



# GIS Delivers Insight into Pipeline Construction

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For today's multi-disciplined pipeline construction projects, using geographic information systems (GIS) has become a necessity. GIS provides the geospatial visualization tools necessary to integrate complex information into any project. This gives all of the decision-makers, from engineers and scientists, to executives and public officials, an efficient way to analyze and overcome the many diverse challenges associated with complex projects that cross multiple regions and unpredictable environmental conditions.

## Applications in Pipeline Construction

According to the U.S. Department of Transportation, the United States built 148,622 miles of oil pipeline and roughly 1.54 million miles of gas pipeline in 2009. The magnitude of planning and constructing this many pipeline miles without relying on GIS is unimaginable.

For example, the 1,700-mile Keystone XL Pipeline project has proven to be a monumental undertaking. From choosing the right route, to balancing the political, environmental, legal and economic factors, this international pipeline project has required precision planning. Even though the project has suffered some recent setbacks, supporters of the \$7 billion project are still actively laying the groundwork for the development and submission of plans for a pipeline system that will bring tar sands oil from Alberta, Canada to Gulf Coast refineries in the United States.

## The Value of Geospatial Visualization

With most projects, GIS first comes into play during the site planning phase. From a pipeline designer's perspective, a potential pipeline route is essentially a connected series of points, with the region between each point characterized by an overwhelming number of factors. These typically include land ownership, meteorological data, elevation, terrain, groundwater aquifers, wetlands, environmental designations, county parcel numbers, land use and zoning classifications, emergency services, and even socio-economic data. All of these factors must be integrated into the planning process, and GIS is an effective tool for accomplishing this.

The benefit of visualizing the geospatial connectivity of all of this information is that planners cannot only see the big picture, they can quickly recognize how even seemingly small factors can ultimately have a significant impact on a large, capital-intensive project. For example, a straight route for a pipeline may, at first glance, seem to be the most efficient and cost-effective option. But once all of the information is fully compiled and integrated, the use of GIS data helps planners develop not just the shortest routes, but the most optimal ones. These tools give engineers and designers an efficient way to make more informed decisions during the planning process.

In the Keystone XL project, TransCanada used mapping data, soil surveys and aerial photographs to identify wetlands and

other bodies of water. This information was essential to ensure the project met the requirements of the United States' Clean Water Act, one of many legal and regulatory requirements that needed to be addressed at various stages of the project. Crossing federal, provincial and state jurisdictions is extremely complex when dealing with an international project of this magnitude, and GIS tools help alert project planners to other potential impacts while tracking the permitting process.

## Juggling Project Resources

Managing a project that spans hundreds of miles requires pinpoint precision when it comes to tracking the construction workers, materials and other resources dispersed over a wide geographical area. Accuracy is essential, and GIS provides construction managers with an accurate way to identify exactly where the different resources are located and where they need to be at any given time.

For the Keystone XL Pipeline project, GIS has been used to access the location of special materials being shipped by truck and scheduling their arrival on site for the next phase of a build out. Matching this information with crew locations and the amount of time it takes to shift locations gives managers an effective tool way to ensure the right people arrive on site with the right materials to do the job.

Managing projects in areas faced with volatile weather conditions can pose challenges for even the most seasoned project managers. Recently, presenters at the 2011 ESRI International User Conference, one of the largest GIS-related conferences in the world, shared some actual cases where GIS was used to manage pipeline projects in Brazil, an area impacted by severe weather extremes. On one project, companies could only ship pipe to the storage yards during the high flood season, while actual construction work in the wet regions could only be scheduled during the dry season. Matching the material shipping dates with the arrival of crews to specific areas and then shifting these resources according to weather changes would have been impossible without the use of GIS.

In automating the data collection process, GIS works with other technologies, as well. For example, Radio Frequency Identification (RFID) tags can be attached to individual pieces of pipe, which provides an accurate way to track pipe sections or pipeline components. This level of tracking offers an efficient way to maintain detailed records relative to the type of pipe or material, its location, size and condition. Combine this data with information about local conditions, such as weather, and GIS helps facilitate the development of an ongoing pipeline maintenance program.

## Virtual Monitoring

One of the more dangerous aspects of pipelines is the possibility of leaks. A single spark can lead to a devastating explosion, like the one that occurred in southern Ohio in November 2011. In this case, a gas line explosion shot flames hundreds of feet into the air, and people up to twelve miles away felt the shock wave from the explosion.



Visually inspecting a pipeline for leaks can be a daunting task. However, by combining GIS with pressure and flow sensors, a company can actually monitor what happens inside the pipes from any location. Information about unexpected drops in pressure or movement can be correlated with the location of the specific pipe, which can provide an ongoing view of pipeline performance. If pressure or volume begins to drop, administrators can isolate specific sections of the pipeline and dispatch an inspector or crew to examine that pipe and its surrounding infrastructure. In that sense, GIS serves as an early warning system or a practical fluid dynamics debugging tool.

Monitoring the pipeline's performance is an important economic indicator, as any indication of a gas loss suggests that the utility is losing money. For a more complex set of pipes, a computer system could be stationed at a central facility to track the pipeline flow and adjust valves to direct fluid or gas where it's needed. Through GIS tools, the weld and metal inspections, outage reports, and other information can all be made immediately available to crews, specialists and executives.

## Leveraging the Opportunities

Companies, governments and communities that want to use their resources wisely and ensure smooth construction and safe operations of such projects will need to maximize the efficiencies that GIS tools provide.

For those professionals who know how to combine geospatial techniques with data collection, analysis and interpretation, considerable career opportunities await.



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