Applied GIS: Reducing Capital Improvement Costs

Kevin B. Gunn
Director of Information Technology
City of Killeen, Texas

Abstract

The City of Killeen, Texas is rapidly growing. The demand for critical infrastructure: streets, water/waste water, and drainage is outpacing the funding available for these projects. Leaders in the Public Works Department surmised that a significant portion of engineering and design fees were attributed to contingency. Under current construction practices, design consultants have to plan and budget for the unknown. Public Works staff theorized that by minimizing or even eliminating the unknowns for the design consultants the City could realize significant savings. Geographic Information Systems (GIS) proved to be the means to accomplish the task. This paper discusses the planning, criteria, processes, and methodology used by the City of Killeen for one street capital improvement project. This project realized more than ten percent savings of approximately $82,000 on design consultant fees for preliminary engineering alone.

Introduction

The City of Killeen, Texas is located in Central Texas between Waco and Austin on Interstate Highway 35. Adjacent to Fort Hood, the largest Army training installation in the free world, Killeen proudly serves as home to our nations soldiers. The city has experience a prolonged growth period over the past decade. In 2001, the incorporated city covered approximately 35 square miles. That same year the population was estimated to be just under 87,000 residents. By 2007, Killeen topped 45 square miles with a population over 103,000. The City also maintains 467 miles of paved roads, 266 miles of drainage channels, and over 450 miles of waste water collection mains. Residents consume an average of 13 million gallons of potable water per day, connecting to over 507 miles of water distribution piping. Over 36,000 residential solid waste containers are emptied weekly. The growth continues today. In 2005, construction permits for single family dwellings exceeded $142.9 million in construction value. That figure represents an 80 percent increase over permit values just five years earlier.

The sustained period of growth in Killeen has strained Capital Improvement Project (CIP) planning. The demand for CIP projects continues to increase. Annexed areas need roads that meet City standards. Older areas of the City desperately need infrastructure rehabilitation. At the same time, funding for CIP projects is uncertain. General Obligation (GO) Bonds have traditionally funded long-lived infrastructure in municipalities. However, debt issuance has a direct impact on tax rates in order to service the debt over the life of the bond (typically 10 years). By 2005, debt supported by property taxes surged to $47 million. The City recognized

that business processes needed to be modified to reduce the expense of CIP projects and to receive the most benefit from each CIP dollar spent.

Discussion

Figure 1 illustrates a generic CIP process. CIP projects arise from any number of different sources. City growth, resident's complaints, thoroughfare plans, elected officials, development community, etc. all play a roll in identifying and prioritizing which CIP projects are needed and funded. In the case under consideration, a Blue Ribbon Committee picked several street improvement projects for a $23 million GO Bond election, which was approved by voters in 2004. Once a project is selected and funded it moves into the engineering and design phase. An engineering firm is hired to perform design tasks and develop a set of construction plans. The firm is selected following procurement regulation and local policy and signs a contract on a fixed-price, not-to-exceed basis. Finally, the construction plans are put out for a construction contract bid. The road is built, inspected and turned over to the City for operation and maintenance.

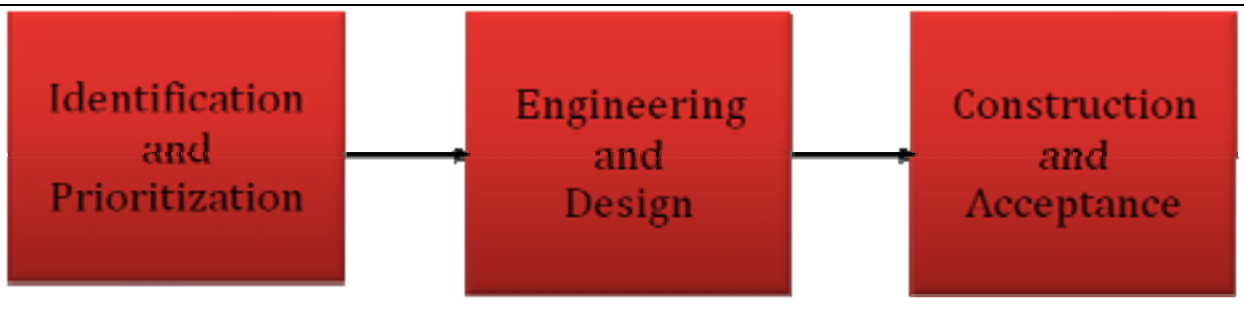

Figure 1

The Public Works Department approached the Information Technology Department for assistance. The Project Engineer for street projects surmised that contingency in the Engineering and Design bids represented a significant portion of the total expense for Engineering and Design fees. Since the design firm agrees to produce plans on a not-to-exceed basis, the fee proposal will include built-in contingency for unknown or unforeseen field conditions. The contingency is a standard practice to ensure the firm makes a profit. The City wants the firms to earn a profit and stay in business because they provide talented engineers and years of experience to Killeen's CIP projects. However, the City is striving to deliver the most benefit for every CIP dollar spent and must balance the competing purposes.

The design firm often incorporates contingency for a number of different activities. Table 1 lists a few examples. Public Works and Information Technology staff discussed strategies for reducing the unknown field conditions for the design firm and thereby reduce the contingency included in the fee proposal. City staff determined that Geographic Information Systems (GIS) had a role to play.

Item	Description
Unknown field conditions	Utility locations, fence lines, manhole locations, sidewalks, driveways, and other items in the right of way must be accounted for in the street design.
Survey work	Surveyors will pinpoint location of items in the right of way. Design firms often subcontract for survey work and add contingency and overhead to the fee.
Time to collect data	The design firm collects information about the project site and surrounding development. Labor and fees are included in the fee proposal for gathering this information.
Skills mix	The design firm brings a number of different skills to the project, each with different labor rates. Principle engineers, Project engineers, project managers, draftsmen, administrative staff, etc.

	The firm wants to ensure billing enough hours to cover the expense of the different skill sets. Under billing high labor rates can be very costly to the firm.

Table 1

The City of Killeen has been using GIS since 2001. A wealth of information was already collected and available to City staff using GIS. Digital aerial orthophotography from 2001 and 2006 was available in GIS format. Street centerline, parcel, drainage, topology, surface and subsurface utilities were available in GIS format. Plat and as-built construction plan documents for adjacent development were scanned and available in digital format. The only information not readily available was the location of surface features (i.e. buildings, fence lines, sidewalks, driveways, signs, creeks/stream, etc.). GIS staff decided to collect this information using handheld GPS devices. The entire collection of GIS information was to be submitted to the engineering firm to be used in the design phase. The goal was to provide the necessary information for the design firm to perform preliminary engineering (30 percent design review) without fielding a survey crew, charging for data collection, and without multiple site visits (preferable no site visits).

In addition, GIS professionals often have a difficult time quantifying the value of GIS information. Many times GIS information provides cost avoidance or efficiency savings which are hidden costs and difficult to estimate. The City staff devised an experiment to quantify the value of GIS information. City staff requested a fee proposal as they normally would. Then, staff provided the GIS data to the engineering firm and requested a revised fee proposal. The difference between the two would represent the value of the GIS information.

City staff had just two weeks to collect the surface information to meet Public Works' contracting timelines. GIS staff devised a data collection application using Pathfinder software on a handheld Trimble GeoXH GPS unit. This application collected surface features such a points, lines and polygons. Additionally, the field workers could annotate the collected features using drop down menus (manhole, fence line, driveway, etc.) and add field notes/comments. The field information was collected by Public Works and GIS staff over the course several days. Table 2 provides a summary of the expense incurred as a result of collecting data in the field.

Staff Member	Units	Rate*	Extended
GIS Tech (2)	52 hours	$20.52	$1,067.04
Drainage Tech	8 hours	$19.85	$158.80
GIS Project Manager	16 hours	$36.28	$580.48
Streets Project Engineer	4 hours	$37.12	$148.48
		Total	$1,954.80
Mileage	80 miles	$0.445	$35.60
		Total	$35.60
		Grand Total	$1,990.40

Table 2

***Fully burdened rate includes salary and benefits where appropriate**

Results

As planned, the data was delivered to the engineering firm after the City received the initial fee proposal. The firm was asked to revise the fee proposal for preliminary design up to the 30 percent design review stage. Four weeks of anxious anticipation passed. When the

revised fee proposal arrived, city staff poured over the results. The street CIP project was split between two sites. The scale of the project differed at the two sites so the results varied. Table 3 summarizes the cost reductions by site.

Site	Initial Proposal	Revised Proposal	Delta	Percent Delta
Trimmier	$71,800	$54,650	($17,150)	(24 %)
Watercrest	$117,520	$92,390	($25,120)	(21 %)
Total	$189,320	$147,040	($42,280)	(22 %)

Table 3

Subcontracted survey costs we also reduced by 90 percent. The City saved $40,000 as a result of the engineering firm not fielding the survey crew. Total savings for the preliminary design phase was $82,000 for a project estimated to be $760,000 total cost. A 10 percent reduction in cost for the design phase was realized by the City. Put another way, the City could buy ten street design projects and get the eleventh one free. The City was also able to quantify the value of GIS information as a result of the experiment. The $82,000 reduction in the fee proposal represents the intrinsic value of the GIS information provided to the engineering firm.

Conclusion

Two conclusions are highlighted as a result of this project. First, GIS information collected and maintained by municipalities has an intrinsic value. GIS information is not just an inventory of points, lines and polygons. It is a scare resource that can be utilized in many different situations. In this example, the value of the GIS information was $82,000. However, the harder the information is to collect and utilize the more valuable it becomes. Second, GIS practitioners need to be on the lookout for inventive ways to apply their trade. Public Works staff has been building road projects the same way for decades. It took collaboration between Public Works and GIS to realize a new model for conducting business. A prerequisite for this realization was personal relationships between staff and an understanding of GIS and GIS capabilities. It is up to GIS practitioners to cultivate and foster that understanding with the other professional in their organization.