (Gas and Electric), Cincinnati Department of Transportation and the Hamilton County Engineer’s Office. On completion of phase III, all road management agencies in other forty nine municipalities and townships in Hamilton County will be direct participants.

2. What are the ultimate decisions/operations/services being affected? If appropriate, provide a few examples including, but not limited to: screen input/output forms, paper products, or other descriptive graphics.
The primary goal is the extension of the life of the pavement and cost savings by effective collaboration and coordination of all players who impact the right-of-way. Two major areas that impact decisions are:

Effective Management of projects and pavement assets:
With the ability to view all planned projects in a comprehensive way, not only can projects be coordinated effectively, sometimes certain repair or maintenance projects can be eliminated based on a capital improvement project planned for the same asset.
The integrated CWCC system also provides a one click view of:
- Pavement Condition: Various street conditions like PCI, Construction Moratoriums, etc.
- **The Past**: All projects that impacted the street – Example: streets cuts by utilities providing a window into the state of the infrastructure buried under the street (Number of emergencies)
- **The Current**: On-going projects.
- **The Future**: All projects from concept to planning in a shared system to enable collaboration and coordination.

**Life Cycle Tracked in CWCC**

**Effective Collaboration and Coordination of projects between agencies:**
The CWCC system ultimately affects the scheduling of utility and road agencies’ right-of-way projects in conjunction with the Street pavement programs of the various municipalities and townships within Hamilton County. Through the coordination interface in the CWCC system users can review the schedules of spatially related projects, group the projects, propose new start times and accept or decline suggested schedule changes. All these collaboration and coordination activities are stored in the system for review at any point in time.

**Interaction with other integrated systems like Customer Service Request systems, business workflow and permitting systems, snow plowing, pot hole services, etc.**
3. What were the quantitative and qualitative impacts of the system?

Streamlining of the entire Right-of-Way management process: The CWCC system led to the reengineering as well as new development of effective and efficient processes across the board from start of projects to actual permitting for construction.

Easy identification of opportunities for Coordination: The system has made project managers and county and city administrators more aware of the extent of opportunities in their jurisdictions. The transportation departments control the permitting of street cuts and the information provided by the system enables the managers to encourage coordination when significant conflicts are anticipated. In addition utility agencies are able to document their planned alignments in the roadways and other agencies are encouraged to respect these plans.

Potential Cost Savings through better coordination and scheduling: The system has currently identified 1,344 projects with opportunities for coordination.

Revenue Enhancement: As a result of the creation of the pavement asset model a more accurate estimate of the City of Cincinnati’s lane miles was calculated which resulted in a 15% increase in total area. This calculation is used to submit for reimbursement of maintenance dollars from the state.

Community Benefits: The potential for disruptions to residents and business can be minimized significantly through better coordination and scheduling of projects as well as better detour planning across jurisdictional boundaries.

4. What effect has the system had on productivity?

Effective Collaboration and Coordination of projects: CWCC has provided the ability to view all planned projects in a comprehensive way to collaborate, coordinate and process it through its entire life-cycle within a single shared framework leading to efficiency in information access, saved time and costs.

Easy, Consistent User Interface Design: Through consistent data models and standard interfaces for all project types related to right-of-way, project data is entered, viewed and used more accurately and efficiently than ever before.

Integration through Automation: Increase efficiency by eliminating redundant data entry between systems by automating synchronization of key data. Manual input of data through the CWCC interface is minimized for all agencies that already have internal project planning systems.

Accurate and Timely Data instantly: Users throughout the county have access to pavement data and the related project data in real-time allowing them to make better informed and instant decisions.

5. What, if any, other impacts has the system had?

Initiation of new shared pavement management system: As a result of CWCC the new county-wide shared pavement management system for right-of-way management agencies is currently under planning and development potentially for all communities in Hamilton County.
Transparency and Openness: Initially some agencies were reluctant to openly share planning data for capital projects due to fluidity of funding or concern that their utility alignment in the right-of-way may be lost to another agency that may accelerate their project to take up the desirable alignment. With all agencies developing a consensus on registering planned projects (years out in the future) into a shared system with known ground rules for data accuracy, status and frequency of project updates led to more transparency and openness.

6. How did the system change the way business is conducted with and/or service delivered to clients? Give specific examples comparing the old way with the new.

Before the implementation of the Construction Coordination system road and utility agencies shared information regarding capital improvement projects through a combination of hard copy and digital spreadsheets. This data was distributed at an annual Infrastructure Committee meeting and occasionally through other ad hoc meetings throughout the year. Given the dynamic nature of road and utility projects this information was essentially out of date within days after the meetings. None of the agencies possessed a reliable and comprehensive long-range view of projects impacting the streets throughout the city and county.

The system represents a new standardized framework for sharing information, collaborating and coordinating projects among agencies. Now project managers are alerted through email if one of their projects has a potential opportunity for coordination or is in conflict with another project currently in construction. Also the project managers can explore past, current and future projects to discover opportunities or review paving schedules. By directly accessing project planning systems for capital projects and providing an interface to efficiently apply for operational and emergency permits, the system provides a wealth of information to the stakeholders accurately and in real-time.

F. System Resources

1. What are the system’s primary hardware components? Give a brief list or description of the hardware configuration supporting the system.
   - Dell Microsoft Windows highly available multi-core application servers (2)
   - HPUX Itanium highly available, multi-core Oracle database servers (4) and HP SANs
   - Internal users connect to application and database servers across high speed, multi-gigabit enterprise backbone networks and gigabit LANS

2. What are the system’s primary software components? Describe the primary software and, if a commercial package, any customizations required for the system.

   CAGIS developed a SOA based Web-services middle tier to interact with spatial and non spatial data from enterprise Oracle databases. The Web-services utilized spatial SQL within Oracle Locator, a feature of Oracle Database 10g Enterprise as well as Oracle Linear Referencing System (LRS) in Oracle Spatial product that provides core GIS functionality exposed through standard SQL calls. This functionality enables the system to perform complex spatial analysis.

CAGIS also developed a rich internet application built on the TIBCO General Interface JavaScript Framework, an Ajax engine and set of JavaScript libraries that load and run on the end user’s browser. This application interacts with the Web-services tier and provides the tools to create registrations, view and search project information in a table or map and coordinate the scheduling of projects.

ESRI’s ArcGIS Server provides high quality, high accuracy cached and dynamic map services to the map component of the application. Interaction with the map is through ArcGIS JavaScript API. And ArcMap Desktop was used to create map services and manage spatial data.

CAGIS developed windows server based scheduled services that synchronize project data from the utilities and road agencies project planning systems.

The business workflow framework for the city and county is Accela’s Permits Plus. CAGIS developed the Construction Coordination system to utilize the data structure of Permits Plus, and users at the road agencies rely on the Permits Plus interface to assess fees, attach conditions and issue permits.

3. What data does the system work with? List and briefly describe the database(s).
   - Accela’s Permits Plus – Vendor business workflow/permitting system database
   - Enterprise GIS databases – spatially enabled base data and construction coordination specific data
   - Primavera Project Planning system.
   - NESIS – Pavement management application.

4. What staff resources were required to implement the system? (i.e., report approximate staff and consultant time as FTE’s)

<table>
<thead>
<tr>
<th>Staff</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIS/Workflow Developers</td>
<td>4</td>
</tr>
<tr>
<td>GIS Managers</td>
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</tr>
<tr>
<td>Database Administrator</td>
<td>1</td>
</tr>
<tr>
<td>Consultant</td>
<td>1</td>
</tr>
</tbody>
</table>

5. Comment on anything unusual about the resources used to develop your system, such as data, software, personnel and financing.

Software:

   **Technology Strategy:** Many of the aspects of this system such as spatial SQL web services and web mapping were started as prototypes and developed into an overall core CAGIS technology strategies as a result of this project.
Hybrid Client technologies: The user interface of CWCC is designed as a Rich Internet Application (RIA + AJAX) using a combination of open source frameworks like the TICBO GI JavaScript application development and vendor frameworks like ESRI JavaScript Map API, Server Technologies: A combination of geospatial technologies like Spatial SQL, Oracle Linear Referencing System (LRS), ESRI ArcGIS Server Map services were used to solve wide ranging integration needs with goal toward maximizing automation.

Personnel and Financing:
CAGIS is a shared services organization funded by Hamilton County, City of Cincinnati and DUKE Energy with a mission to apply geospatial technologies in business solutions for effective service delivery. The participants include the utilities and the Hamilton County Engineer’s office with region-wide service areas as well as various departmental agencies in the City of Cincinnati and Hamilton Counties. Other jurisdictions in Hamilton County and non-profits participate as associate members in CAGIS through nominal annual membership fees. A significant portion of the funding for this project was through this consortium funds with additional funding and personnel from Metropolitan Sewer District of Greater Cincinnati.
Attachment A

May 31, 2011

URISA, Exemplary System in Government (ESIG) Review Committee  
701 Lee Street, Suite 680  
Des Plaines, IL  60016

Dear ESIG Review Committee:

We are pleased to recommend the CAGIS Enterprise County Wide Construction Coordination System (CWCC) to be considered as an example of an exemplary system in local government. This is yet another example of an enterprise system developed by the Cincinnati Area GIS (CAGIS) that not only is accruing benefits to our community, but has far reaching potential in many areas of local government and utility service delivery.

CAGIS is an organization established as a cooperative effort between the City of Cincinnati, Hamilton County, Ohio and Duke Energy. The mission of CAGIS is to support the sharing of information across government agencies and utilities, with the primary goal of enabling coordination and collaboration toward effective service delivery to our citizens.

The CAGIS Enterprise County Wide Construction Coordination System benefits local governments and citizens in a number of ways. These benefits include cost savings by extending the life of the pavement through coordination of construction; minimizing disruption to businesses, residents, and traffic; and creating a positive community impact by maximizing uncut roadways.

We believe the design of the system to be cutting edge and exemplary with its emphasis on cradle to grave tracking, collaboration, coordination, and permitting of all projects that impact the street across multiple agencies using GIS. It is currently utilized in the day-to-day work by users in Cincinnati Department of Transportation and Engineering, Hamilton County Engineers, Metropolitan Sewer District, Greater Cincinnati Water Works and Duke Energy. Other transportation agencies in the region will begin participation in a phased manner. The innovations springing from its development are far ranging and have great implication in other areas of service delivery as well.

Thank you for the opportunity to submit the CAGIS Enterprise County Wide Construction Coordination System to the ESIG committee as an exemplary system.

Sincerely,

Christian Sigman  
County Administrator  
Hamilton County, Ohio

Milton Dohoney, Jr.  
City Manager  
City of Cincinnati, Ohio
Attachment B

Date: June 3, 2011
To: Raj Chundur, CAGIS Administrator
From: Christopher M. Ertel, Supervising Engineer
Subject: County Wide Construction Coordination

The new County Wide Construction Coordination application that is contained in our GIS system provides a wealth of information at one’s fingertips and also has the potential to save millions of tax dollars by coordinating the City of Cincinnati’s limited resources to resurface streets only after all planned utility work has been completed.

This new initiative allows the Metropolitan Sewer District of Greater Cincinnati, the Greater Cincinnati Water Works, Duke Energy Gas Engineering, the City of Cincinnati Department of Transportation and Engineering, the Hamilton County Engineer’s Office and other municipal transportation agencies to add projects to the GIS so that potential conflicts, identified by overlapping project sites (polygons in the GIS), appear as opportunities to coordinate work. Each time a new project is entered an e-mail message is sent to the other agencies describing the timeline of the work involved, the contact person and the contact person’s phone number so that work can be scheduled to set the street resurfacing after all the utility work has been completed.

I have already seen the benefit of the program. In the past it took hours to review the work lists of each agency to determine opportunities to coordinate. Now, whenever a street is scheduled for resurfacing the GIS queries the current list of projects, finds the opportunities and sends the information to all the project managers. The City of Cincinnati’s Pavement Management database has been upgraded to an Oracle database to achieve seamless integration with the County Wide Construction Coordination application. I now know when Duke Energy is installing a new gas line on a street that has been scheduled for resurfacing even 5 years into the future.

As we bring more data online the process will only get better. The addition of identifying pothole locations on city streets will assist in the planning of road resurfacing and the scheduling of repair crews.

This is a great advancement for the City of Cincinnati and Hamilton County. This is truly an exemplary tool.

Chris Ertel
Supervising Engineer
Street Rehabilitation Program Manager
City of Cincinnati

Date: 06/03/2011

To: Raj Chundur, CAGIS Administrator
From: Mike Niswonger, Principal Engineer - ROW Management
Copies:

Subject: User Testimonial for County-Wide Construction Coordination System

The creation and implementation of the "County-Wide Right-of-Way Construction Coordination" System has been a major advancement in our attempt to prevent excavations (street cuts) in the City's newly paved streets. The system allows utility and municipal users across Hamilton County a standard platform to register construction projects, whether emergency or planned, that impact streets. It is miles ahead of the old paper reports, sticky notes, and remember in your head method of coordination.

The Right-of-Way Management Section of the City of Cincinnati's Department of Transportation and Engineering (located in Hamilton County) is responsible for issuing all permits for work in the right-of-way. We use this system daily as it has become the backbone of our permitting process. Since its implementation last April 1, 2010, the system continually evolves as we streamline the coordination of utility work with upcoming City initiated and other development projects. This allows for the identification of opportunities to coordinate utility work before a street is scheduled to be paved as well as potential cost sharing between participants. It also allows the utility companies to coordinate their proposed construction and alignments with each other in addition to eliminating possible duplicate restoration work.

The Construction Coordination System is also of assistance in minimizing public/ business disruptions due to multiple construction activities in the same area. In addition, with the system being County wide, we are able to coordinate restricted and detour routes outside the City limits to avoid potential "roadblocks".

CAGIS Staff is to be commended for their continued support and flexibility as we seek to expand the system and its uses.
The office of the Hamilton County Engineer has recognized the need for a region wide system for tracking work within the public roadways for decades. Through the hard work of the dedicated employees of the Cincinnati Area Geographic Information Systems this has become a reality. CAGIS took a proactive role in the development of the system by going out and talking to and learning the needs of all the various end users.

The County Wide Construction Coordination system has become an integral tool used on a daily basis by our permitting staff that has allowed our office to see what is being planned and constructed by not just utilities within our own jurisdiction but also work planned by adjacent communities. This includes both projects within the concept stage and those currently under construction, including all daily permit activities. This has provided an extremely positive opportunity to time projects together thus saving money for the infrastructure owners and also saving time and inconvenience for the local residents and the travelling public. Without this tool we would continue to have haphazard coordination!

A great product put together by a great team!

Respectfully,

[Signature]

Eric J. Beck, P.E.
Deputy Engineer for Field Operations
June 3, 2011

ESIG Review Committee:

Duke Energy leverages the county wide Construction Coordination program to order permits and view current and future work being completed by other agencies. We utilize this system for emergency work as well as non-emergency work. The system allows us to obtain permit numbers for emergency work at the time of entry, along with a registration number for the non-emergency work. At the time that the permit is issued, we are informed of work being done by others in the same area. This process streamlines the work, increases our ability to coordinate with other agencies, minimizes impact to the public, and reduces costs.

Sincerely,

Stephen Adams

Stephen W. Adams
Manager, Midwest GIS Department
Duke Energy