Enabling Success in Enterprise Asset Management: Case Study for Developing and Integrating GIS with CMMS for a Large WWTP

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ABSTRACT

The Trinity River Authority (TRA) Central Regional Wastewater System (CRWS) Treatment Plant in the Dallas-Fort Worth Metroplex has implemented an asset management plan. TRA strives to implement efficient and effective operations throughout the Authority, and their asset management plan at CRWS allows TRA to view their asset data and location within the Treatment Plant. This asset management plan is also being implemented at the rest of their facilities in North Texas. In order to achieve the goals of the asset management plan, a vision and associated business requirements were developed for how asset management would evolve at TRA. A plant wide ESRI Geographic Information System (GIS) geodatabase that integrates the Computerized Maintenance Management System (CMMS) with their geographic data was implemented. As a result of this project, TRA was able to incorporate over 3,000 surveyed assets and associated asset data into their asset management system at CRWS Treatment Plant.

KEYWORDS: Asset management, ESRI geographic information system (GIS), computerized maintenance management system (CMMS), reliability centered maintenance (RCM), ISO 55001

INTRODUCTION

The Trinity River Authority (TRA) Central Regional Wastewater System (CRWS) Treatment Plant in the Dallas-Fort Worth Metroplex is an advanced secondary treatment plant and permitted to treat up to 613,200 m3/d (162 mgd) on an average daily basis. TRA developed a strategic asset management plan to implement at CRWS in order to support the goals and objectives of the organization, and specifically at CRWS, to support the operation of the plant and perform predictive, preventative or corrective maintenance. The development of the asset management practices at CRWS is the foundation for asset management implementation across other TRA plants.

As part of the asset management objectives, TRA has implemented at CRWS a plant-wide ESRI Geographic Information System (GIS) geodatabase that integrates the plant's Computerized Maintenance Management System (CMMS) software with TRA's geographic data. Freese and Nichols, Inc. (FNI) and Brio Consulting, LCC were retained to develop and implement a GIS database and synchronization with TRA's CMMS. Through the implementation of this project, TRA is now able to have a more streamlined approach to managing and maintaining assets through using GIS maps and field (mobile) tablets to locate assets and access work orders assigned through its CMMS. The maps will also be a training tool for on-boarding new staff to get familiar with the assets at the CRWS Treatment Plant.

ASSET MANAGEMENT STRATEGY

In 2015, TRA conducted an asset management and reliability centered maintenance (RCM) evaluation for its CRWS Treatment Plant. The approach to asset management at the CRWS Treatment Plant was assessed against the requirements of the international asset management standard ISO 55001. The recommendation from the evaluation included several improvement initiatives which were ranked and prioritized based on benefit, urgency, cost, and resource commitment. In addition, the evaluation provided TRA with an asset management plan roadmap which laid out a timeline and critical path for completion of each initiative. Since 2015, TRA staff have been actively working on the highest priority improvement initiatives. TRA's strategic plan includes several goals. These strategic goals are listed in Table 1.

Table 1. TRA's Strategic Plan Relevant Goals

TRA's Strategic Plan
Customer Service Excellence
Human Capital Development
Efficient and Effective Operations

Efficient and effective operations is a goal that TRA strives to implement throughout the Authority because it allows staff to minimize their time spent searching for information and frees up this time for focusing more on asset reliability and maintainability. One of the improvements initiatives identified from the ISO 55001 assessment included, developing and implementing a data needs assessment and improvement plan. TRA began utilizing their CMMS system to store asset data, which was located within buildings/structures. Assets located outside of buildings/structures were not recorded in the system because it was difficult to identify a location for that particular asset. The nearest building location was typically used in the work order for those assets.

For the collection system, TRA had already began utilizing GIS, which helped identify assets in the field more efficiently and it was a centralized data storage center for all of the as-built and survey information for the collection system assets. This same concept was used for assets within the CRWS Treatment Plant and for assets located outside of buildings/structures. In addition to capturing these assets, TRA understood the time and effort to manually update asset data into their CMMS and wanted to evaluate options for additionally efficiency in which the assets located outside of buildings/structures could be auto populated from GIS to their CMMS. FNI was retained by TRA for this improvement initiative and developing a plan and executing the plan for collecting this asset data.

VISION

A short and long vision statement was developed to communicate the GIS vision at TRA CRWS. Figure 1 illustrates the GIS vision statement, "To provide a reliable map that is a window to our plant data." This statement was created after a series of staff visioning workshops to align the priorities and business requirements at the TRA CRWS plant with GIS. Long term visions were developed to define "a good map and good window" into viewing assets, such as provide an overall map to visualize asset and maintenance data and depict open and historical work orders with views of work order details, status and assigned staff.

Short Vision Statement	
To provide a reliable map that is a window to our plant data.	
Long Vision Statement	
A good map:	Provide an overall map for daily functionality, with the ability to visualize our asset and maintenance data.
	Depict good relative positional accuracy (horizontal and vertical) to support proper identification of assets in the field, and provide access to surveyed coordinates to facilitate location of buried assets.
A good window:	Provide asset life cycle and operational status data as well as views of asset nameplate and criticality data.
	Depict open and historical work orders with views of work details, status and assigned staff, and depict current operational observations related to the assets.
	Further support asset identification and troubleshooting by providing map-based access to electrical drawings, CAD files and surveys, and provide a map of project boundaries and links between project data and the assets installed under the project.
	Connect the assets to support hydraulic and process modeling.

Figure 1. CRWS WWTP GIS Vision

The visioning workshops, which focused on identifying GIS business applications and creating a vision for GIS at CRWS, identified the key business requirements. A subsequent strategy evaluation workshop was held to further refine and prioritize these business requirements. Table 2 depicts the business requirements and their ranking for incorporating GIS into their asset management at CRWS. These requirements and rankings allowed FNI to evaluate TRA's existing geodatabase structure and propose the new geodatabase design process.

Table 2. CRWS WWTP Business Requirements

Ranking	Business Requirement
1	Rapid and reliable access to asset record information
2	Overall CRWS Plant map with footprints and piping
3	Locating plant features
4	Identifying plant features
5	Map-based viewing of asset status throughout the plant
6	Map-based viewing of project boundaries and information associated with active projects and affected assets
7	Map-based access to condition assessment scoring data
8	Map-based access to as-built drawings
9	Map-based access to electrical drawings (one-line diagrams)
10	Hydraulic modeling capability
11	Asset isolation tracing to determine impacts on plant system

DATABASE DESIGN

A series of strategic workshops and evaluations were held to allow TRA and FNI staff to collaborate, develop, and design the geodatabase structure.

The GIS business requirements indicated that a simpler geodatabase design would more effectively meet the identified business needs, as well as the desired integration level with the CMMS system. Figure 2 shows the overall geodatabase structure for CRWS assets. The integration allows for spatial and tabular views of asset and work order information in the ArcMap environment.

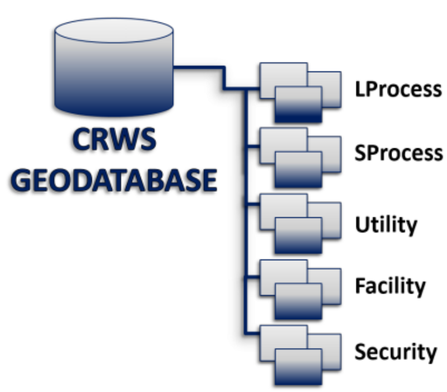

Figure 2. Geodatabase Structure

The new geodatabase provides a single repository for CRWS' Treatment Plant GIS data, where it is organized by process, which makes maintaining and editing the data much simpler. This is shown in Figure 3. The project team utilized the existing CRWS master AutoCAD file along with ground surveying to develop an initial geodatabase design. The team considered a variety of options for integrating GIS and their CMMS, discussed the relative advantages and costs of each approach and decided to pursue the installation of a commercial, off -the-shelf tool (GeoWorxSync) for data synchronization with geoprocessing scripts to generate work order points in the GIS.

In addition to development of a GIS database, a series of technical memorandums outlining the geodatabase design, data capture plan, and GIS to CMMS synchronization were developed. These were used to support the development of the geodatabase design. The data capture plan was developed to determine the ground surveying of assets and post-processing of the data in the geodatabase.

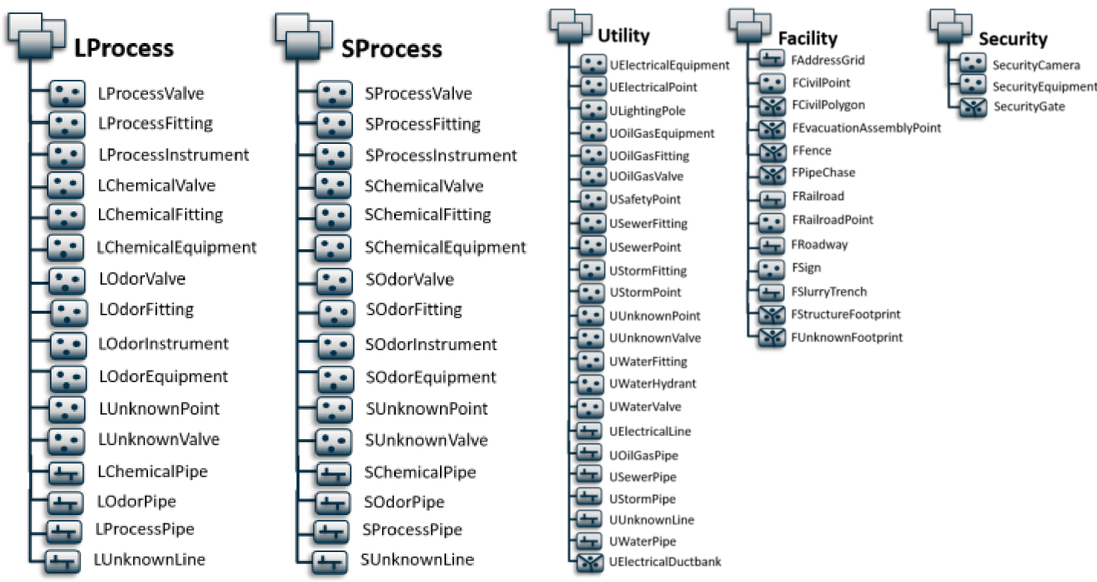

Figure 3. Geodatabase Datasets and Classes

DATA COLLECTION

By collaborating together with project team leaders, plant managers and staff, a data collection plan and approach was developed to be able to provide project efficiencies in collecting survey and asset data at the CRWS Treatment Plant.

The next phase of this project involved data collection, including GPS of more than 2,000 assets, to enhance the accuracy of the geodatabase. Between September and November 2016, one surveyor and one engineer ground surveyed over 2,000 of the CRWS plant assets. The survey effort did not include any assets inside buildings, structures, or pump stations, but assets located outside of structures. Assets included valves, structure footprints, visible fittings and cleanouts, light poles, manholes, electrical equipment and others. As shown in Figure 4, a mapbook, with a total of 180 maps, was developed, which separated the plant into different sections. The maps included any existing CAD or GIS that the plant had in order to create a guide of asset locations. The survey effort was then focused on these sections for completion. Certain attributes for each asset were uploaded into the survey unit for population while out in the field, such as process type, valve type, size, and operational status.

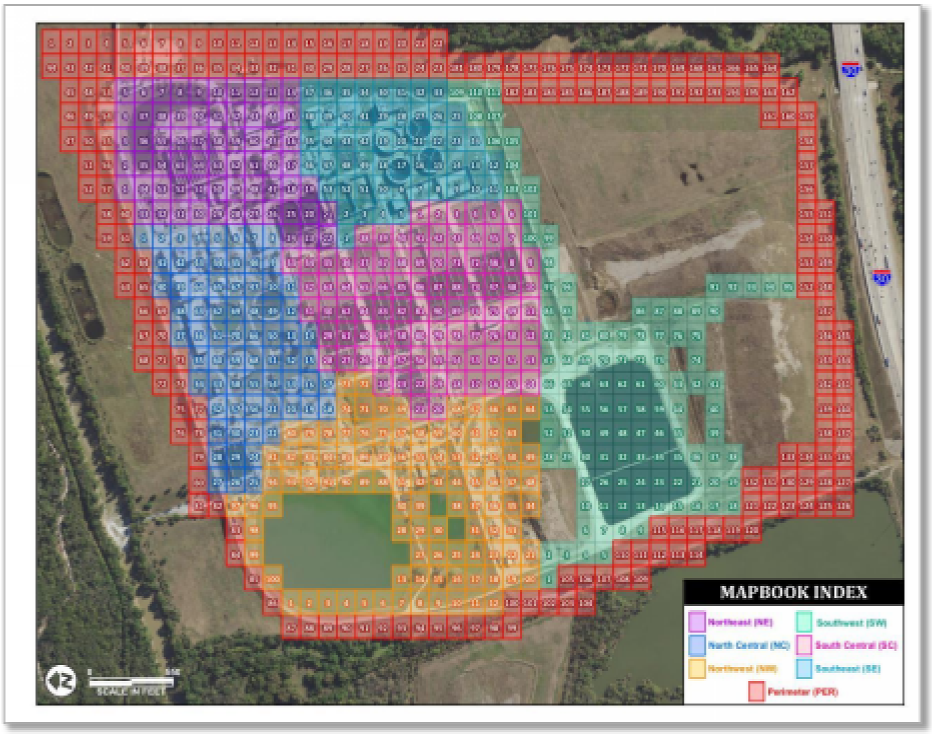

Figure 4. CRWS Data Capture Mapbook

POST-PROCESS PHASE

After the survey effort was complete, the task of processing the data and researching as-builts was initiated. This process included verifying that the asset was appropriately attributed in the field, and determining attributes such as size, material, project name and date of project installation, link to record drawings, and then connecting to the pipe attribute. Figure 5 previews the map of the post-process phase.

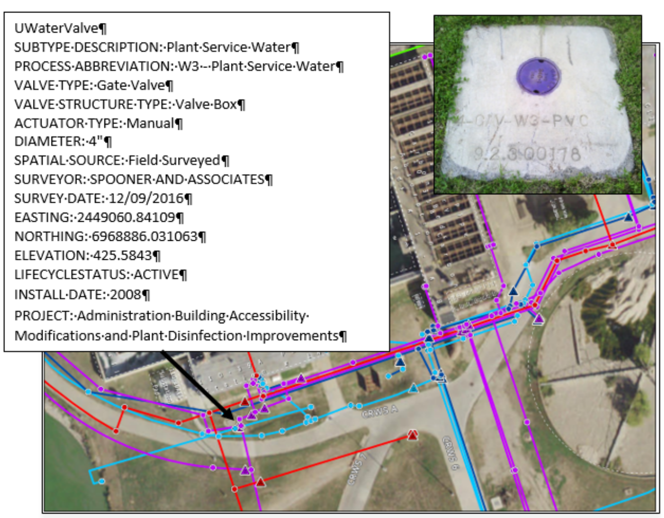

Figure 5. Asset Post-Process Map

GIS TO CMMS INTEGRATION

The primary purpose for integrating the CMMS work management system with the CRWS GIS was to provide spatial and tabular views of asset and work order information in the ArcMap environment. Integration with their CMMS was an important element of the GIS Vision. Among TRA's top priority business requirements for the GIS was to provide access to asset record information, much of which is stored in their CMMS. Other requirements that depended on GIS integration with their CMMS were map-based access to asset status as well as map-based access to condition assessment data. These business requirements drove the plans for system integration. The team discussed the option of using the GIS to store only spatial data (e.g., mapped points, lines or polygons) with all non-spatial data (asset characteristics) stored in their CMMS. Such an approach would limit the GIS/CMMS integration requirements to the storage of a CMMS foreign key reference in the geodatabase. However, the team determined that some non-spatial data had to be resident in the GIS for the following reasons:

- GIS editing tools rely on non-spatial data to ensure data quality as features are edited. For example, the editing tools might consider pipe size when determining whether two pipe features can be connected without an appurtenance such as a reducer.

- Some of the applications supported by GIS (such as hydraulic modeling and map-based document access) rely on non-spatial data provided by the GIS. Users need to access these applications independent of accessing their CMMS.

- Some assets (such as plant piping) will be created in GIS before they are added to their CMMS, making the GIS the logical point of entry for all the data about those assets.

The team also discussed the possibility of leaving all non-spatial data in the GIS for those records that are originally generated in the GIS (such as plant piping). However, much of the non-spatial data is also needed directly in their CMMS to take advantage of lookups, reports, queries and other CMMS functions (such as automatic description generation) that rely on data in the asset and location tables and the asset and location specification tables.

For these reasons, it was determined that the integration model needed to support TRA's vision was one of data synchronization. In addition to linking the GIS features to particular CMMS assets or locations, there is also a need to synchronize certain non-spatial data so that it is consistent across systems and available independently in both systems.

To support data synchronization, TRA defined classifications in their CMMS to correspond to the new GIS feature classes. The CMMS classification attributes were aligned with the geodatabase design to minimize the need for data transformation. The project team then developed a detailed cross reference plan that linked each GIS feature class and attribute to the corresponding tables and fields in their CMMS. This design alignment process included the development of a design for a work order feature class to be linked to the CMMS work order tables. After completing these detailed integration designs, the project team investigated five different integration technologies and considered how well each would support the business requirements. TRA opted to implement GeoWorx Sync software, which was configured to provide the field-to-field synchronizations defined in the detailed integration plans.

RESULTS

After the multiple strategic sessions, workshops, field survey, and post-processing, there was review, attribute research, and data population for 5,636 water assets, 306 light poles, 262 solids process assets, and 1,789 liquids assets. The remaining assets that were field surveyed have been imported into the geodatabase with their raw survey attributes until further data population can be accommodated or completed by TRA staff. These assets along with the other field surveyed assets have been synchronized with the CMMS work order system. Plant staff can view assets in a field (mobile) tablet with attributes populated during the data collection and post-process phase. TRA can view active work orders in the GIS map to determine location and status of maintenance requests.

An additional tool was created under this project for TRA. An ESRI Water Utility Network Report Toolbar was customized for the plant to allow for valve isolation scenarios to be run. This will be used to determine valve locations for water line shutdowns.

CONCLUSIONS

Thanks to this project, TRA now has a baseline to visually view assets in a map and link it to their work order system to be able to improve the way they perform maintenance. This project is also able to serve as a training tool for new staff at the plant to get familiar with the assets at the facility.

TRA has executed an asset management plan at CRWS that aligns with the overall organization strategic objectives and is the baseline for future implementation of asset management at their other treatment facilities. Over the course of three years, TRA was successful at creating a vision for asset management at the CRWS facility and started the process to implement an asset management plan.

After completion of this initial phase of survey and data collection, FNI went back out in the field and surveyed an additional 1,000 assets at the plant and attributed 500 electrical assets. As a result, TRA was able to incorporate over 3,000 surveyed assets into their asset management system at CRWS. This project allows TRA to view their assets on a GIS map in the field or in the office and to track the status of and location of work orders for predictive or corrective maintenance.