ENTERPRISE GIS FOR UTILITIES

GIS Implementation at Long Beach Gas and Oil

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Background

The Long Beach Gas and Oil Department is one of the largest municipally owned Natural Gas Utilities in the United States. It has been in existence for over 80 years and has reached a point where maintaining the aging system and records has become an overwhelming challenge. Due to major Capital Improvement Programs and increased monitoring requirements Long Beach Gas and Oil recognized its need for a GIS based record and analysis system. The possible GIS implementation within LBGO brought to the surface many hopes and needs of various LBGO staff members to make their day-to-day work more effective and efficient through the use of well-designed information systems as well as bringing information into the field for both maintenance and emergency work.

LBGO has been an organization with a rich heritage of developing and maintaining spatial data. Granted, this was done using paper based systems, but for the vast majority of the agency’s over 80 years of existence, this was the only option. As a testament to the staff that has served as stewards of the gas system and its information, the paper-based records are amazingly complete and well organized. As with most paper-based systems, the processes and procedures needed to maintain this high quality set of records was complicated. There are many steps that must be performed with precision for each and every Service Order or Work Order in order to maintain data quality. These processes are well established at LBGO and, based on the quality of the paper records, were followed with little deviation. For over 80 years, this methodology has served LBGO well, but has resulted in huge stacks of documents in filing cabinets. Although, it is easy to find an individual service order or work order, any attempt to aggregate data on these records would require a massive effort. These paper-based records also do not allow for rapid analysis of trends across areas or types of material because an individual would have to pour over thousands of records.

In addition to the challenges posed by the Service Order and Work Order records, the record keeping systems that were in place did not integrate with other systems at LBGO. For example, there was little correlation between what assets were added, removed and maintained in the field with what the Business Operations maintained as assets on paper. In addition, Cathodic Protection, a keystone in ensuring pipeline longevity, has been handled over the years manually. LBGO staff members have done an amazing job
manually keeping tabs on CP test stations and system potentials but have very few tools to allow them to do any engineering analysis on the systems.

In addition to these challenges, the regulatory environment of 2007 was not envisioned by the owners/stewards of the system from 20 years ago. In fact, some of the regulatory requirements for documentation and analysis would be very complicated to satisfy using current methods of data collection and storage. Moreover, it is expected that future regulatory recordkeeping requirements will increase further. So, to continue to maintain quality data, improve access to that data throughout the organization, deliver the data to people wherever they are, and provide records for regulatory compliance, a change had to be made.

**LBGO Approach:**
The first step in this transformation was to capture all spatial information into GIS. This was the primary emphasis of the original Request For Proposal (RFP) – data conversion. The complexity lies in having a complete understanding of the needs of the end user so that appropriate information can be collected from the source documents. This process of Geodatabase design was done in a precise manner, taking into account all of the current and anticipated business and regulatory processes that will rely on the data. The design was done to meet the requirements of Code Compliance, Stoner Modeling and field use and ensure it was serving the needs of all stakeholders of LBGO.

A GIS alone did not really solve any of the various business process issues that LBGO was trying to improve as part of this project. This is where a variety of software systems, designed to integrate tightly with the GIS, comes into play. LBGO staff had expressed a need for a variety of information systems related to business functions and as part of this project, Nobel Systems partnered with Advantica to deliver the software tools that were requested by the Department to meet its needs.

The primary need was DOT compliance, and so the project needed software systems that are specifically tailored to meet these stringent requirements. These software systems will also improve workflow, reduce paperwork, and provide a huge benefit to the Department.
Geodatabase Design and Data Conversion

The Geodatabase is the cornerstone of the GIS and its associated applications.

In order to provide maximum functionality, Advantica’s Code Compliance was configured to meet LBGO’s Department of Transportation regulatory requirements. To facilitate the configuration process, Advantica conducted an on-site workshop at LBGO to learn about:

- LBGO’s business processes and current methodologies on meeting the compliance regulations
- Review compliance data that is currently collected, stored, and maintained by LBGO
- Goals and aspirations for the new compliance system
- Configuration settings for the Code Compliance product
- Understanding of the roll out and support of the compliance system

Upon completion of the on-site workshop, Nobel and Advantica created a design document that detailed the results from the on-site workshop. LBGO had the opportunity to review and comment on the document prior to the project moving into the configuration phase of the project. Advantica developed data managers to manage different functions within LBGO:

- Corrosion Control Data Manager
- Survey and Patrol Data Manager
- Leak Tracking Data Manager
- Equipments Data Manager
- Unscheduled Maintenance Data Manager
- Public Awareness Data Manager

Geodatabase Design

The Geodatabase design task included the rapid adaptation of the existing ArcGIS gas distribution model that was modified as needed to properly interact with the various software systems to be deployed. The physical data models were developed using UML (Unified Modeling Language) and Visio.

Primary considerations for the adaptation of the data models included:

- Assurance that all of the information required to capture and reproduce the essential features depicted in the existing maps and databases was accounted for
- Consideration for ease of access, use and maintenance of the basic information for mapping purposes
- Preservation of scalability for future refinement and implementation of key links to integrate other LBGO databases (Code Compliance, SynerGEE, etc)
- Ability of the Geodatabase to evolve into a fixed asset register that can be used to help integrate the GIS with other existing and future information systems at LBGO (GASB 34).
- Creation of appropriate domains ranges which are valid value tables.
- Identification of key fields in the Utility Billing system for subsequent links to the GIS
- Establishing the Geometric Network rules for the gas system

Nobel Systems also conducted an onsite database design workshop to review the preliminary data models and define additional requirements.

**ArcFM Configuration**

As a long-standing Miner & Miner business partner, Advantica was exceptionally qualified to implement ArcFM at LBGO.

**Data Conversion**

The data conversion process for this project was extensive in scope due to the sheer number of source documents involved.

**Scanning**

The first step in the process was the scanning of source documents. Scanning of source documents such as Gas Atlas Sheets, Work Orders, Repair Orders, Retirement Orders and Service Orders was performed onsite at LBGO. Scanning equipment was installed with appropriate Internet access for transferring files to the production facility in San Bernardino.

A sticker or label was placed on all the maps to differentiate them from the ones that were not scanned. Scanning was performed at appropriate resolution ranging from 100 DPI to 300 DPI based on the vintage and quality of the maps.

**Indexing**

As the maps were being scanned, attribute information such as Work Order Number, Description, Atlas Number, Drawing Number and As-built Date as agreed upon with LBGO was entered in a Microsoft Access Database.

This Database can be used as a document repository to query and retrieve appropriate maps. LBGO staff was given highest priority to retrieve maps they need for the day-to-day operations. The published maps were inventoried to ensure all the maps were scanned and transferred to the production facility.
Scrubbing

Due to various types of source documents and their quantity, Nobel scrubbed all the maps prior to conversion. This scrubbing process occurred onsite at LBGO so that LBGO staff can assist in interpretation conveniently. The scrubbing process played a vital role in efficient data conversion.

Discrepancies between the Atlas Sheet and Work Orders, Service Orders etc. were notified to the LBGO via Problem and Resolution (PAR) forms. Special notes or comments were listed to assist the drafting/digitizing technician during the conversion process.

Data Capture

Using the appropriate engineering measurements noted on the source documents, the point or pipeline was placed accurately within the drawing. A qualifier was added in the database to show the method of data capture. This will ensure complete conformance with LBGO’s requirements that all features located relative to the landbased features are within ±0.5’ accuracy.

Service laterals and risers were digitized using the stationing and distances listed on the Service Orders. The technician then entered the attributes. Programmatic validity checks were built into the system, so that entries were made through a default entry system, limiting operator error.

QA/QC

After data capture special QA/QC tools were run. These tools identified graphical connectivity errors, features with missing attributes among others. Errors are fixed and QC tools were re-run until the drawing was error free.

Entry into Geodatabase

At this point the AutoCAD data is ready to be brought into the GIS. The data was imported to ArcGIS Geodatabase into appropriate feature classes as defined by the Data Model. ESRI’s Object Loader was used to load the data. Soon after loading the data, the Geometric Network was validated against the Geodatabase Connectivity Rules established during the Geodatabase Design. Errors were reviewed and fixed as appropriate.

Annotation
As soon as the features were loaded into the Geodatabase, feature-linked annotations were automatically created based on the label parameters set during the creation of the feature class.

Based on the needs of the different stakeholders of the project and functions there, the idea was to have an outcome that meets all user needs – primarily related to Code Compliance, Stoner Modeling and Field use. Nobel/Advantica provided full functionality in each of these areas.

Nobel/Advantica team:

- Leak Survey Management
- Cathodic Protection Survey Management
- Valve Maintenance Management
- Atmospheric Corrosion Survey Management
- Service Order Sheet Generation
- Mobile GIS Access
- Gas Flow Modeling
- USA Order Generation

**Primary Business Processes**

The four business processes, Leak Survey, Cathodic Protection Survey, Valve Maintenance, and Atmospheric Corrosion Surveys were all handled by Advantica’s Code Compliance suite of software.

The core foundation of the solution was Advantica’s off-the-shelf product Code Compliance. The product configuration tailored the Code Compliance product to Long Beach Gas and Oil’s (LBGO) data and user requirements:

1. **Insure that inspections and surveys were scheduled and completed as required per 49 C.F.R. Part 192**
2. **Report tasks at risk of non-compliance**
3. **Maintain historical data for compliance audits**
4. **Provide audit trail**
5. **A common system for tracking and reporting all types of work using a common interface for all tasks:**
   a. Defining Business Districts (including schools, churches etc)
   b. Defining Cathodic Protection Districts
   c. Defining Critical Valves (including Fire Control Valves)
d. Integration and implementation of Tablet PCs including:
   i. Downloading daily workloads to a Tablet PC
   ii. Uploading field survey information directly from the Tablet PCs into database (nightly)

e. Identify/Highlight pipeline near end of compliance window

f. Identify/Highlight pipeline ready to be surveyed
g. Divide pipe surveys into survey packages

6. **System to integrate with LBGO’s GIS to provide a single data entry portal**

7. **Software to be open and configurable to facilitate modification for Long Beach Gas and Oil's business practices**

**Other GIS Driven LBGO Wide Implementations:**

**Service Order Generation**

The current business practice for Service Order generation is essentially unchanged from the early days at LBGO. Paper forms are filled out and distributed to the appropriate parties for the performance of the work. One of the main goals was to bring elements of the GIS into the map frame portion of the Service Order itself. The system, while still a simple prototype of the potential configuration, allows the user to generate a service order for any given location on the map.

The system allows the user to enter data about the service order, and once generated, the Service Order is produced as a PDF document, ready for sharing throughout the organization. A printed version of this document could be sent out into the field with the construction workers if they did not have access to a PC. Data on pipe quantities and other information that is only available after the work is done can be entered into the system for display on the Service Order.

**Gas Flow Modeling**

The SynerGEE gas flow modeling was developed by Advantica over 30 years ago. Working together, the Nobel/Advantica team delivered a pilot gas flow model to meet the modeling needs of LBGO now and into the future. The development of any hydraulic model consists of three separate yet integrated processes: Facility Model Development, Load Model Development, and Model Verification. The Facilities Model Development incorporates all of the tasks and processes required to take facility data, located in Long Beach Gas and Oil’s ArcGIS Geodatabase, and generate an accurate representation of those facilities in the SynerGEE Gas software. The exporting of the data from the ArcGIS Geodatabase will be accomplished by Advantica’s Model Builder application.
The Load Model Development incorporates all the tasks and processes required to generate accurate customer loads on the SynerGEE model. This includes calculating the demand of each customer and attaching that customer to a facility in the model. This proposal does not include any services relating to creating an accurate load model for Long Beach Gas and Oil’s SynerGEE model. Finally, an effort to perform a Model Verification ensures the accuracy of the model. Incorporated in a model verification are all the tasks and processes to compare the SynerGEE model to system pressure and flow data captured during a historical peak send out hour.

**Underground Service Alert Generation**

LBGO receives dozens of dig alert requests per day and must respond to each one by law. Determining how to assign these can be a lengthy chore that can be remedied by the GIS. Using this knowledge, Nobel configured a database that automatically created a new dig alert ticket record for each email that is received from the USA computer.

From there, the ticket will be linked to the GIS using the coordinates provided by USA. Upon receipt, each ticket will have a status field coded as “Unmarked”. Using GeoViewer Online either in the office or in the field, users will be able to retrieve the ticket info by clicking on the symbol on the map. Once the mark out is completed, the user will be able to change the status field to “Marked” at which point the symbol will be removed from the map of pending mark outs. As an option, a separate map of completed mark outs could be maintained but it is envisioned that this would become fairly cluttered in a rapid fashion.

Using this system, the LBGO Coverage area could be separated into different zones of responsibility that are assigned to different individuals. Each morning, a quick glance at GeoViewer Online will show all the tickets in a given area. If desired, the staff person would pull up maps in the office so that printed version could be taken out in the field. An alternative would be to install small, portable inkjet printers in the trucks so mark out technicians could print maps on the fly.

Using this system, if a mark out is missed, it will stay on the map. If desired, an aging system could be developed to change the color of the symbol if a mark out is not completed within a specified time period.

**Training**

All of this new software was designed to be as user friendly as possible. Certainly, the gas model will only be operated by Engineers who will receive extensive training. Other
systems are designed to be used throughout the organization and while user friendly, will also require staff training.