Research Report
KTC-06-19/SPR-293-05-1F

KENTUCKY TRANSPORTATION CENTER

AN ANALYSIS OF THE DIRECT AND INDIRECT COSTS OF UTILITY AND RIGHT-OF-WAY CONFLICTS ON CONSTRUCTION ROADWAY PROJECTS

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An Analysis of the Direct and Indirect Costs of Utility and Right-of-Way Conflicts on Construction Roadway Projects

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16. Abstract

Utility conflicts are unfortunately a common occurrence on many roadway projects. This report examines the frequency and severity of utility conflicts both within and outside of Kentucky Understanding which type of utility conflicts most likely occur and the potential magnitude of their costs when will help the Cabinet better understand the risk of utility conflicts on future projects. The report details a series of five case studies that quantified the direct and indirect costs of utility conflicts on previous projects. The report also reports on the result a national survey of 45 state utility directors (out of a possible of 50) throughout the U.S. regarding their perception on the frequency and severity of utility conflicts within their state. The survey analyses also examined the impact of state best practices on the perceived frequency and severity of utility conflicts. Finally, the report outlines a comprehensive roadmap for the Cabinet in order to avoid utility conflicts on future roadway projects.

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Executive Summary

The following report details a research effort that examined the frequency and severity of right-of-way (ROW) and utility conflicts in not only Kentucky but across the U.S. as well. While ROW conflicts were included the project scope and are addressed in this report, the Study Advisory Committee decided very early in the study to focus on utility conflicts, due to their frequency and severity within on Kentucky roadway projects.

The report describes the three phases of the project efforts. Phase one involved a series of five case studies on past projects that focused on both the cause and cost (direct and indirect) of utility conflicts. Phase two involved a national survey of state utility directors employed by their respective state transportation agency; 45 states completed the survey. Finally, phase three utilized the experience and diverse expertise to prioritize a list of suggestions on how the Cabinet can avoid future utility conflicts on its roadway projects. Very brief summaries of each of these phases are provided below.

The case studies provide a very insightful understanding of the true costs of utility conflicts on Kentucky roadway projects. Each case study involved numerous interviews and correspondence with project participants on each past project. The total project costs of the five case studies ranged from \$5.2 million to \$22.2 million. When considering both direct and indirect costs of the utility conflicts on these projects, the conflict costs ranged from \$146,000 to \$1,100,000. The costs due to the utility conflicts as a percentage of the total project costs ranged from 1.3% to 4.8%. While the case studies provided many valuable lessons learned, they also clearly showed that efforts to reduce the frequency and severity of utility conflicts are warranted.

The state surveys identified the frequency and severity of different types of utilities and also showed the impact that state practices are having to minimize their impact. The analyses of the state surveys allowed the researchers to conclude:

1. State utility directors perceive that utility conflicts occur with greater frequency and severity on urban projects compared to rural projects;
2. Of the different types of utility systems examined in the research, existing underground telecommunication, water, gas, and above ground electrical lines in urban areas appear to be the most frequent and most sever utility conflicts on road way projects;

3. State utility directors that report frequent communication with utility companies, especially through written correspondence and by telephone, reported less frequent and less severe utility conflicts on their state's roadway projects;
4. States that reported earlier involvement of utility companies during the project development process, especially during the planning and preliminary line and grade phases, reported less frequent and less severe utility conflicts on their state's roadway projects. The advantages of early utility involvement were also seen when funding of utility design was available during the planning and preliminary line and grade phases; and
5. States that require SUE Quality Level A or B prior to project letting indicate less severe utility impacts.

While Phases 1 and 2 of the research focused on quantifying the frequency and severity of utility conflicts, phase 3 took a look forward by developing a road map for the Cabinet to help avoid utility conflicts on future roadway projects by considering the potential impact and investment costs of sixteen suggestions. The implementation plan is divided into three parts: a short-term (5 year) plan, a medium-term (5-10 year) plan, and a long-term (10 years and more) plan. The short-term implementation plan contains methods that can be enacted within the next 5 years and typically has an average to high impact with below average investment costs. A suggestion in this plan does not require any special legislation or major policy changes. The medium-term implementation plan contains methods that can be enacted within the next 5 to 10 years and typically has an average to high impact with an average investment cost. A suggestion within this plan may require special legislation and minor policy changes. The long-term implementation plan contains methods that cannot be enacted until 10 or more years to produce feasible benefits. A suggestion in this plan has an average to high impact with an average to high investment cost and will generally require special legislation and major policy changes to enact. Details for each of the below suggestion are discussed in section 5.4 of the report.

<u>Short Term Implementation Plan (Next 5 Years)</u>:

1. Set time limits for plans kept on file to avoid using outdated design information during construction
2. Require the contractor to submit as-built drawings in order to improve the accuracy of utility information on future projects.

3. Maintain a pre-qualified list of utility contractors and/or Allow Contractors to Perform Relocation Work Whenever Possible.
4. Pending contracts in anticipation of utility relocation (low bidder is identified, but a contract is not awarded until all utilities are successfully relocated by the utility companies of other parties.)

Medium Term Implementation Plan (5 to 10 Years):

1. Formation of utility coordinating councils
2. Minimum utility coordination requirements
3. Use of monetary incentives or penalties for (un)timely completion of utility relocations
4. Cost sharing between the state and utility companies for utility relocation expenses.

Long-Term Implementation Plan (10 years or longer):

1. Change the culture within the Cabinet to better address utility needs before a project is released for bid;
2. Develop a utility web page to provide contact information at all utility companies and provide the state's five year work program.
3. Development and dissemination of five-year work programs
4. Develop a common database of utility locations
5. Develop utility corridors/utility preservation for common areas of utility locations on future projects.

Of all the above suggestions, there was a strong consensus among the SAC that changing the culture within the Cabinet regarding its approach to utility design and relocation needs would have the greatest impact on avoiding future conflicts. The reality is that there are numerous internal and external forces that push the Cabinet to award jobs and repair roadways and bridges in the shortest amount of time possible. The SAC felt that this acceleration comes at the expense of increased costs with respect to utility relocations. Considering the magnitude of the increases in project costs attributed to utility conflicts, the time and money spent to thoroughly address all required utility relocations is justified.

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1 Introduction

1.1 Problem Statement

When highway improvements and utility relocation are not well coordinated, the public, the utilities and the highway contractors suffer delays and additional expenses. Each year, many state and local highway improvement projects require the relocation of utility facilities. Within the limits of these highway projects lies a complex network of utility lines, including electric, telephone, cable TV, telecommunications, fiber optics, natural gas, water, sanitary and storm sewers. Finding practical solutions that have the greatest impact on the frequency and utility conflicts is very challenging.

Issues regarding the location, coordination and relocation of utility facilities are a growing concern among public agencies, utility owners, construction contractors and designers. Improved coordination among these four entities is needed to reduce project delays, conflicts, safety risks, traffic congestion and added inconvenience and expense to taxpayers, motorists, contractors, utility companies and adjacent property owners. The University of Kentucky has developed this report to identify the problem and provide suggestions to avoid the relocation of utilities

Some states allow utility companies to place their facilities on the public highway right-of-way at no cost, provided these facilities do not interfere with the construction, maintenance or safe operation of the roadway (Hakimi 2005). If relocation of these facilities is necessary to accommodate highway improvements, the facilities are normally moved at the utility company's expense. On the other hand, the relocation of utility facilities from land on which they have an easement or other property interest is paid for by the highway agency when this land is needed for a highway improvement. The highway/utility relationship has existed for much of the past century. Both parties serve a public interest and find that it makes sense to cooperate with one another in accommodating utility facilities within the public right-of-way. However, even with this long history and good intentions from parties, utility companies and highway agencies do not always agree on their respective rights and responsibilities.

A proliferation of new and competing utilities in congested urban highway corridors and an increasing emphasis on the part of both utilities and governments to keep project budgets and staff expenses under tighter control, add further complications. In this environment, it is not entirely surprising that there are an increasing number of conflicts on highway improvement projects where utility facilities need to be relocated. Accommodating utility facilities within the right-of-way has never been a more complex task than presently exists.

In the past, the utility coordination challenges of a highway improvement project were much simpler because emphasis was on the construction of new highways rather than the reconstruction or expansion of existing roads where the right-of-way adjoining the pavement serves as home for a host of above- and below-ground utility services. The number of utilities using the right-of-way has also grown as a result of an ever-growing population, growth of suburban communities, demand for additional services and developments in technology. For example, 33 million miles of fiber cable were installed in the United States in the year 2000 alone (Carter 2002).

The current focus on improving and expanding existing highways also means inconvenience and delay for motorists, which, in turn, brings pressure to speed construction. Therefore this environment magnifies the impact of any delays when utility facilities need to be relocated. Competitive pressures and reductions in government and utility company staffs due to budgetary constraints have also contributed to the problems by reducing the staff resources available to address utility relocation issues. Frequent personnel changes, as a result of these factors, have further compounded these issues. All of these ingredients have made it more difficult to maintain communication as construction projects advance through the development process.

1.2 Purpose of Project

The purpose of this research project was to attempt to quantify the impact of the anticipated utility conflicts that occur after on roadway construction projects and to also identify solutions that may prevent utility conflicts from occurring on future roadway projects.

There are numerous causes of utility conflicts on roadway construction projects. Some of these include incorrectly marked plans, inaccurate utility location designation, improper installation of relocated or non-relocated facilities, design changes, and numerous other sources. Many of these problems could be easily remedied if changes are made to current policies and procedures. Researchers have proposed numerous solutions intended to minimize the occurrence of these utility conflicts. These solutions have proven to be effective by organizations that have already incorporated their practices into many facets of their projects. This research will describe the frequency and severity of utility relocation conflicts; quantify the costs and delays associated with these conflicts, and offer suggestions to alleviate the problems.

1.3 Research Objectives

The goal of this study is to address utility relocation conflicts on highway construction projects and pursue practices that can aid in reducing their occurrence and impact. The following objectives have been identified for this study:

1. Identify the conflict frequency of various utility relocation problems on highway construction projects.
2. Identify the conflict impact of various utility relocation problems on highway construction projects.
3. Identify utility practices currently used by other state transportation agencies.
4. Identify practices to alleviate or minimize the impact of utility relocation problem.
5. Recommend utility practices for implementation on highway construction projects.

1.4 Background and Significance of Work

The number of utilities within roadways' right-of-way is increasing, with the trend leading to a greater number of utility occupants (Thomas and Ellis 2001). There are not only more utilities within the right-of-way, but there are new types of utilities requiring occupancy. Gas lines have become more common, growth of the telecommunications industry has prompted new occupants, and there is also an increase in the number of fiber optic communication lines requesting permission to locate within the right-of-way (Thomas and Ellis 2001). With an increasing number of utilities located within the right-of-way, one can only anticipate the potential problems that can arise when roadway expansion is required and utilities are forced to relocate their facilities. Magnifying the already difficult task of coordinating relocations among the various utilities is the inability of most state transportation agencies to motivate utility companies to move their facilities in a timely manner. Utilities are typically required to perform relocations of their existing facilities at their own expense due to construction or expansion of a roadway, unless the utilities have a prior land right.

Since utility relocation can require expansion of right-of-way lands, best practices expediting utility relocation within right-of-way need to be identified that can minimize project delays. Identifying utilities that have the greatest potential for delaying a project will provide insight of the utilities that warrant the most consideration throughout the project development process. Also, identifying the various sources of utility conflict that generate delays at the greatest frequency and severity will identify the sources that need consideration for attention and improvement. There is also a need to identify the location accuracies of various utility provided by One Call Centers; this will display if there is any correlation between utility location accuracy and project delays.

1.5 Report Overview

This report is organized into six chapters. Chapter 2 of the report contains the literature review concerning both right-of-way and utility practices. Chapter 3 describes the case study analyses that quantified the direct and indirect costs of utility conflicts on five previous projects. Chapter 4 presents the results of questionnaire administered to 45 of 50 the outcome of the states questionnaire with a detailed analysis of the results. Chapter 5 lists and prioritizes the best practices that can be implemented to reduce utility conflicts. The final chapter of the report, Chapter 6, contains the research team's conclusions, recommendations, and proposed implementation plans.

2 Literature Review

Issues regarding the location, coordination and relocation of utility facilities are a growing concern among public agencies, utility owners, construction contractors and designers. Some states allow utility companies to place their facilities on the public highway right-of-way at no cost, provided these facilities do not interfere with the construction, maintenance or safe operation of the roadway (Hakimi 2005). If relocation of these facilities is necessary to accommodate highway improvements, the facilities are normally moved at the utility company's expense. However the relocation of utilities can have a great impact on projects causing major problems as delays and extra costs.

2.1 Right-of-Way Practices

2.1.1 Background

Right-of-way acquisition has an important impact on the schedule of most transportation projects. After a complete review of state right-of-way literature, it was concluded that there are both federal regulations (established by FHWA) and state statues that create unique factors or requirements that impact each state's process. Generally, right-of-way acquisition proceeds in a five step process: right-of-way determination, appraisal, acquisition, relocation, and condemnation. While all steps of this process are not required for each parcel affected by a transportation project, combinations of these steps are required for all affected parcels. A brief overview of the essential functions of right-of-way is provided, followed by a discussion on the legal aspects and their role in controlling right-of-way acquisition practices. Also addressed is a review of effective practices in accelerating right-of-way delivery time, along with specific state methods that have proven effective in enhancing the right-of-way process. This summary will yield a better understanding of the concurrences found among state right-of-way processes and identify effective practices that are currently implemented in the right-of-way function. Gaining a general understanding of how various states proceed through their acquisition processes will facilitate a comparison of Kentucky's acquisition procedures to other states, allowing for recognition of potential improvements to the state's current practices.

2.1.2 Appraisal

After project alignment has been finalized and the affected parcels identified, appraisal of the necessary land required for the project commences. The acquiring agency also reviews public records and other information about the affected parcels and other parcels in the area for utilization in the appraisal process. The appraiser will contact the property owner to schedule an appointment for appraisal, where the property owner may accompany the appraiser to identify unique features that could potentially increase the appraisal value. A fair market value[1] is determined by the appraiser and submitted to the acquiring agency for approval, who then determines just compensation[2] for the parcel (FHWA 2002). Buildings, structures, and other improvements must also be considered for compensation, when the acquiring agency determines that the project will impact the improvements (FHWA 2002). However, appraisals are not required when the appraisal is considered uncomplicated and the fair market value is less than $2,500; some states have extended the value for appraisal waiver to $10,000 (FHWA 2002).

2.1.3 Acquisition

Establishment of just compensation by the acquiring agency facilitates negotiations, initiating the acquisition process for a parcel. A negotiating statement should be delivered to the owner and will generally include: the amount offered as just compensation, a location and description of the property, and identification of structures and other improvements considered to be part of the real property (FHWA 2002). If applicable, the negotiation will also list the real property items in which the owner has the option to retain (FHWA 2002). The property owner is given reasonable time to consider the offer and to request information on anything that is not understood (FHWA 2002). If an agreement between the property owner and the agency cannot be reached, and the agency has exhausted all opportunities to reach an agreement with the property owner, the agency will initiate condemnation proceedings (FHWA 2002). If the property is being acquired by a federal agency, federal legal procedures will be followed and the case heard in federal court (FHWA 2002). Statues and regulations imposed at the federal and

[1] FHWA (2002) defines fair market value as the sale price that a willing and informed seller and a willing and informed buyer can agree to for a particular property.
[2] FHWA (2002) defines just compensation as the price an Agency must pay to acquire real property. The price offered by the Agency is considered to be fair and equitable to both the property owner and the public. The Agency's offer to the owner is “just compensation” and may not be less than the amount established in the approved appraisal report as the fair market value for the property. If it becomes necessary for the acquiring Agency to use the condemnation process, the amount paid through the court will be just compensation for the acquisition of the property.

state level play a large role in the procedures that must be followed by the acquiring agency (FHWA 2002).

2.1.4 Statutes and Regulations

The federal Uniform Relocation Assistance and Real Property Acquisition Policies, Uniform Act, provides important protections and assistance for individuals affected by federally funded projects. This law ensures that individuals, whose property is acquired or must move as a result of projects receiving federal funds, will be treated fairly and equitably and will receive assistance in moving from the property they occupy. Subpart B of the Uniform Act (49 CFR Part 24) deals specifically with acquisition of real property, outlining the procedures and requirements each agency must adhere to when conducting acquisition of land for a federally funded program or project. Basic acquisition policies, appraisal procedures, and incurred owner expenses are the main components addressed within this article.

Appraisals must be completed by appraisers who comply with qualifications established by the agency. Each appraisal at a minimum must include: a purpose for the appraisal, a description of the property's physical characteristics, the method used to obtain the value, a description of comparable sales, a statement of value, and required dates and validations. The appraiser cannot act as a negotiator for real property in which they have appraised, unless the value is $2,500, or less. Each appraisal at a minimum must be reviewed by a qualified reviewing appraiser, approved or given a recommended value by the reviewing appraiser, and given proper verification by the reviewing appraiser. Acquisition of real property on any federally funded program or project must adhere to the regulations and policies defined in the Uniform Act.

2.1.5 State Methodology

As previously indicated, there are federal and state laws that affect the acquisition process, resulting in varying procedures from state to state. While each state must maintain compliance with federal guidelines, state statues create diverse methods among state right-of-way agencies. A recent study by the Center for Transportation Research at the University of Texas at Austin provided a general overview of what practices are permitted by state law. This study, "Right-of-Way Acquisition and Property Condemnation: A Comparison of U.S. State Laws" by Hakimi and Kockelman (2005), examines key right-of-way laws and their impact on the acquisition process. The key laws are as follows:

1. **Allowing the acquiring agency to take uneconomic remnants through negotiation and/or condemnation.** An uneconomic remnant is a remaining part of land, after a

partial acquisition, which is of little or no utility or value to the owner. The Uniform Act requires that the acquiring agency offer to purchase uneconomic remnants. This requirement is based on the reasoning that an owner should not be burdened by having to maintain and incur taxes for a property that is created by public taking and that is of no value to the owner. State law may differ from the federal law in allowing use of eminent domain for acquisition of uneconomic remnants (Hakimi and Kockelman 2005). State provision of law that allows an agency to acquire uneconomic remnants through negotiation or condemnation reduces condemnation rates and enhances the acquisition process (Hakimi and Kockelman 2005).

2. Allowance of "quick taking". Quick taking allows the acquiring agency to take immediate possession of the property upon offering to buy it, and then the agency must deposit the amount offered with the clerk of the county district court in which the property is located. Should the property owner wish to challenge the property taking or the amount offered for the parcel, they must appeal to the district court.

3. Requirement of the state to pay owner a portion of litigation costs (if the court awards an amount higher than the "Just Compensation" previously determined by the agency). While the Uniform Act does require the acquiring agency to pay for litigation costs under the circumstances described above, the statue does not mandate a reimbursement for this scenario. However, some states do allow for payment of a portion of litigation costs, when a higher amount is awarded than that previously determined by the agency.

4. Allowance of an appraisal waiver up to $10,000. An appraisal waiver essentially allows an agency to use abbreviated procedures for appraisal where the estimated cost of a parcel is less than $10,000. Thirty-six states have received approval to modify their policies to allow for appraisal waivers up to or exceeding $10,000 (FHWA[1] 2003). States have used the waiver process to varying degrees and it seems to significantly reduce the time and expense needed to complete an appraisal (FHWA 1999).

5. Requirement of the state to provide proof of efforts to reach agreement through negotiation. A large percentage of states require proof of efforts to reach agreement through negotiation for an acquired parcel.

6. Allowance of land consolidation. "Land consolidation involves adjusting property boundaries in the area of a highway project and redistributing the land to affected landowners" (FHWA 2002). Land consolidation allows property owners to regain one large parcel of property as apposed to retaining property segmented by the project alignment. This method is more effective in rural regions, where farmers generally prefer to have their operations on one side of the facility. "Land consolidation requires more agency intervention and owner coordination, but reduces damages and property owner dissatisfaction" (Hakimi and Kockelman 2005).

7. **The state provides comprehensive and detailed laws on compensable items.**
8. **Mandate from the state for early public involvement.**
9. **Requirement of the state to share appraisal and appraisal details with the property owners.**
10. **Encouragement of the state to employ meditation and provide reasonable freedom (e.g., administrative settlements and alternative dispute resolution) in using this technique.**
11. **Allowing property owners more than 30 days to petition against the just compensation offer.**
12. **Allowance of early taking.** An early taking or early acquisition occurs when a parcel is acquired in advance of authorization to begin right-of-way acquisition. Early acquisition enables the acquiring agency to prevent development along a potential corridor, therefore, allowing the state to avoid increased costs in the land as a result of development (this practice is also known as protective buying) (FHWA 2004). It should be noted that early acquisition laws vary considerably from state to state and do reduce condemnation rates (Hakimi and Kockelman 2005).
13. **Allowance of land exchange.** Land exchange occurs when a property owner exchanges the land desired by the acquiring agency along the project for another parcel of land outside the acquiring area. While land exchange rarely occurs, it can alleviate many acquisition issues under proposed circumstances (Lindas 1963).

Table 1 below summarizes the question data to give a better understanding of the key questions pertaining to state right-of-way laws. Table 1 delivers a percentage of states answering yes for each question to provide a generalized analysis of what methods state law permits. To provide a more state specific analysis, Table 1 also lists the states answering yes to each question supplying the reader with details on which methods individual states allow.

Individual state responses are provided in Table 1, the states' postal abbreviations are listed in one column with the number for each question that state law allows appearing in the second column. The states with the fewest yes responses were Arkansas, Maine, and New Hampshire with only four questions. The states with laws permitting the greatest amount of right-of-way practices included California, Florida, Maryland, North Carolina, North Dakota, Oklahoma, Oregon, South Carolina, Texas, and Washington each answering yes to eight of the thirteen questions. Kentucky provided yes to just under half of the questions with six yes responses.

Table 1: Percentages of States Answering Yes to Key State ROW Questions

	Question - Does state ROW law do the following:	Percentage of States answering Yes	
1	**Allowing the acquiring agency to take uneconomic remnants through negotiation and/or condemnation.**	60	AK,AL,AR,AZ,CA,DE,FL,HI,IA,ID,IN, KS,KY,MD,MI,MO,MS,NC,ND,NM,NV, OH,OK,OR,RI,SC,TN,TX,UT,VA,WA, WV,WY
2	**Allowance of "quick taking"**	50	AK,CA,CT,ID,IL,LA,MA,MD,ME,MI,MN, MT,NC,ND,NH,NJ,NM,NY,OK,PA,RI, SC,TX,VT,WV
3	**Requirement of the state to pay owner a portion of litigation costs (if the court awards an amount higher than the "Just Compensation" previously determined by the agency).**	20	CT,FL,MA,MN,MT,NJ,NY,SC,VT
4	**Allowance of an appraisal waiver up to $10,000.**	76	AL,CA,CO,CT,FL,GA,ID,IL,LA,MA,MD,M E,MI,MN,MO,MS,MT,NC,ND,NE,NH, NJ,NM,NY,OH,OK,OR,PA,RI,SC,SD, TX,UT,VT,WA,WI,WV,WY
5	**Requirement of the state to provide proof of efforts to reach agreement through negotiation.**	70	AR,AZ,CT,DE,FL,GA,HI,IA,IL,KY,LA, MA,ME,MN,MO,MS,MT,NC,NE,NH,NJ, NY,OH,OK,OR,PA,SC,TN,TX,UT,VA,VT, WA,WI, WY
6	**Allowance of land consolidation**	38	AL,AZ,CO,GA,IA,IN,KS,KY,MO,MS,NM, NV,OK,OR,SC,SD, TN,TX,WA
7	**The state provides comprehensive and detailed laws on compensable items.**	60	CA,CO,DE,FL,GA,IA,ID,IL,IN,KY,LA, MA,MD,MI,MN,MT,ND,NE,NJ,NY,OH, PA,RI,SD,TN,UT,VA,WI,WV,WY
8	**Mandate from the state for early public involvement**	54	AR,CA,FL,HI,IA,IL,IN,KS,KY,LA,MD,MI, MO,MS,NC,ND,NM,NV,OH,OR,PA,RI, TN,UT,WA,WV, WY
9	**Requirement of the state to share appraisal and appraisal details with the property owners**	80	AK,AZ,CA,CO,CT,DE,FL,GA,HI,IA,ID, IN,KS,KY,MD,ME,MI,MO,MS,MT,NC, ND,NE,NH,NM,NV,OH,OK,OR,RI,SC, SD,TN,TX,UT,VA,VT,WA,WI,WV,WY
10	**Encouragement of the state to employ meditation and provide reasonable freedom (e.g., administrative settlements and alternative dispute resolution) in using this technique**	62	AK,AL,AR,CA,CO,CT,HI,ID,IL,IN,KS, LA,MD,MI,MT,NC,ND,NV,OH,OK,OR, PA,RI,SC,SD,TX,UT,VT,WA,WV,WY
11	**Allowing property owners more than 30 days to petition against the just compensation offer**	24	AZ,CT,GA,ID,KS,NC,NE,NV,OR,VT, WA,WI
12	**Allowance of early taking**	38	AK,AL,CA,CO,DE,FL,IL,LA,MA,MD,MN, MS,ND,NJ,NY,PA,SD,TX,VA
13	**Allowance of land exchange**	10	IN,KS,MO,NV,OK

Another study completed by the National Cooperative Highway Research Program examined the effectiveness of different practices as they relate to accelerating right-of-way delivery. This study, "Innovative Practices to Reduce Delivery Time for Right-of-Way in Project

Development" (2000), queried respondents on nine specific practices and asked them to rank their effectiveness. The results from this synthesis are shown in Table 2, with the right-of-way practices in use listed and their corresponding effective ranking provided by each state. The practices are ranked by each state from one to four, with one indicating the practice is very useful while a ranking of four indicates not useful. In addition to the nine specified practices, respondents were asked to include and rank other practices they implement. In total eighteen additional practices were included from the thirty-six responding states.

The responses were averaged to generate a mean effectiveness of each right-of-way practice at reducing project delivery time. A lower average represents the most effective practices, while a higher average indicates a less effective method of reducing right-of-way delivery time. As can be seen from Table 2, the practices are listed in order of their relative effectiveness, from the most effective practice listed first to the least effective practice. Staff training received the lowest aggregate average at 1.76, indicating that states feel the training of their staff is the most important practice in reducing project delivery time. Expanded administrative settlements[3] compiled the second lowest average of 1.83, demonstrating its effectiveness of reducing right-of-way delivery time. Prequalification of right-of-way consultants, use of right-of-way consultants, and release waivers[4] all fell slightly above somewhat useful practices at 2.07, 2.18, and 2.18 respectively. Appraisal modifications[5] (average 2.23), appraisal review modifications[6] (average 2.31), and public information programs (average 2.57) amassed averages that indicated these practices were between somewhat useful and useful practices. The least useful practice from the original nine listed was mediation, which received an average of 2.94 indicating that the practice was good but not significant in reducing delivery time.

[3] An administrative settlement is any agreement to purchase that exceeds the agency's approved valuation of just compensation (NCHRP 2000).
[4] Lien release waivers are implemented on low value acquisitions, permitting acquisition of the parcels to be obtained without increased delays and costs (NCHRP 2000).
[5] It should be noted that appraisal modifications and appraisal review modifications are employed on noncomplex or lower-value acquisitions (NCHRP 2000).

Table 2: Effectiveness of Existing Practices in Accelerating Right-of-Way Delivery

No.	Practice in Use	Alabama	Arizona	Arkansas	California	Colorado	Connecticut	Delaware	Florida	Georgia	Idaho	Illinois	Iowa	Kansas	Kentucky	Louisiana	Michigan	Minnesota	Mississippi	Missouri	N. Carolina	N. Dakota	Nebraska	Nevada	New Jersey	New York	Ohio	Okalahoma	Pennsylvania	Rhode Island	S. Dakota	S. Carolina	Tennessee	Utah	Virginia	Washington	Wisconsin	Average	Relative Rank
1	Staff Training	2	2	2	1	2	1	1	3	1	2	1	1	3	2	1	2	2	1	2	2	3		2	1	3	2	3	3	2		1	2	1	1	1	1	1.76	1
2	Expanded administrative settlements	2	2	1		2	2	1	3	2	2	2	1	3	2	1	2	1	1	2	1	3	2	1	1	3	2	2	3	3	2	2	1	1	1	3	1	1.83	2
3	Prequalification of consultants		2	1		2	1	2	3	1	2	1		3		2	3	3	1	3	1	3	3	1	3	3	3	3	3		3		1	1	1	2	1	2.07	3
4	Use of right-of-way consultants	3	3	4		2	3	2	3	2	3	1	2	3	1	2	2	3	1	2	1	3	3	1	3	3	2	2	2		3	1	1	1	2	2	2	2.18	4
5	Lien release waivers		3	1			4	3	3	1	3		4	3	2	1	1	2	3		1	2			1	3	3	2		3	2	2	2	1		2	1	2.18	5
6	Appraisal modifications	3	3	2	3		4	1	3	1	3		4	3	1	2	2	2	2	1	2	2		2		3	2	3		2	2	2	2		2	2	1	2.23	6
7	Appraisal review modifications	3	3	2	3		2	1	3	2	3		4		2			2	1	1	2	3		1		3	2	3		3		2	2		2	3	2	2.31	7
8	Public information programs		3	1	3	3	2	1	3	3	3	3	1	3		4	3	3	3	3	4	3		1	2	3	2	4	4	2		3	3	1	3	3	2	2.57	8
9	Mediation	4	4				4		3	3	3		4				3	2	2		1					3		3		3			4	1		3		2.94	9
	Other Practices																																					Lower Average is Better	
A	Advance acquisition of total takes in corridor		1																															1					
B	Project teams												1																					1					
C	Protective renting									1																								1					
D	Minimal appraisal procedure											1																	1					1					
E	Minimum damage assessment																	1																					
F	Negotiation by mail															1														2									
G	Contracting specific problem areas																		1															1					
H	Computer training																		1															1					
I	Comprehen. written apprais. assignments																			1																			
J	Quality assurance																			1																			
K	Document waivers--minor takings																			2														2					
L	Separate negotiator from relocation personnel																			2														3					
M	Staff experience level																							2															
N	Early right-of-way involvement																					1												1					
O	Right-of-way estimates																					3																	
P	Early public involvement																										2												
Q	Exemption agreement with FHWA																												2										
R	Consultant resource manager																																	1					
S	Pre-approved descriptions																										2												
T	Design/build																																	1					

Note: Key--1 = Very useful--reducing right-of-way delivery time by more than 6 months; 2 = Somewhat useful--reducing right-of-way delivery time by less than 6 months; 3 = Useful--good practice, but not significant reduction in right-of-way delivery time, and 4 = Not useful--no measurable impact on right-of-way delivery

2.2 Utility Practices

2.2.1 Relocation Impacts

Utility relocation efforts on a project have the potential to increase project cost and schedule. A report by United States General Accounting Office, examined the potential for cost and time savings from better utility location and relocation practices. This report, "Transportation Infrastructure: Impacts of Utility Relocation on Highway and Bridge Projects" (GAO/RCED-99-131) (1999), surveyed the department of transportations of all 50 states and the District of Columbia and examined the fiscal years of 1997-98. The report looked at the percentage of project delays caused by the relocation of utilities on federal-aid highway and bridge projects. With a total of 42 states responding, 20 states reported delays of 0-10 percent on their projects, 8 for 11-20 percent, 6 for 21-30 percent, and 8 for above 30 percent. These results are summarized in Table 3; it should be noted that Kentucky experienced reported project delays on over 30 percent of their projects.

Table 3: Percentage of Project Delays Resulting from Utility Relocations (GAO 1999)

Number of States	Percentage of Projects Delayed
20	0-10 percent
8	11-20 percent
6	21-30 percent
8	above 30 percent

States identified multiple reasons for project delays resulting from utility relocations. The ten most frequently indicated reasons are listed below according to the number of states considering them to be a moderate or major reason for delay:

1. Utility lacked resources;
2. Short time frame for state to plan and design project;
3. Utilities gave low priority to relocations;
4. Increased workload on utility relocation crews because highway/bridge construction had increased;
5. Delays in starting utility relocation work: some utilities would not start until the construction contract was advertised or let;
6. Phasing of construction and utility relocation work out of sequence;
7. Inaccurate locating and marking of existing utility facilities;
8. Delays in obtaining rights-of-way for utilities;

9. Shortages of labor and equipment for utility contractor; and
10. Project design changes required changes to utility designs.

The report also measured the impact of utility relocation delays on construction schedule, construction costs to the state, construction costs to contractors, and costs to other utility companies. Each state transportation agency was asked to analyze the effect that utility relocation delays had on each of these issues and rate the effect as: increased a little or not at all, increased somewhat, increased moderately, increased greatly, increased very greatly, or do not know. Figure 1 summarizes the rating results for impact on construction schedule; 8 states reported little or no increase in construction schedule, 22 reported increased somewhat, 13 reported increased moderately, 3 reported increased greatly, 2 reported increased very greatly, and 2 reported did not know.

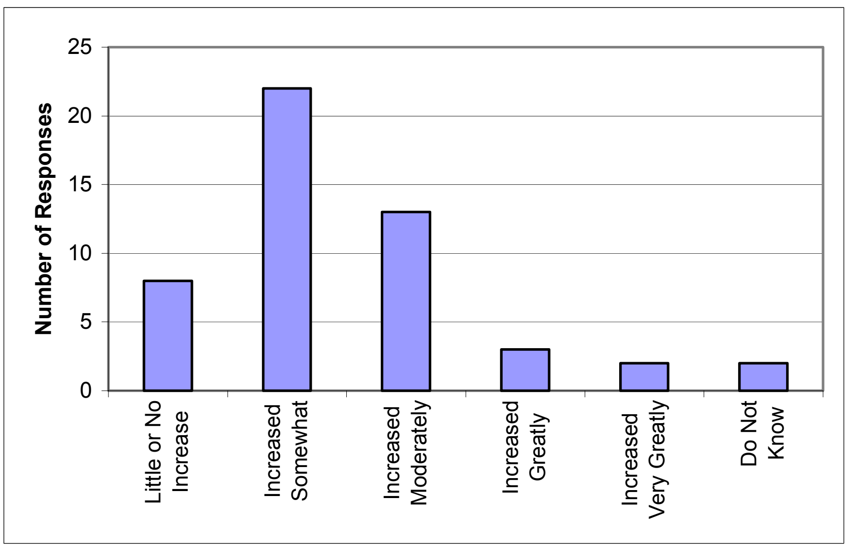


Figure 1: Effect of Utility Relocation Delays on Length of Construction Schedule

Figure 2 recaps the rating impact that utility relocation delays had on construction costs to the state; 11 states indicated little or no increase in construction cost to their state, 21 increased somewhat, 12 increased moderately, 5 increased greatly, 0 increased very greatly, and 1 did not know.

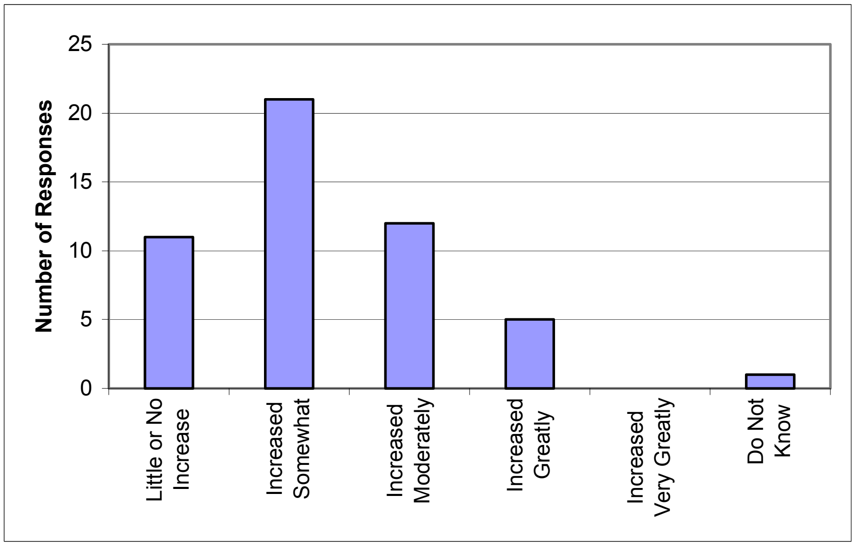


Figure 2: Effect of Utility Relocation Delays on Construction Costs to the State

The effect of construction costs to contractors as a result of utility relocation delays is provided in Figure 3; 13 states denoted little or no increase in cost to construction contractors, 14 increased somewhat, 12 increased moderately, 2 increased greatly, 0 increased very greatly, and 9 did not know.

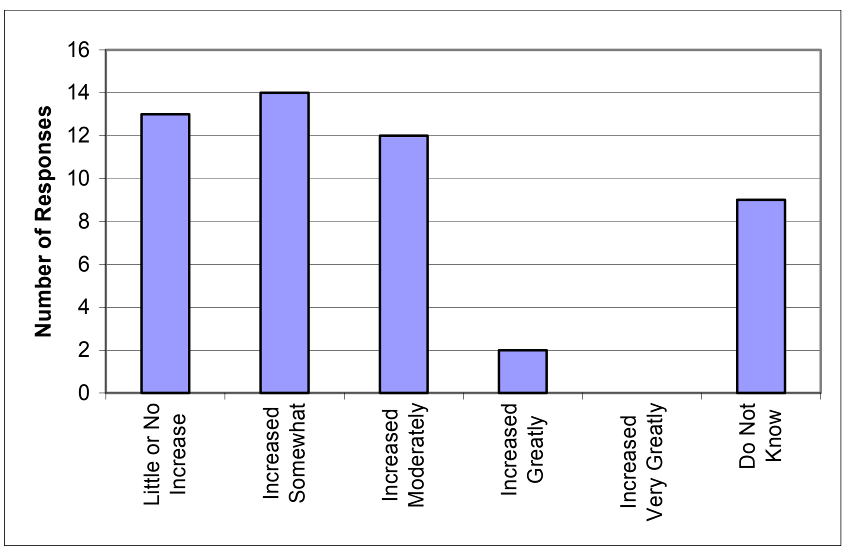


Figure 3: Effect of Utility Relocation Delays on Costs to Construction Contractors

Finally, the effect of utility relocation delays on cost to other utility companies was assessed and is supplied in Figure 4; 12 states reported little or no cost to other utility companies, 15 increased somewhat, 3 increased moderately, 1 increased greatly, 1 increased very greatly, and 18 did not know.

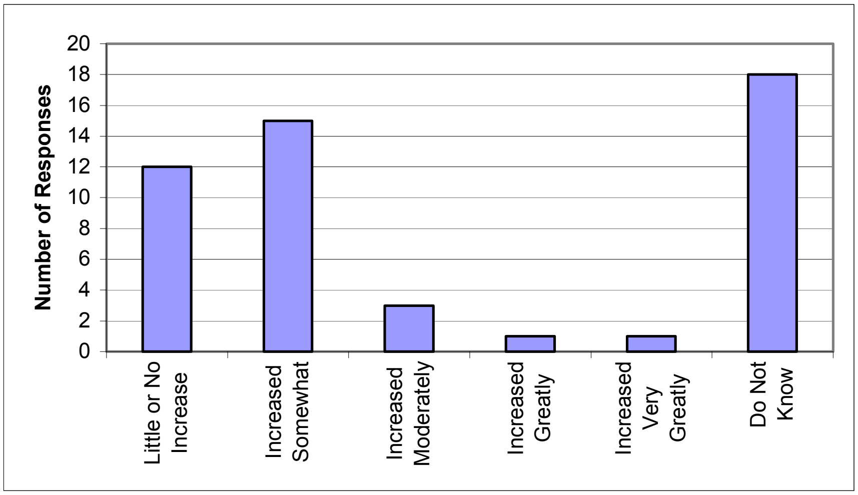


Figure 4: Effect of Utility Relocation Delays on Costs of Other Utility Companies

For the fiscal year of 1997-98, five states indicated a great or very great impact on construction schedule and construction cost to the state. Kentucky indicated a great or very great impact for both construction schedule and construction cost to the state as a result of utility delays.

2.2.2 Subsurface Utility Engineering

Subsurface Utility Engineering (SUE) is a discipline dedicated to determining the precise location of existing underground facilities. It is generally defined as an engineering process for accurately identifying the quality of subsurface utility information needed for highway plans, and managing that level of effort during the highway project (Anspach 2001). Existing utility information as shown on construction plans can originate from variant sources, but the defining difference is the quality of information used to denote the existing utilities. One advantage of SUE is that responsibility for wrong or missing utility data on plans is better defined, and the risks to the contractor are also more clearly defined (Anspach 2001).

The responsibility of information provided via SUE is depicted through different quality levels of information. Quality levels may be thought of as degrees of risk or how much information is really needed to adequately design and construct a highway project (FHWA[2]). The use of quality levels allows project owners to decide what quality level of information they want to apply to their risk management challenge and to certify on project plans that a certain level of accuracy and comprehensiveness has been provided (FHWA[2]). There are four quality levels ranging from Quality Level D (the lowest level) to Quality Level A (the highest level).

- **Quality Level D:** The most basic level of information for utility locations. It comes solely from existing utility records or verbal recollections. It may provide an overall "feel" for the congestion of utilities, but is often highly limited in terms of comprehensiveness and accuracy. The only aspect the engineer can be held accountable for is investigating appropriate sources of information and interpreting the records as best as can be done (Anspach 2001).
- **Quality Level C:** Probably the most commonly used level of information. It involves surveying visible utility features (e.g., manholes, valve boxes, etc.) and correlating this information with QL-D information. The survey is endorsed by a licensed professional; with liability revolving around the appropriate utility records search, the survey, and the best interpretation of the records information (Anspach 2001).
- **Quality Level B:** Involves the application of appropriate surface geophysical methods to determine the existence and horizontal position of virtually all utilities within the project limits. The information obtained in this manner is surveyed to project control. Liability is generally confined to surface geophysics method selection, education of the client, correct interpretation of the surface geophysics, correct marking of the utility on the ground surface, survey of those markings, depiction on the plans or in the database, and evaluation of all appropriate records to see if utilities must be depicted to a lower quality level (Anspach 2001). The appropriate professional affixes their stamp on the deliverables; insurance covers all aspects of the end work deliverables (Anspach 2001).
- **Quality Level A:** This is the highest level of accuracy presently available and involves the full use of the subsurface utility engineering services. It provides information for the precise plan and profile mapping of underground utilities through the nondestructive exposure of underground utilities. This level of information is endorsed by the licensed professional completing the services.

An independent study, "Cost Savings on Highway Projects Utilizing Subsurface Utility Engineering", completed by Purdue University in 2000 for the FHWA utilized data from 71 projects in four states that had used SUE and quantified a savings of $4.62 for every $1.00 spent. Only three of the 71 evaluated projects had a negative return on investment; while one project had a $206.00 to $1.00 return on investment. The study also concluded that the proper use of SUE in a systematic manner would result in a minimum national savings of approximately $1 billion per year. SUE is not only endorsed by the FHWA, but is also a key component of many utility best practices suggested by AASHTO.

2.2.3 Avoiding Utility Relocation Practices

The Federal Highway Administration (FHWA) sponsored a report, "Avoiding Utility Relocations" (2002), completed by Nichols Consulting Engineers to "develop a manual that encouraged highway designers to avoid unnecessary utility relocations in the designs for which they are responsible." One component of the report identified alternative planning and design strategies for avoiding utility relocations. The most important planning strategy for avoiding utility relocations on highway projects is providing adequate notice to all affected utilities. Other suggested planning strategies include:

Meetings: Many agencies surveyed for the report indicated that they send out annual and even quarterly updates of their 5 or 6-year plans to the utility companies within their jurisdiction (Nichols Consulting Engineers 2002). This provides the utility companies with the opportunity to program upgrades or expansions to their facilities that could be impacted by a project and identify potential conflicts with existing utilities. While some states choose regularly scheduled meetings to coordinate the planning effort, the most effective method is to distribute information regarding the master plan and other project issues to the utility. The utility can then determine the most important projects, and dedicate the necessary staff for meetings and coordination.

Utility Coordinating Councils: Many states have formed Utility Coordinating Councils (UCC) as a forum for discussion of master plans and general utility issues. The UCC consists of representatives from utilities, governmental agencies, contractors, excavators, and support companies who meet on a regularly scheduled basis to discuss problems, work programs, and planning issues. Having representatives from each stakeholder of the utility process allows for input from all parties when problems and issues arise.

Utility Agreements: A utility agreement is any document by which the highway authority regulates and/or gives approval for the use and occupancy of highway right-of-way by utility facilities (Nichols Consulting Engineers 2002). These agreements are based on the state's utility accommodation policies and set forth the understandings, costs, and special considerations associated with a given project (Nichols Consulting Engineers 2002). When utilities already occupy (existing facilities) or request to occupy (new facilities) existing right-of-way, a permit is typically issued and represents the entire utility agreement (Nichols Consulting Engineers 2002). When relocation of facilities is present, additional documents are normally required. A permit or agreement is a contract between the agency and the utility and is a permanent record indicating the utility's right to occupy the right-of-way (Nichols Consulting Engineers 2002). The agency and utility are mutually bound to enforcing the requirements of the permits and agreements, ensuring that utility accommodation are a component of the project development and design process (Nichols Consulting Engineers 2002).

Cost Sharing: If a project redesign or alternate design to accommodate an existing utility requires a significant increase to the project design or construction costs, the utility is given the opportunity to pay for the increased design costs in lieu of an expensive relocation (Nichols Consulting Engineers 2002).

Joint Project Agreements: Many state transportation agencies are advocating incorporation of utility work into the highway contract, with the contractor responsible for utility relocation (Nichols Consulting Engineers 2002). Consolidating the work into a single contract improves the contractor's control over utility relocation, more clearly defines responsibility, and may result in lower costs (Nichols Consulting Engineers 2002). The primary purpose of this agreement is to facilitate the relocation of utilities discovered in the design process that were incorporated into the competitive bid package (Nichols Consulting Engineers 2002).

Locate Next to Right-of-Way: Due to clear zone issues, the FHWA requires above ground utilities to be relocated as close to the right-of-way line as possible; minimizing the risk for vehicular impacts (Nichols Consulting Engineers 2002). Most state transportation agencies also require underground utilities to locate as close to the right-of-way line as possible; this generally provides the least probably chance of conflict with widening of the highway (Nichols Consulting Engineers 2002).

Trenchless Technology: Under certain conditions, trenchless technology can reduce the costs of relocations (Nichols Consulting Engineers 2002). Trenchless technology encompasses a variety of methods to install, replace, renew, or repair underground facilities with minimal surface disruption by minimizing an open trench excavation (Nichols Consulting Engineers 2002). Some methods of trenchless technology are utility tunneling, pipe jacking, micro-tunneling, pipe bursting, directional drilling, auger boring, and slip-lining (Nichols Consulting Engineers 2002). Although trenchless, the application of these technologies still requires the accurate location of existing utilities (Nichols Consulting Engineers 2002).

Joint Trenching / Utility Corridors: Some states regulate utilities to specific corridors or easements that will prevent them from coming into conflict in the future (Nichols Consulting Engineers 2002). Reduction in relocation costs and saving critical space in the right-of-way can also be accomplished by combining compatible utilities into a single common trench that has to be excavated and backfilled only once (Nichols Consulting Engineers 2002).

Utility Tunnels: No longitudinal utilities were allowed on freeway right-of-way until 1988 when right-of-way land was opened up to fiber optic communication lines and wireless towers per the federal Telcommunication Act (Nichols Consulting Engineers 2002). The use of utility tunnels has been proposed to alleviate some of these problems; this would involve constructing large diameter pipes or box culverts for exclusive utility use near the right-of-way in conjunction with the other highway construction (Nichols Consulting Engineers 2002). Using abandoned large diameter sewer and storm drain lines as tunnels for new, smaller diameter utilities is also a possibility (Nichols Consulting Engineers 2002).

Removal of Abandoned Lines: Out of service or abandoned utility lines within a project corridor can create major problems; these facilities are often undocumented and discovering who owns them and confirming their status can create costly delays (Nichols Consulting Engineers 2002). Utility lines that are in conflict and proposed to be relocated should be removed completely to avoid such confusion in the future (Nichols Consulting Engineers 2002). If for some reason, portions of an abandoned line must be left in place, it should be documented on the as-built plans as part of the project record (Nichols Consulting Engineers 2002).

Design strategies for avoiding utility relocation were also identified, with the most effective identified as having accurate and complete utility information in the hands of designers prior to any design activity. In terms of subsurface utility engineering, this means obtaining Quality Level B data within the 0 to 30 percent design phase (Nichols Consulting Engineers 2002). This provides the designer with maximum flexibility in adjusting alignment and grade or obtaining additional right-of-way to avoid costly, time consuming relocations (Nichols Consulting Engineers 2002). The report identified alternative design strategies for avoiding utility relocations into four groups: alignment and grade changes, drainage changes, structural changes, and slope / curb / retaining wall modifications (Nichols Consulting Engineers 2002).

3 Case study

A June 1999 report by the U.S. General Accounting Office found that about half of all federal-aid highway and bridge projects involved the relocation of utility facilities. A study done by Penn State University for the American Association of State Highway and Transportation Officials (AASHTO) Highway Subcommittee on Construction found that highway improvement projects are more likely to be delayed or cost more than planned when utility facilities need to be relocated (FHWA 2002). Through a series of case studies, this chapter will exam typical problems encountered from the relocation of public utilities from 4 different projects

3.1 Methodology

All of the information gathered for the case studies was provided by personal interviews with various individuals. These interviews were conducted by phone and in person. Follow-up questions were asked through email correspondence. At each of the interviews, information pertaining to direct and indirect costs related to the various utility conflicts was collected. In addition, a voice recorder and written notes were used to document the information gathered during the interviews. All of the gathered information was then assembled to write the case studies.

The case study analysis began by asking members of the research advisory committee for suggestions on projects that could be used as potential case studies. Participants for each project were contacted by phone to seek their permission to be interviewed as part of the study. Interview participants included representatives from the corresponding project's contractors, affected utilities, resident engineers, affected businesses and any other individuals affiliated with the utility conflicts.

Each project's case study is divided into five sections. The first section provides an overview of the project that includes specific details about the project such as the project scope, costs, and schedule. The second section includes all of the quantified utility conflicts that were identified through the various interviews. Many of the utility conflicts were grouped together if they were related to a single utility. At the end of each group of related utility conflicts, a summary table is provided indicating the total direct and indirect costs that were accumulated from the related conflicts. Many conflicts accrued indirect costs from the time spent by various individuals through meetings, site visits, paperwork, and various other activities that required their time. These indirect costs are also included in tables throughout this section. The third section of the case studies documents any additional costs that businesses may have sustained from the utility conflicts that occurred on the projects. The fourth section documents other problems identified through the numerous interviews that were not quantifiable, but likely produced additional costs to the affected stakeholders. Finally, the last section of each case study summarizes the total cost and hours accrued from the various utility conflicts.

3.2 Direct and Indirect Costs Defined

An explanation of what is defined as direct and indirect costs is required to understand how the costs in the case studies were compiled. As indicated in the introduction, direct costs are those costs which can be clearly identified and specifically related to an unanticipated additional expense. Direct costs identified in the case study analyses included the following:

•Change orders issued by the state to pay for any additional costs that accrued from the various utility conflicts;
•Additional costs paid for by the state for removal of asbestos piping;
•Relocation and repair costs funded by utility companies;
•Loss of service costs sustained by the utility companies during the utility conflict;
•Additional maintenance costs that may accrue over the life of the utility;
•Idle crew and equipment costs sustained by the contractor during the utility conflict; and
•Charges for utility personnel in the field that were easily traceable and directly related to a particular utility conflict.

In contrast, indirect costs were assumed to be costs that were incurred, but not directly assignable to a project. The indirect costs identified in the case study analysis included the following:

•Time spent by the state, utility company officials, contractors, designers, and any other individuals that were required to resolve the utility conflict but were not incorporated into the direct cost of the repairs;
•Monetary impacts sustained by businesses affected by the various utility conflicts;
•Road user costs due to additional construction and detour delays due a particular utility conflict; and
•Reduced productivity sustained by the contractor.

3.3 Case Study Analysis

3.3.1 US 27 Cumberland River Bridge Project

3.3.1.1 Overview of Project

Location: Somerset, KY, Pulaski County (District 8)

Project Description (Scope of Work):

The US 27 Cumberland River Bridge Project was constructed concurrently with the Pitman Creek Bridge. The project entailed the removal of the existing bridge and the construction of the new bridge and expansion of the roadway leading to and exiting the bridge. Figure 5 shows a picture of the location of the Cumberland River Bridge Project. The project extended 1500 feet south of the Cumberland River and ran northerly until just past KY 90 as shown in Figure 5. Because of the roadway expansion and construction of the new bridge, several utilities and businesses were affected. However, the numerous utility conflicts did not produce any additional lane closures other than those caused by the originally planned roadway construction.

Figure 5: US 27 Project Map (KyTC 2005).

Some of the utility work for the project was performed prior to construction, but in one situation involving a waterline and storm sewer drain, this became a problem. The project also sustained utility conflicts that were related to rocker plates that support the waterline attached to the bridge; the addition of a waterline on the bridge; the removal of an asbestos waterline; an underground telephone line; and numerous waterline breaks. The project also incurred additional costs due to the limited availability of ROW for the waterline construction. In addition to the ROW issue, all of the utilities that were relocated at the US 27/KY 90/KY 1247 intersection will likely have to be relocated a second time prior to the release of the roadway plans for the new interchange which will be part of the KY 90 Bridge Project. The estimated loss in productivity through the limited availability of ROW and the likely additional costs that will result from having to relocate the utilities at the US 27/KY 90/KY 1247 intersection a second time, were not quantified. However, the costs sustained by the previously mentioned utility conflicts were tabulated.

All of the waterline work for the project was bid and awarded separately from the roadway contract except for the waterline work that was on the bridge itself, which was included in the general contractor's roadway contract.

Total Project Cost: $22,173,290.65

Schedule: The project was originally scheduled to be completed in 395 working days, and the project required 500 working days to complete.

Project let – 02/12/1999

Construction began – 06/15/1999

Project completion – 03/28/2003

3.3.1.2 Utility Conflicts

Rocker Plates:

To support the waterline that was attached to the Cumberland River Bridge, the use of hangers was required that attached to the bridge via rollers located on the ends of the hangers that rested on a plate that is embedded into the bridge. This plate is called a rocker plate. The hangers wrap the waterline to support it in place. The rollers allow the line to move while resting on the plates. However, this movement is supposed to be minimal. The rollers on the Cumberland River Bridge Project moved to the edge of the rocker plates once the waterline was energized. To fix the problem, change orders involving a time extension was required so that additional rocker plates could be installed to ensure that the waterline was safely secured. Figure 6 illustrates the shifting of the rocker plates. There were a total of 74 additional plates that had to be installed at a cost of $3,100 (Edwards, 2005).

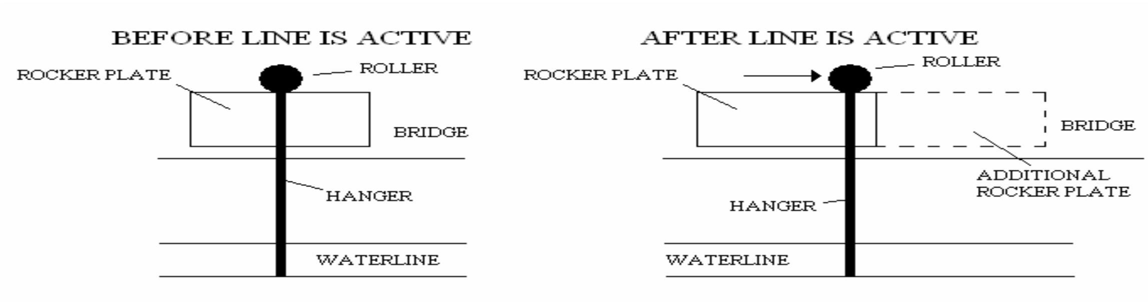


Figure 6: Illustration of the Shifted Rocker Plates.

Along with the direct costs of fixing the rocker plates, it also produced significant indirect costs from the time spent in remedying the situation by various individuals from the state, a water utility, and a design firm. The cost and time breakdown for each of the various affected parties is displayed in Table 4. The KyTC Director of Utilities for District 8 estimated that he and the local water utility, spent 25 hours resolving the incident (Edwards, 2005). The state estimated that a District Director for Utilities could be billed at $28.04/hr (Tingle, 2005). The field manager for the water utility estimated that he could be billed at $25.00/hour (Vaughn, 2005). The design engineer estimated that he spent 40 hours on the incident and that he could be billed at $75.00/hour (Shot, 2005). Table 4 indicates that a total cost of $4,326.00 was spent on the individuals trying to remedy the rocker plate problem.

Table 4: Indirect Costs Spent on Resolving the Rocker Plate Conflict.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Engineering Tech III	25	$ 28.04	$ 701.00
Water utility	Field Manager	25	$ 25.00	$ 625.00
Design firm	Design Engineer	40	$ 75.00	$ 3,000.00
Total		**90**	**-**	**$ 4,326.00**

Table 5 summarizes the direct and indirect costs that accrued from the rocker plate conflict.

Table 5: Summary of Direct and Indirect Costs Incurred for the Rocker Plates Conflict.

Conflict	Direct Costs	Indirect Costs	Total
Rocker Plates on the US 27 Cumberland River Bridge	$ 3,100.00	$ 4,326.00	$ 7,426.00
Total	**$ 3,100.00**	**$ 4,326.00**	**$ 7,426.00**

Re-Routing of Waterline:

One section of the waterline that was located just north of the Cumberland River Bridge had to be re-routed due to a conflict between the waterline and storm water drains. Originally, the plans indicated that the waterline was to follow alongside the roadway, but due to a conflict with the storm water drains, the waterline had to be re-routed across the roadway. The conflict arose from the fact that the storm water drains had to be placed deeper than originally anticipated. Due to the deeper placement of the storm water drains, the waterline had to be lowered as well. The problem is that in order to moving the line deeper would have required blasting due to the abundant presence of rock located below the storm water drains. To avoid damaging existing facilities, the state decided to reroute the line across the street. The re-routing of the waterline entailed altering the alignment of 200 ft of waterline. This additional 200 ft resulted in a change order to the contractor for $25,000 (Edwards, 2005). Table 6 summarizes the total costs associated with the re-routing of the waterline.

Table 6: Summary of Direct and Indirect Costs Incurred for Re-Routing the Waterline.

Conflict	Direct Costs	Indirect Costs	Total
Re-Routing of Waterline North of Cumberland River Bridge	$ 25,000.00	$ -	$ 25,000.00
Total	**$ 25,000.00**	**$ -**	**$ 25,000.00**

Storm Sewer Drain/Waterline Conflict:

Prior to construction, a waterline was relocated that ran in front of a local restaurant. The problem with the waterline was attributed to the fact that the waterline and storm sewer were not designed concurrently. A conflict arose when it was determined that a storm sewer drain had to be located in the position where the waterline had already been relocated. The state had already paid once for the waterline relocation, but it had to pay for the utility to relocate the second time, since it is responsible for all the relocation costs of municipally owned utilities that are required to relocate in accordance to KRS 177.035. The second relocation of the waterline resulted in an $8,000 change order that was paid to the contractor by the state (Edwards, 2005). The indirect costs spent on the storm sewer drain/waterline conflict stemmed from the time spent by various state officials, the Mayor of Burnside, the water plant manager for the City of Burnside, and a laborer for the City of Burnside. Table 7 outlines the total indirect costs that were experienced by the various parties. The state estimated all of the time spent by the various state employees involved in the conflict that are listed in Table 7 (Edwards, 2005). The billing rates for the state employees were also provided by the state (Tingle, 2005). The cost and time information for the remaining individuals was provided by the City of Burnside (Sadler, 2005). Table 8 summarizes the additional costs that the various parties involved incurred.

Table 7: Indirect Costs Spent on Resolving the Storm Sewer Drain/Waterline Conflict.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Engineering Tech III	10	$ 28.04	$ 280.40
State	Transportation Engineering Assistant II	30	$ 14.36	$ 430.80
State	Resident Engineer	10	$ 27.30	$ 273.00
State	Engineering Tech I	10	$ 17.79	$ 177.90
City of Burnside	Mayor	10	$ 50.00	$ 500.00
City of Burnside	Water Plant Manager	2	$ 35.00	$ 70.00
City of Burnside	Laborer	2	$ 35.00	$ 70.00
Total		**74**	**-**	**$ 1,802.10**

Table 8: Summary of Direct and Indirect Costs Incurred for the Storm Sewer Drain/Waterline Conflict.

Conflict	Direct Costs	Indirect Costs	Total
Relocation of Waterline at The Goodie Shack	$ 8,000.00	$ 1,802.10	$ 9,802.10
Total	**$ 8,000.00**	**$ 1,802.10**	**$ 9,802.10**

Additional Waterline:

Prior to constructing the Cumberland River Bridge, the City of Burnside purchased their water from the City of Somerset. The Mayor of Burnside felt that it might be advantageous for the City to begin producing its own water; hence, the Mayor proposed that an additional pipe be attached to the Cumberland River Bridge in order to provide the City of Burnside the capability of producing its own water from Lake Cumberland. The administration for the City of Burnside changed once the project was completed and the new administration decided to continue receiving its water from its supplier; hence, the line is yet to be used. Table 8 summarizes the costs associated with the waterline conflict. The $1,000,000 change order issued for the additional waterline is the only cost from the incident. However, this waterline can be viewed as a back-up supply line and will not be included as a direct cost.

Removal of Asbestos Line:

The existing waterline that was located on the old bridge also created a problem, since it contained asbestos. The state stipulated that the removal of the asbestos line from the old bridge cost at $4/ft with a $450 fee for both mobilization and demobilization (Keiser, 2005). Since the pipe spanned the full length of the bridge, which extends 1,400 feet, the line's removal cost the state $1,800 for the per diem charge and $900 in mobilization and demobilization costs. Table 9 summarizes the direct cost associated with the removal of this line.

Table 9: Summary of Direct and Indirect Costs Incurred for the Removal of the Asbestos Waterline.

Conflict	Direct Costs	Indirect Costs	Total
Removal of Asbestos Line from the Old Cumberland River Bridge	$ 2,700.00	$ -	$ 2,700.00
Total	**$ 2,700.00**	**$ -**	**$ 2,700.00**

Underground Telephone Line:

Originally, a telephone line had been designed to cross US 27 at the US 27/KY 90/KY 1247 intersection. The phone utility line was originally intended to make an aerial connection from one utility pole on one side of US 27 to a utility pole located on the other side of the US 27. However, during construction it was determined that the proposed of the aerial line was too long. It was then decided that the line should be installed under the roadway instead of over it. This change resulted in an additional cost that was paid by the phone utility. According to a phone utility official, this resulted in approximately $5,000 in additional costs that the phone utility had to pay to install the line underground versus the originally designed aerial routing (Sadler, 2005).

Table 10: Summary of Direct and Indirect Costs Incurred for the phone utility Underground Line.

Conflict	Direct Costs	Indirect Costs	Total
Undergound Line at the US 27/KY 90/KY 1247 Intersection	$ 5,000.00	$ -	$ 5,000.00
Total	**$ 5,000.00**	**$ -**	**$ 5,000.00**

Waterline Hits:

There were numerous instances when a local water utility line broken during construction. Each instance resulted in additional costs from having to repair the line and from lost water escaped the line during the break. Repairing the waterline in these instances required assistance from both the contractor and the Southeastern Water Association.

One incident occurred during blasting for pier number six of the new bridge. A waterline attached to the old Cumberland River Bridge broke while a subcontractor was blasting for the pier. Due to this break, the local water utility had to relocate their waterline at a cost of $10,000 to avoid further conflicts with the blasting (Vaughn, 2005). The waterline also broke numerous times at the north end of the Cumberland River Bridge. These breaks also occurred while the previously mentioned subcontractor was blasting. The local water utility estimated that the line was broken six different times at this location at a cost of $1,000 per incident for repairs and lost water (Vaughn, 2005).

The waterline was also broken three times during the demolition of the deck of the old Cumberland River Bridge. Originally, a subcontractor was supposed to relocate the existing waterline that was on the north side of the Cumberland River Bridge to the east side of US 27. The subcontractor was instructed to bore under US 27 to run the new line along the east side of the roadway. This was scheduled to be performed in the fall of 1999. However, the subcontractor did not relocate the line as planned. The failure of the subcontractor to relocate the line on the east side of the roadway as planned was not brought to the attention of the general contractor until it was time to tie into the line that was attached to the new bridge. Because the line had not been relocated to the other side of the roadway, the contractor had no choice but to leave the line on the old bridge active during demolition of its concrete deck in order to maintain the project's schedule. During demolition, concrete debris broke the line causing it to dump water directly into Lake Cumberland. During one particular instance, the general contractor had to use a couple of his workers and a man basket to repair the line. The contractor estimated that this resulted in $1,000 in additional costs to fix the line (Steve Hayes, personal communication, May 12, 2005). The local water utility estimated that each break cost the water district $300 in lost water and repairs. Overall, the district lost $900 because of these three waterline breaks (Vaughn, 2005). Table 11 displays the total costs that resulted from each of the different waterline break locations.

Table 11: Summary of Direct and Indirect Costs Incurred for the Waterline Hits.

Conflict	Direct Costs	Indirect Costs	Total
Line Hit During Blasting at Pier 6	$ 10,000.00	$ -	$ 10,000.00
Lines Hit at the North End of the Cumberland River Bridge	$ 6,000.00	$ -	$ 6,000.00
Lines Hit During Demoltion of the Old Cumberland River Bridge	$ 1,900.00	$ -	$ 1,900.00
Total	**$ 17,900.00**	**$ -**	**$ 17,900.00**

3.3.1.3 Affected Businesses

Local Restaurant:

Due to the construction on US 27, the entrance to a local restaurant located directly off the highway was closed. This entrance was closed for a period of one month. However, this entrance was specifically closed due to the storm sewer drain/waterline conflict for only one day (Edwards, 2005). The owner of the local restaurant stated that July turned out to be one of the slowest months of the year for the restaurant and estimated his losses at $500 per day (Owner, 2005).

3.3.1.4 Summary of Results

Numerous utility conflicts were identified for the project. A couple of these conflicts sustained both the direct cost of correcting the conflict and indirect costs stemming from the various individuals that were involved in resolving the conflict. Table 12 summarizes the total costs accrued from the various utility conflicts experienced on the Cumberland River Bridge Project. As shown in Table 12, the total cost of the utility conflicts for the Cumberland River Bridge Project was $1,068,328.10. Omitting the sizeable $1,000,000 change order for the additional waterline on the bridge, the total cost for the utility conflicts would have been $68,328.10. Of this $68,328.10, $6,628.10 was attributed to the indirect costs related to these conflicts. The indirect costs approximately represented 10% of the $68,328.10 in total additional costs.

Table 12: Cost Breakdown of Utility Conflicts for the US 27 Cumberland River Bridge Project.

Conflict	Direct Costs	Indirect Costs	Total
Rocker Plates	$ 3,100.00	$ 4,326.00	$ 7,426.00
Re-Routing of Waterline	$ 25,000.00	$ -	$ 25,000.00
Storm Sewer Drain/Waterline Conflict	$ 8,000.00	$ 1,802.10	$ 9,802.10
Removal of Asbestos Line	$ 2,700.00	$ -	$ 2,700.00
Underground Phone Line	$ 5,000.00	$ -	$ 5,000.00
Waterline Hits	$ 17,900.00	$ -	$ 17,900.00
The Restaurant	$ -	$ 500.00	$ 500.00
Total	**$ 61,700.00**	**$ 6,628.10**	**$ 68,328.10**

The impact of these utility conflicts was not limited to those sustained strictly by monetary means; it also included the substantial amount of time spent in trying to resolve these conflicts by various affected parties. The total time spent resolving the various conflicts is outlined in Table 13.

Table 13: Summary of Time Spent Resolving Utility Conflicts on the Cumberland River Project.

Conflict	Total Time (hr)
Rocker Plates	90
Re-Routing of Waterline	0
Storm Sewer Drain/Waterline Conflict	74
Additional Waterline	N/A
Removal of Asbestos Line	N/A
Telephone Underground Line	N/A
Waterline Hits	N/A
Local Restaurant	-
Total	**164**

US 27 Pitman Creek Bridge Project

3.3.1.5 Overview of Project

Location: Somerset, KY, Pulaski County (District 8)

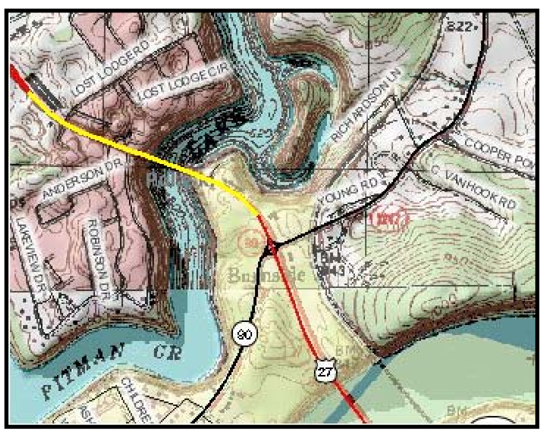


Figure 7: US 27 Project Map (KyTC 2005).

Project Description (Scope of Work):

The Pitman Creek Bridge Project entailed the demolition of the existing bridge and expansion of US 27 both north and south of the bridge. The project was constructed concurrently with the Cumberland River Bridge, which is located one mile south from the Pitman Creek Bridge (Figure 7).

The Pitman Creek Bridge Project produced several different utility conflicts. These conflicts included a problem with two utility vaults that were located in front of a local business, just north of the bridge; extra rock that was encountered during excavation for a waterline; and a waterline tie-in that was covered in an excessive amount of concrete.

Total Project Cost: $11,267,193.02

Schedule: The Pitman Creek Bridge Project was not completed on time, but the delay was not related to any utility conflict. The project was originally scheduled to take 393 working days, and it required 417 working days to complete.

Project let – 03/19/1999

Awarded to Massman Construction Co. – 03/29/1999

Construction began – 09/27/1999

Project completion – 07/29/2002

3.3.1.6 Utility Conflicts

Water Meter and Check Valve Vaults Conflict:

In front of a local business on US 27, there were two new utility vaults constructed that were included as part of the project's costs. Originally, there was a single vault that was located on the opposite side of the road to the newly constructed vaults. The old vault contained a water meter which was used to monitor the amount of water sold by the City of Somerset to the local water utility. The old vault was approximately 8 x 10 ft and contained only a few valves. Due to changes in state laws established by the Kentucky Division of Water, the old vault did not meet state standards; therefore, it required the construction of the two new vaults that were located in front of a local business. The two new vaults were needed because one vault would house the water meter and the other would contain the check valves that would be used to shut off the water in case of an emergency or if repairs were being performed on the line. The vaults served as the dividing line between the two water districts. The vault with the water meter was to belong to the City of Somerset while the other vault with the check valves was to be the property of the Southeastern Water District. The division of the ownership between the two vaults was a problem after a conflict arose in the two vaults.

The conflict in the vaults occurred when there was a fire in the City of Burnside. During the fire, the check valve in the utility vault became jammed and caused water to flood the vault. The water that filled the vault was unable to drain because a drain was not installed in either vault. After the vault filled with water, it overflowed into the nearby ditches and released a considerable amount of water. According to state officials, neither the water meter nor the check valve was working properly (Edwards, 2005). Figure 8 shows a picture of the vault with the check valve that overflowed. Figure 9 shows the water from the check valve vault overflowing into the nearby ditch alongside the roadway. The local water utility estimated that 2,000,000 gallons of water were lost due to the faulty check valve at a cost of $13,000 (Vaughn, 2005). Even though the Southeastern Water Association bore the costs of the lost water and was not reimbursed for its loss, this cost is viewed as a direct cost since it was directly attributed to the conflict.

Figure 8: Overflowed Check Valve Vault.

Figure 9: Ditches Filled with Water.

To resolve the conflict, the state met with the Kentucky Division of Water, who estimated that it would take $60,000 to prevent this from happening again. This estimate included installing drains in both vaults and running a pipe from the drains to the nearby Pitman Creek. According to the state, it is common for utility vaults such as the one constructed on the Pitman Creek Bridge Project, to have drains installed in their floor slab (Edwards, 2005). However, none of the parties involved in the construction of the vaults were willing to pay the estimated $60,000 needed to repair them. The ongoing dispute for the payment of the repairs to the vaults eventually prevented the contractor from obtaining substantial completion, who contractor could not achieve substantial completion until the waterline that ran through these vaults was turned on.

The debate over the payment for the repairs of the vaults went on for a year and a half. Eventually, the state sought advice from various experts and the Kentucky Division of Water in Frankfort in order to develope alternative. After the meeting with the various experts and Kentucky Division of Water, it was decided that the valves would be replaced and a party agreed to periodically drain the vaults with a submersible pump. To put an end to the payment debate, the contractor agreed to pay for the new valves. The cost of the new valves was approximately $4,000 (Edwards, 2005). It was also determined that the City of Somerset would only be responsible for the water meter located in one of the vaults and that the rest of the equipment in the water meter and check valve vault would be the responsibility of the local water utility.

Since the local water utility agreed to be responsible for the upkeep of the two vaults, they assumed the responsibility of draining the two vaults. To perform this task, the water utility sends two workers for 2-3 hours about 6 times per month to pump water out of the two vaults at a rate of $15/hour per worker (Vaughn, 2005). This produces a total of cost of $450 per month for the two workers to pump the vaults. Since the incident occurred in August of 2001, a total of 41 months will have passed by the end of June of 2005. Over the 41-month period, 615 man-hours have been allocated to draining the two vaults at a cost of $18,450. These man-hours and additional costs will continue to accumulate until either a drain is installed, or new vaults are constructed. Figure 10 shows a picture of the check valve vault while Figure 11 shows a picture of the vault with the water meter.

Figure 10: Flooded Check Valve Vault.

Figure 11: Water Meter Vault.

Along with the direct costs sustained from the lost water, replacement valves, and pumping crew, indirect costs accrued from various parties through the numerous hours they spent in trying to resolve the water meter and check valve vault conflicts. The parties that spent time in resolving the conflict with the two vaults included the state, the City of Somerset, the local water utility, the consultants for each water district, and the contractor. Table 14 shows the total time and costs spent by each party in trying to resolve the vault conflict

Table 14: Indirect Costs Spent on Resolving the Water Meter and Check Valves Conflict.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Engineering Tech III	350	$ 28.04	$ 9,814.00
State	Engineering Tech I	350	$ 17.79	$ 6,226.50
State	District Branch Manager of Construction	70	$ 42.40	$ 2,968.00
State	Resident Engineer	100	$ 27.30	$ 2,730.00
State	Engineering Assistant II	25	$ 14.36	$ 359.00
City of Somerset	Field Manager	350	$ 24.70	$ 8,645.00
City of Somerset	Laborer	350	$ 24.70	$ 8,645.00
City of Somerset	Laborer	350	$ 24.70	$ 8,645.00
Local Water Utility	Field Manager	350	$ 25.00	$ 8,750.00
Local Water Utility	Laborer	350	$ 15.00	$ 5,250.00
Local Water Utility	Laborer	350	$ 15.00	$ 5,250.00
Design Firm	Design Engineer	50	$ 50.00	$ 2,500.00
Design Firm	Design Engineer	40	$ 75.00	$ 3,000.00
Contractor	Project Manager	350	$ 60.00	$ 21,000.00
Contractor	Foreman	350	$ 40.00	$ 14,000.00
Total		**3785**	**-**	**$ 107,782.50**

These combined direct and indirect costs are summarized in Table 15.

Table 15: Summary of Direct and Indirect Costs Incurred for the Water Meter and Check Valves Conflict.

Conflict	Direct Costs	Indirect Costs	Total
Water Meter and Check Valve Vaults Conflict in Front of Lookout Marine	$ 35,450.00	$ 107,782.50	$ 143,232.50
Total	**$ 35,450.00**	**$ 107,782.50**	**$ 143,232.50**

Extra Rock Encountered During Excavation for Waterline:

One section of a waterline had to be relocated between the Pitman Creek Bridge and the Cumberland River Bridge, because it interfered with the construction of the new roadway. The contractor requested an additional $7,000 to cover the costs of the excavating the rock required for the relocated waterline (Edwards, 2005). Although no additional costs due to rock was given to the contractor, the state already spent 30 hours in resolving the conflict (Edwards, 2005). Table 16 shows the total indirect costs accrued on behalf of the state.

Table 16: Summary of Direct and Indirect Costs Incurred for the Extra Rock that was Encountered During Excavation for the Waterline.

Conflict	Direct Costs	Indirect Costs	Total
Extra Rock Encountered During Excavation of Waterline In-between the Cumberland River Bridge and Pitman Creek Bridge	$ -	$ 841.20	$ 841.20
Total	**$ -**	**$ 841.20**	**$ 841.20**

Concrete Tie-in Conflict:

The waterline contract for the Pitman Creek Bridge Project was awarded to a separate contractor than the one awarded on the Cumberland River Bridge Project that was constructed concurrently. Since the waterline contracts for the two projects were awarded separately, the waterlines were not installed at the same time. The contractor for the Cumberland River Bridge Project performed the installation of the waterline first. Upon completing the installation of the waterline, the contractor was supposed to pour concrete over the end of the pipe to seal and secure the end of the line and leave it in a suitable position for the Pitman Creek Bridge Project waterline contractor for future tie-in. However, a valve that was located at the end of the pipe was mistakenly encased in concrete. As a result, a change order in the amount of $1,000 was issued for the contractor on the Pitman Creek Bridge Project that had to perform the tie-in (Edwards, 2005).

Along with the direct costs sustained from the change order that was issued, additional indirect costs accumulated through the state and two separate excavating companies. Table 17 shows a summary of the indirect costs that occurred as a result of the concrete tie-in.

Table 17: Indirect Costs Spent on Resolving the Concrete Tie-in Conflict.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Engineering Tech III	10	$ 28.04	$ 280.40
State	Engineering Tech I	10	$ 17.79	$ 177.90
Akins Excavating Company, Inc.	Operator	5	$ 27.85	$ 139.25
Garrison Construction Company, Inc	Operator	10	$ 27.85	$ 278.50
Total		**35**	**-**	**$ 876.05**

Table 18 summarizes the direct and indirect cost incurred for the concrete tie-in conflict.

Table 18: Summary of Direct and Indirect Costs Incurred for the Concrete Tie-in Conflict.

Conflict	Direct Costs	Indirect Costs	Total
Concrte Tie-in Near the US 27/KY90/KY1247 Interchange	$ 1,000.00	$ 876.05	$ 1,876.05
Total	**$ 1,000.00**	**$ 876.05**	**$ 1,876.05**

3.3.1.7 Summary of Results

The conflicts for the Pitman Creek Bridge Project included the malfunctioning check valve, the extra rock encountered when excavating the waterline, and the waterline tie-in that was covered in an excessive amount of concrete. These conflicts resulted in additional costs stemming from change orders to compensate the direct costs and additional costs attributed to indirect costs for the time spent by various individuals in trying to resolve the various conflicts. Table 19 shows that a total of $145,949.75 was spent on trying to resolve each of the utility conflicts. The indirect costs spent on trying to resolve the water meter and check valve vaults had the greatest influence on the total cost of the utility conflicts. The $109,499.75 in indirect costs represents just over 75% of the total costs expended on the utility conflicts. Since the cost of the Pitman Creek Bridge Project totaled $11,267,193.02, the $145,949.75 spent resolving the various utility conflicts were equivalent to 1.3% of the total project's cost.

Table 19: Cost Breakdown of Utility Conflicts for Pitman Creek Bridge Project.

Conflict	Direct Costs	Indirect Costs	Total
Water Meter and Check Valve Vaults Conflict	$ 35,450.00	$ 107,782.50	$ 143,232.50
Extra Rock Encountered During Excavation for Waterline	$ -	$ 841.20	$ 841.20
Concrete Tie-in Conflict	$ 1,000.00	$ 876.05	$ 1,876.05
Total	**$ 36,450.00**	**$ 109,499.75**	**$ 145,949.75**

The amount of time required to resolve the utility conflicts on the Cumberland River Project was also extensive. Table 20 summarizes the amount of time spent on each conflict. As Table 20 indicates, a total 4,465 hours will have been spent on resolving the utility conflicts on the Pitman Creek Bridge Project by the end of June 2005. The amount of hours spent resolving the water meter and check valves conflict will continue to grow because of the time spent by the two-man crew to continue draining the two vaults.

Table 20: Summary of Time Spent Resolving Utility Conflicts on the Pitman Creek Project.

Conflict	Total Time (hr)
Water Meter and Check Valve Vaults Conflict	4400
Extra Rock Encountered During Excavation for Waterline	30
Concrete Tie-in Conflict	35
Total	**4465**

3.3.2 Richmond Road (US 25) Project

3.3.2.1 Overview of Project

Location: Lexington, KY, Fayette County (District 7)

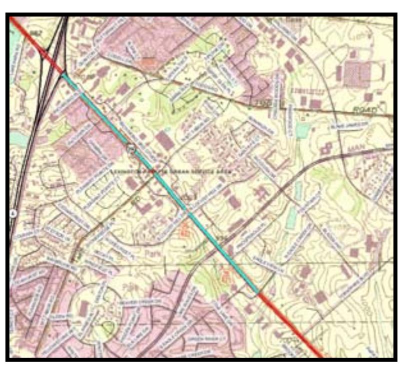


Figure 12: US 25 Project Map (KyTC 2005).

Project Description (Scope of Work):

The Richmond Road Project required widening of the roadway and the conversion of the center median into an additional lane. The project extended from New Circle Road to Eagle Creek Dr in Lexington, KY. Figure 12 shows a map of the project's location highlighted in blue. Since the area surrounding the Richmond Road Project is highly urbanized, numerous utilities were located in the proximity of the project.

Each of the various utilities found in the corridor of the project created conflicts. These conflicts included multiple gas line hits during excavation, various conflicts associated with live and abandoned waterlines, several fiber optic incidents, unforeseen changes to the sanitary sewers, and numerous unanticipated utility pole relocations. The state believes the extended period of time between the completion of the roadway plans and the commencement of construction was one of the main factors that contributed to the utility conflicts experienced on the Richmond Road Project (Travis, 2005).

Total Project Cost: $6,847,597.19

Schedule: The Richmond Road Project was completed on time. Even with the numerous delays created by the various utility conflicts, the contractor was able to work in different areas of the project to avoid any significant delays to his work.

Project Let – 02/14/2003

Awarded to Central Rock Mineral Company – 02/24/2003

Construction began – 03/25/2003

Project completion – 06/14/2004

3.3.2.2 Utility Conflicts

Gas Line Hits:

Throughout the project, there were three incidents when gas lines were hit. These incidents resulted in additional costs due to repairs to the line and gas that was released during the incident. Two of the incidents occurred at the Richmond Road and Man O' War Boulevard intersection and the third was at the Richmond Road and Eagle Creek Drive intersection.

One of the gas line hits at the Richmond Road and Man O' War Boulevard intersection occurred when an electrical subcontractor augured into a gas line while working on a traffic signal in front of the Paw Prints Veterinary Clinic. The gas line's location had been marked by BUD, but the location marking of the line was in error (Proffitt, 2005). This delay forced the subcontractor's crew to remain idle for five hours while waiting for the line to be repaired for a total cost of $370.65 (Lemaster, 2005). The subcontractor's drill truck also remained idle over this same period for a cost of $925 (Lemaster, 2005). Adding the $370.65 in idle crew costs to the $925 in idle equipment costs, this brings the total loss sustained by the electrical subcontractor to $1,295.65. According to the gas company, the total cost of repairing the line and the cost of the gas released was $4,648.99, hence the total cost of this gas line hit was $5,944.64 (Brian Slone, personal communication, June 9, 2005).

The second incident took place when the general contractor was excavating for a curb inlet. According to the general contractor, the vertical location of the line on the plans was incorrect, while the horizontal location of the line was accurate (Proffitt, 2005). The incident delayed the work in this area for one week because the gas line had to be relocated, since it was in the subgrade of the roadway However, the general contractor was able to divert his workforce to other portions of the project and was not delayed by the gas line hit. Even though the contractor was not delayed, he did sustain additional costs from having to change his planned approach for pouring a curb radius located in the vicinity of the incident. Originally, the contractor had planned to pour the curb using a curb pouring machine with the curb inlets already installed, but since he was unable to install the curb inlets due to the conflict with the gas line, the contractor had to hand pour the radius. The contractor estimated that hand pouring the radius cost $12/foot while machine pouring the curb costs $7/ft (Proffitt, 2005). Since the radius was 50 feet in length, the contractor had to pay $250 more to hand pour the curb. The gas company stated that the total cost of repairing the line and the cost of the lost gas was $1,630.53, hence the total cost of this gas line hit was $1,880.53 (Slone, 2005).

The electrical subcontractor hit another gas line while performing a directional bore for installation of a traffic signal pole at the intersection of Richmond Road and Eagle Creek Drive. Because the line was hit while performing a directional bore under the roadway, the pavement located directly above the line, had to be removed to enable workers to fix the line. The incident forced the subcontractor's three-man crew and boring machine to wait eight hours until the line was repaired. Thus, the total costs sustained by the subcontractor were $593.04 in idle crew costs and $1,480 in idle equipment costs (Lemaster, 2005). Indirect costs also accumulated because a lane closure was required to enable Columbia Gas to repair the line, consequently affecting the roadway users. Using a program called CTS developed by the Kentucky Transportation Cabinet, it was determined that the daily traffic count for Richmond Road is 29,145 vehicles at the Eagle Creek Drive and Richmond Road intersection. From this number, it was assumed that the AADT (Average Annual Daily Traffic Count) for Eagle Creek Drive is 10,000 vehicles. Therefore, using the Microsoft Excel based program developed by the Kentucky Transportation Center called KyUCP and the previously described information concerning the lane closure, the estimated road user costs were $116**.** In addition to the idle crew and equipment costs sustained by the subcontractor and additional costs to the roadway users, the direct cost to repair the line and loss of service that accrued during the break also produced additional financial consts. According to the gas company, the total cost of repairing the line and the cost of the lost gas was $6,941.08 (Slone, 2005). The subcontractor was held responsible for these costs because the location that BUD had given the subcontractor had expired two days prior to the incident (Lemaster, 2005). Therefore, combining the costs sustained by the subcontractor, roadway users, and Columbia Gas, the total cost of resolving the conflict was $9,130.12. Table 21 displays the summary of the various gas line hits.

Table 21: Summary of Direct and Indirect Costs Incurred for the Gas Line Hits.

Conflict	Direct Costs	Indirect Costs	Total
Line Hit at Corner of Richmond Rd. and Man O' War Blvd. - Sub	$ 5,944.64	$ -	$ 5,944.64
Line Hit at Corner of Richmond Rd. and Man O' War Blvd. - GC	$ 1,880.53	$ -	$ 1,880.53
Line Hit at Corner of Richmond Rd. and Eagle Creek Dr.	$ 9,014.12	$ 116.00	$ 9,130.12
Total	**$ 16,839.29**	**$ 116.00**	**$ 16,955.29**

Waterline Conflicts:

The waterline conflicts on the Richmond Road project involved breaking a service line to a local fast food restaurant twice, uncovering a waterline to determine its slope and location, and delays caused after the contractor hit an abandoned waterline. These incidents resulted in additional costs to the contractor, the water service provider, and the local fast food restaurant. The waterline hits occurred while the general contractor was excavating for roadway drainage purposes. During one incident, the contractor had to wait for two hours for the proper authority to shut off the waterline (Tom Proffitt, personal communication, April 1, 2005). This forced his pipe crew consisting of six men to remain idle until the line was shut off for a cost of $420 (Proffitt, 2005). During each incident, the contractor repaired the line himself for a total cost of $1,260 (Proffitt, 2005). Adding the repair costs for both incidents and the idle crew and equipment costs incurred during one of the incidents, the total cost of the service line hits totaled $1,680.00.

Along with the two waterline conflicts at the local fast food restaurant, the general contractor also incurred additional costs from having to uncover the 24-inch waterline from Man O’ War Boulevard to Eagle Creek Drive. The contractor had to uncover the line to determine its precise location, since the slope on the line was not consistent (Proffitt, 2005). The general contractor utilized a backhoe, backhoe operator, foreman, and two laborers to expose the waterline (Proffitt, 2005). The total direct cost for this operation was $1,850.

During construction, the contractor hit an abandoned waterline at the corner of Richmond and Man-of-War roads delaying his workforce for three hours in this area while trying to determine who the (Proffitt, 2005). The contractor's suffered $840 in delayed crew costs and $762 in idle equipment costs (Proffitt, 2005). This creates a total of $1,602 in added expenses for the delay caused by the abandoned waterline. Table 22 summarizes the additional costs that accumulated because of the waterline conflicts.

Table 22: Summary of Direct and Indirect Costs Incurred for the Waterline Conflicts.

Conflict	Direct Costs	Indirect Costs	Total
Local Restaurant Service Line Hits	$ 1,680.00	$ -	$ 1,680.00
Uncovering Line From Man O' Blvd. to Eagle Creek Dr.	$ 1,850.00	$ -	$ 1,850.00
Abandoned Watereline Near Fifth Third Bank	$ 1,602.00	$ -	$ 1,602.00
Total	**$ 5,132.00**	**$ -**	**$ 5,132.00**

Fiber Optic/Copper Telephone Line Conflicts:

There were five incidents involving damage or unanticipated relocation to fiber optic and/or copper phone lines. One incident involved two separate fiber optic lines and a copper telephone line that were damaged during excavation. Two other incidents involved damage to underground copper telephone lines. A fourth incident involved a subcontractor hitting an aerial telephone line. Finally, a fiber optic duct at the corner of Man O' War and Richmond Road had to be relocated to permit sufficient space for construction of a retaining wall. These incidents resulted in additional costs to the general contractor, state, the traveling public, and the owner of the fiber optic lines. The general contractor was responsible for each of the damages to the phone lines, except for the aerial telephone line incident where the responsible party was not determined. A picture of the fiber optic duct near the intersection of Man O' War and Richmond Road is shown in Figure 13.

Figure 13: Picture of Fiber Optic Line.

The first incident where the two fiber optic lines (96 and 24 fiber) and copper telephone line were hit occurred at the corner of Patchen Drive and Richmond Road. The 96 fiber line has a diameter similar to that of a thumb, while the 24 fiber has a diameter similar to that of a pencil (Brown, 2005). The copper telephone line was as an 1800 pair telephone line that is 2.5 inches in diameter (Brown, 2005). The general contractor hit the lines while excavating for a storm drain. During the excavation, the operator accidentally lost control of his equipment and cut all three lines. The phone utility fixed the line and billed the general contractor for time and materials for the repair and for loss of service while the line was not in operation in the amount of $57,009.12 (Brown, 2005). The state paid 50% of the costs sustained for this incident, since the conflict may have been averted if the close proximity of the lines in its roadway design had been considered (Paul Travis, personal communication, February 18, 2005). Along with the costs picked up by the state and general contractor for this incident, road users sustained additional costs as well since a lane closure was performed so that repairs could be made to the line. According to KyUCP, road user costs totaled $547.

An 1800 pair copper telephone line was hit in front of a local gas station located at 2900 Richmond Road. Once again, the general contractor hit the line while excavating. The phone utility billed the general contractor $24,702.46 for this incident (Brown, 2005). Once again, the state paid 50% of the cost.

The third phone line conflict involved a 1500 pair underground copper telephone line that was hit during excavation near the corner of Man O' War and Richmond Road (Brown, 2005). The contractor was billed $43,207.08 for the repairs to the telephone line (Brown, 2005), and once again the state paid 50% of the cost.

An aerial telephone line was hit in front of a local restaurant on Richmond Rd, just south of Mount Tabor Road. No party admitted to hitting the line. It cost $2,705 to repair the aerial telephone line, which was paid by the phone utility (Brown, 2005).

As mentioned previously, the final incident involving a phone utility line occurred at the intersection of Man O' War and Richmond Road during the construction of a retaining wall located in front of a large department store. According to the project's plans, a fiber optic line was to remain in place while the retaining wall was built (Proffitt, 2005). Even though the location of the fiber optic line was not in conflict with the retaining wall as shown on plans, there was not enough space between the wall and line to allow sloping the soil back to install the forms for the retaining wall. Figure 14 illustrates the sloping conflict. The dashed portion of Figure 14 indicates the unsafe original position of the fiber optic line, while the solid line represents the safe position of the relocated fiber optic line. As shown in Figure 14, the safe position has a slope that is less steep and provides more clearance between the slope and the retaining wall, which improves workability. The conflict with the fiber optic duct and the retaining wall delayed the work in this area for two weeks (Proffitt, 2005). To accelerate the relocation of the fiber optic line, the contractor worked for three days to uncover the line, dig a trench next to the line, and to finally install the line (Proffitt, 2005). This required the utilization of two dump trucks and operators, a trackhoe and operator, a flag person, and a foreman for a cost of $9,192 (Proffitt, 2005). However, the general contractor did indicate that about 50% of the costs of moving the fiber optic line were part of his scope work, thus the contractor only spent an extra $4,596 in relocating the fiber optic line (Proffitt, 2005). Prior to relocating the line, a meeting was held to discuss the contractor's plan to relocate the line. The meeting lasted one hour and was attended by two representatives from the state, the general contractor's foreman, two design engineers, and one representative from the phone utility (Proffitt, 2005). Table 23 shows a cost breakdown of the indirect costs incurred while the various parties met to discuss the general contractor's relocation strategy.

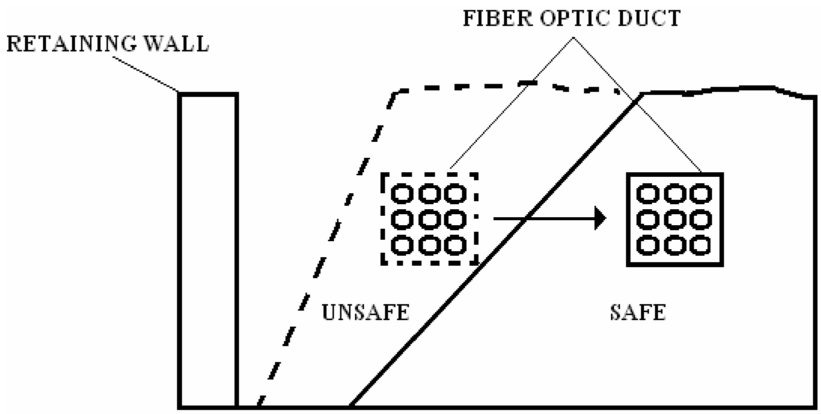


Figure 14: Illustration of Fiber Optic Line Conflict.

Table 23: Indirect Costs Spent on Meeting About the Fiber Optic Duct Relocation.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	District Branch Manager of Construction	1	$ 42.40	$ 42.40
State	Engineering Tech III	1	$ 28.04	$ 28.04
Design Firm	Design Engineer	1	$ 100.00	$ 100.00
Design Firm	Design Engineer	1	$ 50.00	$ 50.00
Contractor	Foreman	1	$ 35.00	$ 35.00
Phone Utility	Outside Plant Engineer	1	$ 45.00	$ 45.00
Total		**6**	**-**	**$ 300.44**

Table 24 summarizes the total costs involved with all of the fiber optic/copper telephone line conflicts. The total cost of the resolving the fiber optic/copper telephone line conflicts was $133,067.10. The majority of these costs were shared between the general contractor and the state.

Table 24: Summary of Direct and Indirect Costs Incurred for the Fiber Optic/Copper Telephone Line Conflicts.

Conflict	Direct Costs	Indirect Costs	Total
Lines Hit at Corner of Patchen Dr and Richmond Rd.	$ 57,009.12	$ 547.00	$ 57,556.12
Line Hit in Front of gas station	$ 24,702.46	$ -	$ 24,702.46
Line Hit at Corner of Man O' War Blvd. and Richmond Rd.	$ 43,207.08	$ -	$ 43,207.08
Line Hit in Front of local restaurant	$ 2,705.00	$ -	$ 2,705.00
Relocation of Line Near Corner of Man O' War Blvd. and Richmond Rd.	$ 4,596.00	$ 300.44	$ 4,896.44
Total	**$ 132,219.66**	**$ 847.44**	**$ 133,067.10**

Sanitary Sewer Conflicts:

There were two separate instances on the Richmond Road project when sanitary sewers were in conflict. The first conflict involved a decision to upgrade an existing sanitary sewer line after construction had commenced. The second conflict involved the realignment of a portion of the sanitary sewer line. Both conflicts created additional costs for the general contractor, while only the sanitary sewer upgrade conflict produced additional costs.

After construction had commenced, the city decided to upgrade a sanitary sewer line located at the corner of Man O' War and Richmond Road in front of a large department store. To discuss the upgrade change, it required a meeting between two city personnel, three state officials, and two design engineers. The actual upgrade did not cost the state any additional funds, since it was paid for by the City of Lexington (Bowman, 2005).

The second sanitary sewer conflict occurred near a local restaurant in the French Quarter Square shopping plaza while realigning a sanitary sewer line. The conflict with the sanitary sewer in this location was attributed to the extremely level grade that was predominant in the location of the line. Since the grade was extremely level, it required some extra work for the contractor to realign the line. It took 6 hours for the contractor to determine a strategy to effectively realign the sanitary sewer for an indirect cost of $210 (Proffitt, 2005). The contractor estimated that it required an additional eight hours of his workforce to make the sanitary sewer realignment work (Proffitt, 2005). The contractor stated that the additional work required a crew consisting of a foreman, two operators, and three pipelayers to perform the additional work (Proffitt, 2005). Along with the additional workforce, the contractor was able to estimate the additional equipment required to perform the work, which included a trackhoe, an loader, and a compactor. Table 25 shows a cost breakdown of the additional costs sustained by the contractor.

Table 25: Indirect Costs Spent on Meeting About the Sanitary Sewer Upgrade.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	District Branch Manager of Construction	1	$ 42.40	$ 42.40
State	Engineering Tech III	1	$ 28.04	$ 28.04
City of Lexington	Manager for Division of Sanitary Sewers in Lexington	1	$ 26.00	$ 26.00
City of Lexington	Superintendent for Division of Sanitary Sewers in Lexington	1	$ 26.00	$ 26.00
Design Firm	Design Engineer	1	$ 100.00	$ 100.00
Design Firm	Design Engineer	1	$ 50.00	$ 50.00
Contractor	Foreman	1	$ 35.00	$ 35.00
Total		**7**	**-**	**$ 307.44**

Table 26: Contractor's Additional Costs for Realignment of Sanitary Sewer Line.

Additional Item	Time Spent (hr)	Hourly Rate	Cost
Foreman	8	$ 35.00	$ 280.00
Operator	8	$ 35.00	$ 280.00
Operator	8	$ 35.00	$ 280.00
Pipelayer	8	$ 35.00	$ 280.00
Pipelayer	8	$ 35.00	$ 280.00
Pipelayer	8	$ 35.00	$ 280.00
Equipment (trackhoe, loader, and compactor)	8	$ 150.00	$ 1,200.00
Total	**56**	**-**	**$ 2,880.00**

Table 27 summarizes the total direct and indirect costs that accumulated from the two sanitary sewer conflicts.

Table 27: Summary of Direct and Indirect Costs Incurred for the Sanitary Sewer Conflicts.

Conflict	Direct Costs	Indirect Costs	Total
Upgrade at Corner of Man O' War Blvd. and Richmond Rd.	$ -	$ 307.44	$ 307.44
Realignment at French Quarter Square	$ 2,880.00	$ 210.00	$ 3,090.00
Total	**$ 2,880.00**	**$ 517.44**	**$ 3,397.44**

Unanticipated Pole Relocations:

There were two separate instances when utility poles had to be unexectantly relocated. Both instances were the result of conflicts that arose during the construction of facilities that were located in close proximity to the poles.

The first incident occurred in proximity the fiber optic ducts that were in conflict during the construction of the retaining wall at the corner of Man O' War and Richmond Road. The plans showed two utility poles that were located within close proximity to the retaining wall to remain in place. However, the poles were located too close to the retaining wall and prevented the contractor from having adequate space for construction (Proffitt, 2005). These two poles took one month to relocate (Proffitt, 2005). However, the contractor did not consider himself delayed by this incident, because he was able to divert his workforce to another section of the project. Nonetheless, the contractor provided an operator and flagman to assist in the pole relocations that resulted in $280 in additional direct costs that were not reimbursed to the contractor. The total cost of the two pole relocations was $2,000, which was paid for by the state (Don Lawson, personal communication, June 22, 2005). Therefore combining the contractor's additional work and the utilities relocation expenses, the conflict cost $2,298.

The second incident occurred in front of a fast-food restaurant located on the block between Mount Tabor and Locust Hill Drives. At this location, a seventy-two inch diameter retention structure was installed. Once again, two poles operated by KU were shown on the plans to remain in place near the location of the retention structure. However, installing the structure required the removal of a large portion of the soil that surrounded the two utility poles. The two pole relocations took three weeks to be performed and cost the contractor $280 (Proffitt, 2005). The state paid for these two poles to be relocated for a total cost of $2,000 (Don Lawson, personal communication, June 22, 2005). Consequently, the total amount spent on resolving this conflict at the fast food restaurant was also $2,280. Table 28 summarizes the total costs accrued from unanticipated pole relocations.

Table 28: Summary of Direct and Indirect Costs Incurred for the Unanticipated Pole Relocations.

Conflict	Direct Costs	Indirect Costs	Total
Poles at Corner of Man O' War Blvd. and Richmond Rd.	$ 2,280.00	$ -	$ 2,280.00
Poles in Front of Fast Food Restaurant	$ 2,280.00	$ -	$ 2,280.00
Total	**$ 4,560.00**	**$ -**	**$ 4,560.00**

3.3.2.3 Summary of Results

The Richmond Road Project endured numerous utility conflicts. These conflicts involved multiple incidents with the gas, water, fiber optic/copper telephone, sanitary sewer lines, and utility poles. Each of these incidents incurred additional costs that in most circumstances were not reimbursed to the affected party. During many of the detailed utility conflicts, state officials spent time resolving the conflict via writing and approving change orders, meeting with the contractor on the site, or through an abundance of other tasks required to resolve any issues created by the utility conflicts. The state estimated that the Branch Manager of Construction for District 7, Resident Engineer, and on-site inspector each spent an estimated five hours on the various groups of utility conflicts (Travis, 2005). The Utilities Director for District 7 also spent time resolving some of the utility conflicts, but specifically on the fiber optic duct relocation in front of the large department store and the utility pole relocations (Lawson, 2005). Based on the estimated time spent by the before mentioned individuals, the cost breakdown shown in Table 29 illustrates the total indirect costs spent by the state in having to resolve the various utility conflicts.

Table 30 summarizes the unforeseen direct and indirect expenses that accumulated because of the various utility conflicts. Table 30 incorporates the indirect cost totals tabulated in Table 29 for the time spent by all of the various state officials involved in each of the utility conflicts. Table 29 indicates that a total of $166,310.31 was spent on the utility conflicts on the Richmond Road Project of the $166,310.31 spent on the utility conflicts, only a small portion was attributed to indirect costs. Most of the costs accumulated during the conflicts were direct since they were easily assignable to the repairs and delays created by the conflicts. The largest portion of additional costs that accumulated on the Richmond Road Project was attributed to the fiber optic/copper telephone line conflicts. The $165,310.31 in additional costs expended on utility conflicts was equivalent to 2% of the project's total cost of $6,847,597.19.

Along with the additional costs experienced from these conflicts, each incident also required an abundance of man-hours. Table 31 shows a summary of the total man-hours spent resolving each conflict. This total likely underestimates the total man-hours spent on each conflict because information pertaining to the time spent making the repair and time spent by various other individuals involved was not available for each conflict.

Table 29: Indirect Costs Spent by the State in Resolving all of the Utility Conflicts.

Job Title	Hourly Rate	Utility Conflict										Total
		Gas Line Hits		Waterline Conflicts		Fiber Optic/Copper Phone Line Conflicts		Sanitary Sewer Conflicts		Unanticipated Pole Relocations		
		# of Hours	Cost	# of Hours	Cost	# of Hours	Cost	# of Hours	Cost	# of Hours	Cost	
District Branch Manager of Construction	$ 42.40	5	$ 212.00	5	$ 212.00	5	$ 212.00	5	$ 212.00	5	$ 212.00	$ 1,060.00
Engineering Tech III	$ 28.04	5	$ 140.20	5	$ 140.20	5	$ 140.20	5	$ 140.20	5	$ 140.20	$ 701.00
Engineering Tech III	$ 28.04	0	$ -	0	$ -	4	$ 112.16	0	$ -	8	$ 224.32	$ 336.48
Engineering Tech III	$ 28.04	5	$ 140.20	5	$ 140.20	5	$ 140.20	5	$ 140.20	5	$ 140.20	$ 701.00
Total	-	15	$ 492.40	15	$ 492.40	19	$ 604.56	15	$ 492.40	23	$ 716.72	$ 2,798.48

Table 30: Cost Breakdown of Utility Conflicts for Richmond Road Project.

Conflict	Direct Costs	Indirect Costs	Total
Gas Line Hits	$ 16,839.29	$ 608.40	$ 17,447.69
Waterline Conflicts	$ 5,132.00	$ 492.40	$ 5,624.40
Fiber Optic/Copper Telephone line Conflicts	$ 132,219.66	$ 1,452.00	$ 133,671.66
Sanitary Sewer Conflicts	$ 2,880.00	$ 1,009.84	$ 3,889.84
Unanticipated Pole Relocations	$ 4,560.00	$ 716.72	$ 5,276.72
Fast Food Restaurant	$ -	$ 400.00	$ 400.00
Total	**$ 161,630.95**	**$ 4,679.36**	**$ 166,310.31**

Table 31: Summary of Time Spent Resolving Utility Conflicts on the Richmond Road Project

Conflict	Total Time (hr)
Gas Line Hits	54
Waterline Conflicts	127
Fiber Optic/Copper Telephone line Conflicts	85
Sanitary Sewer Conflicts	76
Unanticipated Pole Relocations	39
Wendy's	-
Total	**327**

3.3.3 Bryan Station Road (KY 57) Project

3.3.3.1 Overview of Project

Location: Lexington, KY, Fayette County (District 7)

Project Description (Scope of Work):

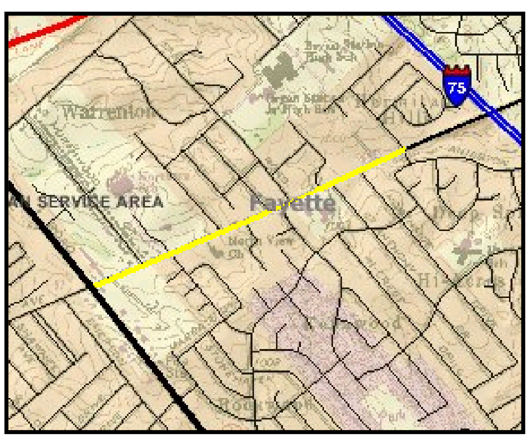


Figure 15: KY 57 Project Map (KyTC 2005).

The Bryan Station Road Project was a road widening project that extended from New Circle Road to Anniston Drive. Figure 15 shows a map of the project's location. The project entailed the construction of a detour initially to allow traffic to be diverted during the widening of the existing roadway. All of the utility conflicts experienced on the project occurred while widening the existing roadway, thus the flow of traffic was not affected significantly by any of the utility conflicts, since it was traveling on the detour that was separated it from the areas in conflict. The project was located in an area of Lexington that is highly urbanized; hence numerous utilities were located throughout the project's corridor. A general note was included on the plans that stated that hand digging would be required due to the numerous utilities located throughout the project's corridor (Toy, 2005). Even though the contractor was aware that he would encounter numerous utilities during the project, he did not anticipate that these utilities would be located in such close a proximity with to each other; this distance was 5 to 7 inches in some situations (Stroop, 2005). Although many of the utilities were in close proximity with each other, the bulk of the utility conflicts that occurred on the project were attributed to delays created by utility companies during relocation of their facilities; utilities being located in a location different from that shown on the plans; abandoned utilities; the poor condition of existing utilities; and design changes that affected utilities. These conflicts resulted in additional costs to all the project participants from having to deal with the delays that were caused by these incidents; the direct cost of repairing the utilities; the loss of service in the lines during the conflict; the time spent at the meetings by various individuals to address utility concerns; vacuum excavations performed to identify locations of utilities; and the numerous businesses and residences that were directly affected by the loss of utility service.

The contractor indicated that he received additional compensation for most of the utility conflicts that did not involve the gas line hits (Denham, 2005). The contractor believed that he was able to recoup most of the costs associated with the utility conflicts from the state since he provided the state with itemized summaries of the additional costs he sustained from the conflicts (Denham, 2005). In January of 1999 the contractor sent a letter to the state indicating that the various utility conflicts that occurred between the period of March 1998 and October 1998 produced $274,418.30 in additional costs to his company (Stroop, 2005). The letter included attachments that itemized the additional costs the contractor sustained during this period.

Total Project Cost: $5,293,579.43

Schedule: The Bryan Station Road project was scheduled for completing on August 1, 1999 and was actually completed on May 1, 2000. One particular reason for this significant discrepancy between completion dates is that the project was shut down for a period of 6-8 months while a local utility performed pole relocations (Denham, 2005).

Project let – 01/30/1998

Awarded to Bluegrass Contracting Corporation – 02/17/1998

Construction began – 03/19/1998

Project completion – 05/01/2000

3.3.3.2 Utility Conflicts

Telephone Line Hits:

There were three separate instances when phone utility lines were hit. Two lines were hit by the general contractor, while the third line was hit by a subcontractor. These incidents produced additional costs from both contractors' crews remaining idle while the line was repaired and from the loss of service and repair costs associated with each incident.

One incident occurred at the corner of Northside Drive and Bryan Station Road. The restore service to telephone customers served by this particular line, the phone utility had to utilize phone lines operated by other companies that ran through Cincinnati (Denham, 2005). The phone utility ended up bearing the burden of the repair costs and loss of service. The phone utility was unable to estimate its loss of service, but it estimated that the repair to the line cost $26,000 (Dunn, 2005). However, the contractor did sustain additional costs from his crew remaining idle until the phone utility responded to the broken line in the amount of $4,000 (Denham, 2005). This produces a total of $30,000 spent in direct costs resolving this conflict. This total likely underestimated the total direct costs significantly since the phone utility was unable to estimate the loss of service costs.

Along with the direct costs sustained by the contractor and the phone utility, indirect costs were also allocated to this particular conflict. These costs were the result of the time spent by various state officials in remedying this conflict. Table 32 displays the indirect costs incurred by the state from having to spend time on the break to the fiber optic line. The time spent by the various individuals was estimated by the former Utilities Director for District 7 who worked on the project (Toy, 2005).

Table 32: Indirect Costs Spent on Resolving the Break to the Phone utility Fiber Optic Line.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Engineering Tech III	40	$ 28.04	$ 1,121.60
State	Resident Engineer	40	$ 27.30	$ 1,092.00
State	District Branch Manager of Construction	40	$ 42.40	$ 1,696.00
State	Engineering Tech III	30	$ 28.04	$ 841.20
State	Engineering Tech III	20	$ 28.04	$ 560.80
Total		**170**	**-**	**$ 5,311.60**

The second incident involving a break to one of the phone utility's lines occurred when a dump truck drove over a ditch that ran along side the old roadway. As the dump truck traveled over the ditch, a piece of clay duct that housed the phone utility's copper telephone line broke, damaging the line. The contractor indicated that the ground above the line was soft when the line was hit, which is common in most drainage ditches (Denham, 2005). The contractor estimated that this incident cost him $1,000 in idle crew and equipment costs (Denham, 2005**).** Once again, the phone utility was unable to retrieve any loss of service records for this incident, but estimated that the repair cost totaled $25,000 (Dunn, 2005). Therefore, the total cost for this incident was $26,000, which does not include loss of service costs incurred by phone utility.

The third telephone line that was hit by a subcontractor while auguring for a traffic signal pole at the corner of Eastin and Bryan Station Road. The contractor indicated that BUD's location of the telephone line was inaccurate (Denham, 2005). Even though BUD may have marked the line in the wrong location, the state had to pay for this particular incident. This is because the state had the phone utility relocate its line to the location where it was hit to make room for the installation of the project's new storm sewers. The signaling plans were not released until after the phone line had been relocated. It turned out that these plans were in conflict with the relocation of the phone line. The amount charged to the state by the phone utility for the repair was approximately $5,000 (Dunn, 2005). The phone utility was once again unable to estimate the loss of service costs during this incident as well (Dunn, 2005). Therefore, this incident only produced $5,000 in direct costs for repairs.

The state also incurred indirect costs from this particular incident from the time spent by various state officials. The former Utilities Director for District 7 estimated the time spent by the state officials involved on this conflict as well (Toy, 2005). The indirect costs accumulated by the state are outlined in Table 33.

Table 33: Indirect Costs Spent on Resolving the Break to the Phone utility Fiber Optic Line.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Engineering Tech III	16	$ 28.04	$ 448.64
State	Resident Engineer	8	$ 27.30	$ 218.40
State	District Branch Manager of Construction	8	$ 42.40	$ 339.20
Total		**32**	**-**	**$ 1,006.24**

Table 34 summarizes the direct and indirect costs incurred from the three separate breaks involving the phone lines.

Table 34: Summary of Direct and Indirect Costs Incurred for the telephone Line Hits.

Conflict	Direct Costs	Indirect Costs	Total
Line Hit at Corner of Northside Dr. and Bryan Station Rd.	$ 30,000.00	$ 5,311.60	$ 35,311.60
Line Run Over by Dump Truck	$ 26,000.00	$ -	$ 26,000.00
Line Hit at Corner of Eastin Rd. and Bryan Station Rd.	$ 5,000.00	$ 1,006.24	$ 6,006.24
Total	**$ 61,000.00**	**$ 6,317.84**	**$ 67,317.84**

Note: Deviation of direct costs for each of the above conflicts includes:

1. $26,000 Phone utility (repair to the line) and $4,000 contractor (idle crew)
2. $25,000 Phone utility (repair to the line) and $1,000 contractor (idle crew)
3. $5,000 Cabinet (signaling plan conflict with relocated phone utility line)

Delayed Pole Relocations:

As mentioned previously, the project was shut down for a period of 6-8 months while an electric utility relocated their poles. The pole relocations were located between Bryanwood and Rookwood Parkway along Bryan Station Road. The poles were originally supposed to be relocated in a manner such that it did not conflict with the contractor's work, but the relocations were delayed (Denham, 2005). The contractor explained that the actual relocation of the poles was not the factor that influenced the shutdown period the most, but it was instead the delays created by the other facilities that occupied the poles that created the largest portion of the delay (Denham, 2005). To compensate the contractor for the shutdown period, the state paid the contractor $60,000 (Denham, 2005). This sum covered the contractor's costs for simply maintaining the project, such as ensuring that the project had adequate drainage. This figure is a direct cost, since it is a direct result of the delays created by the pole relocations. The contractor stated that the delays created by the pole relocations were the most significant delays experienced on the project (Denham, 2005). Table 35 summarizes the additional costs experienced from the delayed KU pole relocations.

Table 35: Summary of Direct and Indirect Costs Incurred for Maintaining the Project while KU Performed their Pole Relocations.

Conflict	Direct Costs	Indirect Costs	Total
Delayed Pole Relocations from Bryanwood Pkwy. to Rookwood Pkwy.	$ 60,000.00	$ -	$ 60,000.00
Total	**$ 60,000.00**	**$ -**	**$ 60,000.00**

Note: Deviation of direct costs for each of the above conflicts includes:

1. $60,000 Cabinet (paid to contractor for delay due to KU pole relocations)

Gas Line Incidents:

An abundance of the utility conflicts experienced on the Bryan Station Road Project were attributed to gas lines. These incidents involved both active and abandoned lines. The active lines were hit causing work stoppages that cost the contractor in idle crew and equipment costs, in conjunction with additional costs related to repairs. The gas utility endured additional costs from having to repair the lines and from the loss of service that occurred during the incident. The abandoned gas lines were an issue on the project since during many incidents both the contractor and gas company inspector, were unable to immediately identify which lines were abandoned and which were active. However, the contractor said the delays created by the abandoned lines did not specifically delay or produce any additional costs to him (Denham, 2005). On the other hand, additional costs were sustained by the gas utility since it had to send an inspector to the job site to determine whether the line was abandoned. Along with the costs that ensued after the numerous gas line hits and encounters with abandoned lines, additional costs were sustained from the numerous meetings that were held specifically for the gas line conflicts.

One of the numerous gas line hits occurred during excavation at the corner of Bryanwood Parkway and Bryan Station Road involving a three-inch plastic line. The line BUD identified as the active gas line was actually an abandoned line that was no longer in use. The contractor hand excavated around the line that was identified by BUD, but later hit the active three-inch plastic line that BUD failed to identify. The plastic line did have tracer wire on the line, but the contractor presumed that the magnetic locating device that the BUD representative used to locate the abandoned steel line was unable to pick up the tracer wire on the plastic line since it was located 10 feet below ground (Denham, 2005). The contractor stated that he accrued $10,000 in idle crew and equipment costs while waiting for the gas company to perform repairs at this location. The gas company estimated that this incident cost $856.65 in repairs and loss of service (Slone, 2005). This produces a total cost of $10,856.65 that was expended on this particular gas line incident.

Another gas line was hit during excavation near the intersection of Northside Drive and Bryan Station Rd involving a six-inch low pressure line (Slone, 2005). The construction plans indicated that the line was supposed to be two feet lower than it actually was (Denham, 2005). The contractor hypothesized that the contractor that installed the line did not place the line at the correct depth likely due to the abundant presence of rock that was encountered below the line (Denham, 2005). To relocate the line, the gas company removed rock and hot tap the line, which is extremely expensive and dangerous (Toy, 2005). The gas company estimated the incident cost $3,770.28 in lost service and repair costs. The contractor had to cleanup the rock that the gas company left behind after they finished their repairs. The contractor estimated his additional costs were $20,000 in cleanup and idle work costs during this incident. This creates a total cost of $23,770.28 that was allocated towards this conflict.

Indirect costs also accumulated for the previously mentioned gas line incident from the time spent by the state during the conflict. These costs are listed in Table 36. During the incident, the former District 7 Director for Utilities, former District 7 Branch Manager of Construction, and Resident Engineer for the project, became involved (Toy, 2005). Table 36 specifies that a total of $2,012.48 was spent by the state in indirect costs and combining this and the direct costs sustained by the contractor and gas company, this incident cost $25,782.76.

Table 36: Indirect Costs Spent on Resolving the Two-Inch High Pressure Gas Line Incident.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Engineering Tech III	32	$ 28.04	$ 897.28
State	Resident Engineer	16	$ 27.30	$ 436.80
State	District Branch Manager of Construction	16	$ 42.40	$ 678.40
Total		**64**	**-**	**$ 2,012.48**

Throughout a nine month period of the project, the contractor hit one-inch plastic service lines during nine separate incidents that served residents located along the project's corridor. The contractor also credited these incidents to the original contractor who installed these lines at improper depths using directional boring (Denham, 2005). The contractor estimated that the overall impact of these frequent incidents involving the one-inch service lines cost him $50,000. The gas company estimated that it lost a combined $2,386.16 in repairs and lost service from the various service line incidents (Slone, 2005).

The state and gas company suffered additional costs from the numerous breaks to the service lines through time spent in trying to remedy the conflicts. The total time and resulting costs accrued by the state and gas company are shown in Table 37.

Table 37: Indirect Costs Spent on Resolving the One-Inch Gas Line Plastic Service Line Hits.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Engineering Tech III	16	$ 28.04	$ 448.64
State	Resident Engineer	8	$ 27.30	$ 218.40
State	District Branch Manager of Construction	8	$ 42.40	$ 339.20
Columbia Gas	Operations Engineer	20	$ 46.76	$ 935.20
Total		**52**	**-**	**$ 1,941.44**

Along with the previously mentioned gas line damaged at the corner of Northside Drive and Bryan Station Road, a second line was hit while excavating at the corner earlier on in the project (Slone, 2005). This incident involved a four-inch gas line that ran to a pressure reducing house. The gas utility encountered difficulties when trying to shut the line off, because the valve to shut off the line was located under the detour that was built to divert traffic. During the construction of the detour, rock became lodged in the valve well, which prevented the gas company from being able to shut the line off (Denham, 2005). To remedy the situation, traffic was diverted from the detour to the existing roadway while the contractor assisted the gas company in accessing the shut off valve. The contractor sustained $10,000 in additional costs for his efforts and delay costs (Denham, 2005). The gas company estimated this incident cost $3,010.40 (Slone, 2005).

Additional costs were also incurred by the gas utility from having to determine whether their lines were abandoned or active. This is because during many instances the contractor would expose two separate lines that looked to be relatively new, in good shape, and made out of the same material, hence it was not obvious which line was active or abandoned. The gas utility estimated its inspection costs to be $36,491.84 over the entire course of the project (Slone, 2005). These costs are direct since the gas company kept record of the inspector's time on the project, thus being easily traceable.

Additional costs were also accumulated from the various gas line incidents through the meetings that were held specifically for the conflicts that occurred on the project. There were three documented meetings that were attended by the state, the gas company, and the contractor (Stroop, 2005). These meetings were held on June 23rd, June 30th, and July 14th of 1998. The state estimated that each meeting lasted two hours on average (Toy, 2005). The same individuals attended all three meetings, thus these individuals each spent a total of six hours attending all three of these meetings. Table 38 displays the costs that accrued from each of the individuals that attended the meetings. Table 39 summarizes the total direct and indirect costs that accrued from the various conflicts relating to the gas lines. The first conflict listed at the corner of Northside

Drive and Bryan Station Road pertains to the six-inch low pressure line that was hit whereas the later one concerns the incident involving the four-inch line. According to Table 39, the combined cost of all the gas line incidents was $144,072.73.

Table 38: Indirect Costs Spent on Meeting About the Gas Line Conflicts.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Engineering Tech III	6	$ 28.04	$ 168.24
State	Resident Engineer	6	$ 27.30	$ 163.80
State	District Branch Manager of Construction	6	$ 42.40	$ 254.40
State	Engineering Tech III	6	$ 28.04	$ 168.24
State	Engineering Tech III	6	$ 28.04	$ 168.24
Bluegrass Contracting Corporation	President	6	$ 200.00	$ 1,200.00
Bluegrass Contracting Corporation	Superintendent	6	$ 200.00	$ 1,200.00
Columbia Gas	Operations Engineer	6	$ 46.76	$ 280.56
Total		**48**	**-**	**$ 3,603.48**

Table 39: Summary of Direct and Indirect Costs Incurred for the Gas Line Conflicts.

Conflict	Direct Costs	Indirect Costs	Total
Line Hit at Corner of Bryanwood Pkwy. and Bryan Station Rd.	$ 10,856.65	$ -	$ 10,856.65
Line Hit at Corner of Northside Dr. and Bryan Station Rd.	$ 23,770.28	$ 2,012.48	$ 25,782.76
One-inch Plastic Service Lines Hit	$ 52,386.16	$ 1,941.44	$ 54,327.60
Line Hit at Corner of Northside Dr. and Bryan Station Rd.	$ 13,010.40	$ -	$ 13,010.40
Abandoned Lines	$ 36,491.84	$ -	$ 36,491.84
Meetings	$ -	$ 3,603.48	$ 3,603.48
Total	**$ 136,515.33**	**$ 7,557.40**	**$ 144,072.73**

Note: Deviation of direct costs for each of the above conflicts includes:

1. $10,000 Contractor (idle crew and equipment) and $865.65 Columbia Gas (repairs and loss of service)
2. $20,000 Contractor (idle crew and clean up) and $3770.28 Columbia Gas (repairs and loss of service)
3. $50,000 Contractor (repairs and idle crew) and $2,386.16 Columbia Gas (repairs and loss of service)
4. $10,000 Contractor (repairs and idle crew) and $3,010.40 Columbia Gas (repairs and loss of service)
5. $36,491.84 Columbia Gas (inspection of abandoned and active lines)

Waterline Incidents:

The various incidents involving the waterlines included a waterline that had to be re-routed; a waterline that was hit during construction; and an abandoned waterline that caused delays to construction. The impact of these incidents was restricted to the contractor and KAWC.

The waterline that had to be re-routed was located at the corner of Northwood Drive and Bryan Station Road . While the general contractor was excavating, he encountered a newly relocated waterline in a location that was different from that indicated on the drawings (Denham, 2005). The general contractor believed that the incorrect alignment of the waterline was done so to avoid some telephone poles. The contractor informed the water utility that the line had been incorrectly installed and the water utility then sent the original contractor that installed the line to the jobsite to try and resolve the conflict. The contractor that installed the waterline tried to remedy the situation by leaving the waterline in place in the general contractor's ditch via attaching straps to the waterline to hang the waterline on the side of the ditch until it was backfilled by the contractor when he finished his work. However, this solution did not work because the waterline began to leak (Denham, 2005). The contractor then had to come back to the jobsite and relocate the waterline into its proper location. The contractor estimated that this conflict cost him $15,000 in delays and rework (Denham, 2005). The water utility estimated that two pipelayers, dump truck operator, backhoe operator, dump truck, and backhoe were utilized for eight hours for the realignment work (Scott Thomson, personal communication, June 16, 2005). Table 40 summarizes the additional costs associated with the crew and equipment requirements. The water utility estimated that the realignment took eight hours to complete (Thomson, 2005). Table 40 indicates that a total of $1,761.84 was allocated towards crew and equipment for the realignment.

Table 40: Additional Costs for the Realignment of the Waterline.

Cost Item	Time Spent (hr)	Hourly Rate	Cost
2 Pipelayers	16	$ 26.06	$ 416.96
1 Backhoe Operator	8	$ 32.55	$ 260.40
1 Dump Truck Driver	8	$ 30.51	$ 244.08
1 Backhoe	8	$ 84.80	$ 678.40
1 Dump Truck	8	$ 20.25	$ 162.00
Total	**48**	**-**	**$ 1,761.84**

The waterline that was hit occurred at the corner of Northside Drive and Bryan Station Road while the general contractor was installing a new storm sewer line. The contractor stated that the ten-inch waterline was hit because it was higher than anticipated (Denham, 2005). The contractor estimated that the waterline hit cost $6,000 in delayed crew and equipment costs. This incident cost the water company $3,600 in repair costs and $93.75 due to loss of water (Thomson, 2005).

An abandoned waterline was located at the corner of St. Anthony Drive and Bryan Station Road. While excavating, the contractor uncovered two cast iron waterlines that looked to be installed at approximately the same time. The contractor estimated that only two years separated the installation time between the two lines (Denham, 2005). To determine which line was active, the contractor followed the lines to the next fire plug to observe which line it was connected to. The contractor estimated that this incident cost him $1,000 in delayed crew and equipment costs (Denham, 2005).

Table 41 summarizes the additional costs experienced from the various waterline incidents.

Table 41: Summary of Direct and Indirect Costs Incurred for the Waterline Conflicts.

Conflict	Direct Costs	Indirect Costs	Total
Re-routing at Corner of Northwood Dr. and Bryan Station Rd.	$ 17,261.84	$ -	$ 17,261.84
Line Hit at Corner of Northside Dr. and Bryan Station Rd.	$ 9,693.75	$ -	$ 9,693.75
Abandoned line at Corner of St. Anthony Dr. and Bryan Station Rd.	$ 1,000.00	$ -	$ 1,000.00
Total	**$ 27,955.59**	**$ -**	**$ 27,955.59**

Note: Deviation of direct costs for each of the above conflicts includes:

1. $15,000 Contractor (delays and rework) and $2,261.84 KAWC (realignment and materials)
2. $6,000 Contractor (idle crew and equipment) and $3,600 KAWC (repairs)
3. $1,000 Contractor (idle crew and equipment)

Sanitary Sewer Line Hits:

There were two separate hits to the sanitary sewer lines. Both lines involved pressurized sanitary sewer lines.

The first incident involving the sanitary sewer line occurred in a tight excavation at the corner of Northside Drive and Bryan Station Road. The line was a cast iron line that pumped about 1,200 gallons/minute (Denham, 2005). The contractor sustained additional costs from having to haul sewage overnight with two tanker trucks at a cost of $15,000. The Local sewer utility estimated that it cost them $1,000 in repairs to fix the broken line (Rick Bowman, personal communication, June 2, 2005). The state also spent additional funds on this incident via the time allocated by various state officials that worked to rectify this conflict. Their additional time and costs are listed in Table 42.

Table 42: Indirect Costs Spent on Resolving the Sanitary Sewer Force Main Break.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Engineering Tech III	40	$ 28.04	$ 1,121.60
State	Resident Engineer	20	$ 27.30	$ 546.00
State	District Branch Manager of Construction	20	$ 42.40	$ 848.00
Total		**80**	**-**	**$ 2,515.60**

The other sanitary sewer line that was hit occurred between the block of Northside and St. Anthony Drive. During this incident, the contractor hit a sanitary sewer air release valve that was not shown on the plans (Denham, 2005). The contractor hit the line on Saturday while he was performing some grading (Denham, 2005). The hit released a stream of sewage several feet into the air and lasted for four hours until the city was able to shut the line off (Denham, 2005). The contractor did not incur any additional costs for this particular incident because he able to work at other locations. The local sewer utility paid $5,000 in repair costs (Martin, 2005). Table 43 summarizes the costs sustained by the two sanitary sewer incidents. Table 43 specifies that a total of $23,515.60 was accumulated for the two conflicts.

Table 43: Summary of Direct and Indirect Costs Incurred for the Sanitary Sewer Line Conflicts.

Conflict	Direct Costs	Indirect Costs	Total
Line Hit at Corner of Northside Dr. and Bryan Station Rd.	$ 16,000.00	$ 2,515.60	$ 18,515.60
Line Hit Between Northside Dr. and Bryan Station Rd.	$ 5,000.00	$ -	$ 5,000.00
Total	**$ 21,000.00**	**$ 2,515.60**	**$ 23,515.60**

Note: Deviation of direct costs for each of the above conflicts includes:

1. $15,000 Contractor (disposal of sewage) and $1,000 Local sewer utility (repairs)
2. $5,000 Local sewer utility (repairs)

Design Change:

The state made a design change after construction had commenced for the corner of Hermitage Drive and Bryan Station Road. Due to the design change, the contractor could not construct the roadway as originally planned because of a conflict with a waterline. Due to the design change, the contractor moved a drainage box and modified a few other minor work items so KAWC could relocate their waterline. The contractor estimated that he spent two extra hours in adjusting his work for this particular design change at $100/hour (Denham, 2005). Therefore, this particular design change cost the contractor an additional $200. The state estimated that the change order issued to KAWC for the relocation of its waterline totaled $40,000 (Toy, 2005). Table 44 shows the summary of costs associated with single design change.

Table 44: Summary of Direct and Indirect Costs Incurred for the Design Change.

Conflict	Direct Costs	Indirect Costs	Total
Design Change at Corner of Hermitage Dr. and Bryan Station Rd.	$ 40,000.00	$ 200.00	$ 40,200.00
Total	**$ 40,000.00**	**$ 200.00**	**$ 40,200.00**

Note: Deviation of direct costs for each of the above conflicts includes:

1. $40,000 State (change order issued to KAWC)

3.3.3.3 Summary of Results

A summary of the direct and indirect costs sustained from each of the incidents are listed in Table 45. The $833,538.77 spent on resolving the utility conflicts equates to approximately 16% of the project's $5,293,579.43 total cost.

Table 45: Cost Breakdown of Utility Conflicts for the Bryan Station Road Project

Conflict	Direct Costs	Indirect Costs	Total
Phone Line Hits	$ 61,000.00	$ 6,317.84	$ 67,317.84
Delayed Pole Relocations	$ 60,000.00	$ -	$ 60,000.00
Gas Line Incidents	$ 136,515.33	$ 7,557.40	$ 144,072.73
Waterline Incidents	$ 27,955.59	$ -	$ 27,955.59
Sanitary Sewer Line Hits	$ 21,000.00	$ 2,515.60	$ 23,515.60
Design Changes	$ 40,000.00	$ 200.00	$ 40,200.00
Additional Change Orders	$ 470,477.01		
Total	**$ 816,947.93**	**$ 16,590.84**	**$ 833,538.77**

Each of the various utility conflicts required additional man-hours that were not intended to be spent by the assortment of affected individuals. These hours were mainly spent by the various state officials on the conflicts, but also included any quantified time spent waiting for the line to be repaired. Table 46 displays the total number of man-hours spent on the various conflicts by individuals that did not directly perform the repairs themselves. "N/A" was listed for the pole relocations because this information was not available. Table 46 indicates that a total of 500 hours were spent on the various conflicts on the projects.

Table 46: Summary of Time Spent Resolving Utility Conflicts on the Bryan Station Road Project.

Conflict	Total Time (hr)
Phone Line Hits	206
Pole Relocations	N/A
Gas Line Incidents	164
Waterline Incidents	48
Sanitary Sewer Line Hits	80
Design Changes	2
Total	500

There were a number of utility related conflicts that occurred on the Bryan Station Road Project. As a result of these conflicts, the Cabinet granted over $700,000 in change orders. The table below gives a brief description of the costs associated with each change order. The costs sustained by the contractor for additional work, repairs, and idle crew or equipment were compensated by these change orders. Conversely, the costs sustained by the various utility companies for repairs to their service lines and loss of service were not covered by the change orders.

Table 47: Summary of Change Orders

Change Order	Description	Cost
#3	Equipment Rental	$ 67,751.45
#4	Construction Delay	$ 49,000.00
#4	Utility Conflict	$ 820.00
#4	Sidewalk Asphalt	$ 22,110.00
#6	Prep. Items	$ 42,904.00
#6	Misc. Pipe	$ 2,500.00
#6	Maint. Grade and Seed	$ 25,200.00
#6	Maint. Of Traffic Winter	$ 43,750.00
#7	General Cond.	$ 21,523.30
#7	Overhead	$ 40,610.00
#7	Equipment Payment and Insurance	$ 87,000.00
#7	Paid up Equipment Idle	$ 24,500.00
#9	Utility Delays Summer 1998	$ 257,400.00
#14	Gas Line Relocation	$ 17,493.01

3.3.4 Harrodsburg Road (US 68) Project

3.3.4.1 Overview of Project

Location: Lexington/Nicholasville, KY, Fayette/Jessamine County (District 7)

Project Description (Scope of Work):

The Harrodsburg Road project was a road widening project that extended from Man O' War Boulevard in Fayette County, KY to 4,800 feet south of Brannon Road in Jessamine County, KY. Figure 16 shows a map of the project with Harrodsburg Road highlighted in yellow. The costliest utility conflicts experienced on the Harrodsburg Road Project were related to the prime contractor's reduced productivity from having to work around various utilities that were delayed in their relocation efforts. The various conflicts with utilities included issues with waterlines, fire hydrants, sanitary sewers, utility poles, various utilities located at an entrance to a subdivision, phone lines, and gas lines. There were no required lane closures for any of the utility conflicts experienced on the project.

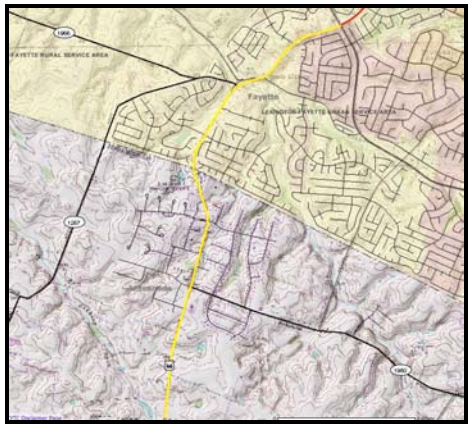


Figure 16: US 68 Project Map (KyTC 2005).

Total Project Cost: $16,809,738.69

Schedule: The project was a working days project, meaning that the contractor and state agreed to a certain number of working days to complete the project. The state issued a change order to the contractor awarding him 53 additional working days as a result of delays in relocating an existing gas line in addition to days lost from poor weather (Barber, 2005).

Project let – 09/27/2002

Awarded to Lexington Quarry Company – 10/07/2002

Construction began – 10/17/2002

Projected completion – 06/30/2005

3.3.4.2 Utility Conflicts

Waterline Incidents:

There were three separate incidents involving waterlines on the Harrodsburg Road project. These included the relocation of a water service line that was not originally anticipated and two separate incidents where the waterline was broken. The impacts of these incidents were limited to the contractor and the water districts where the various incidents occurred.

The first incident involving the relocation of a water service line resulted in a change order issued by the state to the contractor who relocated the line himself. The waterline was situated at a driveway entrance to a residence next to a church in Jessamine County. The line had to be relocated since the grade at the driveway entrance was reduced, consequently reducing the coverage of the waterline to an unsuitable depth. The change order issued to the contractor totaled $875.00 (Barber, 2005). The contractor also sustained additional costs from his crew and equipment having to demobilize and move to another location when he first stumbled upon the water service line that was in conflict. This caused his crew and equipment to remain idle for two hours at an estimated cost of $1,250 (Monohan, 2005).

Indirect costs also accrued from the relocation of the water service line from both the contractor and the state. The contractor estimated that he spent a total of six hours on the relocation of the waterline at an estimated bill rate of $100/hour (Monohan, 2005). One of the state's resident engineers for the project estimated that he spent eight hours on the relocation Barber, 2005). The other resident engineer involved on the project estimated his and the state inspector's time to be eight hours and four hours respectively for this particular waterline conflict (Sharp, 2005). The indirect costs incurred by the contractor and state are summarized in Table 48.

Table 48: Indirect Costs Spent on Resolving the Relocation of the Water Service Line.

Affected Party	**Job Title**	**Time Spent (hr)**	**Hourly Rate**	**Cost**
Lexington Quarry Company	Foreman	6	$ 100.00	$ 600.00
State	Resident Engineer	8	$ 27.30	$ 218.40
State	Resident Engineer	8	$ 27.30	$ 218.40
State	Engineering Tech III	4	$ 28.04	$ 112.16
Total		**26**	**-**	**$ 1,148.96**

One of the waterline breaks that occurred on the project took place near the intersection of Bellerive Boulevard and Harrodsburg Road. The waterline had been properly marked by BUD, but it had been installed too high The contractor had anticipated the waterline to be lower than it actually was and hit the line during excavation. The line actually dead ended at this location, thus to fix the line, the water utility simply recapped the line at a location where the line was at sufficient depth. The line had been installed for future service lines. The incident flooded the contractor out of this area, thus he sustained idle crew and equipment costs from not being able to work in this area. The contractor estimated these costs to be $1,000 (Monohan, 2005). The water utility estimated this break cost $1,000 in repairs and lost water (Tomko, 2005).

The other waterline break was to a service line that was located between the Firebrook subdivision and the South Elkhorn Creek Bridge on the east side of Harrodsburg Road. The line ran to a house located in the Dogwood subdivision. The line was broken by the contractor during blasting (Monohan, 2005). The line was repaired by the water utility at a cost of $2,500 to the contractor (Tomko, 2005). The contractor also sustained idle crew and equipment costs from this incident, estimated to be $2,000 (Monohan, 2005). The total direct and indirect costs that accumulated from the three separate waterline incidents are summarized in Table 49.

Table 49: Summary of Direct and Indirect Costs Incurred for the Waterline Conflicts.

Conflict	Direct Costs	Indirect Costs	Total
Relocated Service Line Near Southland Christian Church	$ 2,125.00	$ 1,148.96	$ 3,273.96
Line Hit Near Corner of Bellerive Blvd. and Harrodsburg Rd.	$ 2,000.00	$ -	$ 2,000.00
Line Hit Between Firebrook Subdivision and South Elkhorn Creek Bridge	$ 4,500.00	$ -	$ 4,500.00
Total	**$ 8,625.00**	**$ 1,148.96**	**$ 9,773.96**

Fire Hydrant Relocations:

There were three separate fire hydrants that were in conflict on the Harrodsburg Road Project. Each of the three fire hydrants in conflict had to be raised due to the addition of fill to the locations where the lines resided. The contractor that raised the hydrants for the water district estimated that he spent four hours on each hydrant at an additional cost of $800 for each hydrant (Stephenson, 2005). The state estimated that an inspector and resident engineer spent four hours each on the three fire hydrant conflicts (Sharp, 2005). Based on hourly rates provided by the state for its employees, the indirect costs for these two individuals were summarized in Table 50. Table 51 summarizes the direct and indirect costs from having to raise the fire hydrants.

Table 50: Indirect Costs Spent on Resolving the Fire Hydrant Relocations.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Engineering Tech III	4	$ 28.04	$ 112.16
State	Resident Engineer	4	$ 27.30	$ 109.20
Total		**8**	**-**	**$ 221.36**

Table 51: Summary of Direct and Indirect Costs Incurred for the Fire Hydrant Relocations.

Conflict	Direct Costs	Indirect Costs	Total
Fire Hydrant at Corner of Springdale Dr. and Harrodsburg Rd.	$ 800.00	$ 73.79	$ 873.79
Fire Hydrant at Corner of Old Coach Rd. and Harrodsburg Rd.	$ 800.00	$ 73.79	$ 873.79
Fire Hydrant at Corner of Brannon Rd. and Harrodsburg Rd.	$ 800.00	$ 73.79	$ 873.79
Total	**$ 2,400.00**	**$ 221.36**	**$ 2,621.36**

Sanitary Sewer Conflicts:

There were three separate conflicts with the sanitary sewer lines, which produced additional costs to the contractor, state, and entities that operated the lines.

A sanitary sewer line ran to a church and was located next to their parking lot which parallels Harrodsburg Road. Figure 17 shows a picture of the church's parking lot and

Harrodsburg Road near the location of the conflict. The church installed the line one year prior to the commencement of construction under an agreement with the state that any conflicts that arose from its installation during construction of the Harrodsburg Road Project would be the church's responsibility (Lawson, 2005). Consequently, a problem did occur with the sanitary sewer force main when the contractor was constructing the drainage ditch (Barber, 2005). The line was constructed four feet closer to Harrodsburg Road than planned (Cox, 2005). The church reached an agreement with the contractor that installed the line that stipulated it would pay for one third of the relocation costs (Cox, 2005). The relocation of the line totaled $30,000 (Cox, 2005).

Figure 17: Church Parking Lot and Harrodsburg Road

Additional costs also accrued from the contractor's reduced productivity and from the meetings that were held specifically to discuss the conflict with the sanitary sewer force main. The contractor estimated the reduced productivity to cost an additional $10,000 (Monohan, 2005). The summary of the time and costs for all the individuals that attended either one or both of the meetings are listed in Table 52. Along with the indirect costs that accrued from the reduced productivity and meetings, time spent by various state officials trying to remedy the force main sanitary sewer conflict outside of that time spent at the two meetings, added up as well. The Director of Utilities for District 7 estimated his time to be eight hours for this particular conflict (Lawson, 2005). The resident engineer that was on the project during this incident estimated his and the state inspector's time to be six hours for the sanitary force main issue at Southland Christian Church (Sharp, 2005). The costs accrued by the state are shown in Table 53. Combining this total with the previously mentioned costs for the meeting, contractor's reduced productivity, and direct cost of relocating the line a second time, produces a total of $42,709.88 spent on the incorrect installation of the sanitary sewer.

Table 52: Indirect Costs Spent on Meeting About the Sanitary Sewer Line Conflict.

State	Engineering Tech III	4	$ 28.04	$ 112.16
State	Engineering Tech III	4	$ 28.04	$ 112.16
State	Resident Engineer	4	$ 27.30	$ 109.20
Church	Campus Operations Director	4	$ 75.00	$ 300.00
Design Firm	Design Engineer	4	$ 100.00	$ 400.00
Design Firm	Architect	4	$ 100.00	$ 400.00
Contractor	Foreman	4	$ 100.00	$ 400.00
Contractor	Owner	2	$ 100.00	$ 200.00
Contractor	Foreman	2	$ 60.00	$ 120.00
Total		**32**	**-**	**$ 2,153.52**

Table 53: Indirect Costs Spent on Resolving the Sanitary Sewer Force Main Conflict.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Engineering Tech III	6	$ 28.04	$ 168.24
State	Engineering Tech III	8	$ 28.04	$ 224.32
State	Resident Engineer	6	$ 27.30	$ 163.80
Total		**20**	**-**	**$ 556.36**

A sanitary sewer force main was broken on the east side of the South Elkhorn Creek Bridge. The 24-inch line was hit while the contractor was installing a new casing pipe that was located near the force main. The pipe being installed ran lower than the elevation of the creek, thus the trench kept filling with water making it difficult for the contractor to see while he was excavating (Monohan, 2005). The contractor estimated that the incident cost him $12,000 in time and materials for the repair (Monohan, 2005). The contractor spent two days repairing the line himself, thus he lost sixteen hours due to the break (Monohan, 2005). The Local sewer utility estimated its personnel and supervisory costs for the incident totaled $2,500, which was not incorporated into the contractor's repair expenses (Charlie Martin, personal communication, June 15, 2005).

Another sewer force main, located at the intersection of Old Coach Road and Harrodsburg Road reduced the contractor's productivity. The force main reduced the contractor's productivity since he had to reduce the slope of the drainage ditches in this area to avoid exposing the line. To prevent this from happening, the state's resident engineer for the project agreed to let the contractor flatten the slope to avoid the line (Barber, 2005). The change was reflected in the project's as-build drawings. Although the contractor was able to avoid exposing the line, he had to work extra cautiously in this area to ensure that he did not hit the line (Monohan, 2005). The contractor stated this reduced productivity cost him an additional $1,000 for the work in this area (Monohan, 2005).

Table 54 summarizes the total direct and indirect costs experienced from the three sanitary sewer conflicts. According to Table 54, the combined effect of all the sanitary sewer conflicts produced $58,209.88 in additional costs.

Table 54: Summary of Direct and Indirect Costs Incurred for the Sanitary Sewer Conflicts.

Conflict	Direct Costs	Indirect Costs	Total
Line Relocated Next to Southland Christian Church	$ 30,000.00	$ 12,709.88	$ 42,709.88
Line Hit By South Elkhorn Creek Bridge.	$ 14,500.00	$ -	$ 14,500.00
Line Located near Drainage Ditch at Corner of Old Coach Rd. and Harrodsburg Rd.	$ 1,000.00	$ -	$ 1,000.00
Total	**$ 45,500.00**	**$ 12,709.88**	**$ 58,209.88**

Utility Pole Relocations:

During construction of the Harrodsburg Road Project, it was determined that several poles would have to be relocated to accommodate the roadway. These relocations were not originally planned by the affected utility companies. The conflicts with the poles stemmed from additional fill that was placed in the proximity of the poles and from poles that had to be relocated to make room for the construction of the roadway. The additional direct costs associated with these relocations were paid by the utility companies (Lawson, 2005). The contractor and state sustained additional costs from the time they spent in trying to get the poles out of the way. These costs were viewed as indirect.

The pole relocations that were required because of the insertion of additional fill occurred near the intersection of Military Pike and Old Bridge Ln. The utility company estimated that the two poles in conflict cost $10,000 to relocate and an additional $3,000 for the various utilities that had to relocate their lines (Long, 2005).

There were two poles that conflicted with the construction of the roadway. These poles were located at the corner of Bellerive Boulevard and Harrodsburg Road. These two poles were located too close to the roadway and were not shown on the plans to require relocation. The owner of the two poles in conflict estimated that the relocation of the poles cost $14,000 and an additional $2,000 for the relocation of the various utilities that occupied the poles (Raleigh Deaton, personal communication, June 20, 2005). Therefore, an additional $16,000 accrued from these two pole relocations.

The contractor and state both incurred additional costs from the time they spent on trying to get the poles relocated. The contractor estimated that he spent a total of four hours at

$100/hour on all the pole relocations (Monohan, 2005). The state estimated its resident engineer and inspector spent eight and two hours respectively on the utility pole relocations (Sharp, 2005). The summary of the indirect costs accumulated by the contractor and state are outline in Table 55.

Table 55: Indirect Costs Spent on Resolving the Utility Pole Relocations.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Engineering Tech III	8	$ 28.04	$ 224.32
State	Resident Engineer	2	$ 27.30	$ 54.60
Contractor	Foreman	4	$ 100.00	$ 400.00
Total		**14**	**-**	**$ 678.92**

Table 56 summarizes the additional costs associated with utility pole relocations that were unanticipated.

Table 56: Summary of Direct and Indirect Costs Incurred for the Utility Pole Relocations.

Conflict	Direct Costs	Indirect Costs	Total
Poles Relocated at Corner of Military Pike and Old Bridge Ln.	$ 13,000.00	$ 339.46	$ 13,339.46
Poles Relocated at Corner of Bellerive Blvd. and Old Bridge Ln.	$ 16,000.00	$ 339.46	$ 16,339.46
Total	**$ 29,000.00**	**$ 678.92**	**$ 29,678.92**

Firebrook Entrance Conflict:

At the entrance to Firebrook subdivision, there is a significant amount of landscaping. The entrance is located at the intersection of Overlake Boulevard and Harrodsburg Road. The contractor felt it would have been advantageous for the subdivision to relocate its facilities because any damage he may have caused would not have been his responsibility to repair, since the state owned the rights to the land that the utilities occupied (Monohan, 2005). The contractor estimated that the additional work in this area from having to hand excavate in some areas and other added work cost him $2,000 (Monohan, 2005). The state also suggested that it spent additional costs at the entrance because of time it allocated towards dealing with the concerns brought to their attention by the contractor and the subdivision's homeowners association. These additional indirect costs are outlined in Table 57. The Director of Utilities for District 7 estimated his time to be eight hours for the conflicts at the entrance (Lawson, 2005). The state also estimated that the resident engineer and project inspector spent ten and four hours accordingly, on the conflicts at the entrance (Sharp, 2005).

Table 57: Indirect Costs Spent on Resolving the Firebrook Entrance Conflict.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Resident Engineer	10	$ 27.30	$ 273.00
State	Engineering Tech III	8	$ 28.04	$ 224.32
State	Engineering Tech III	4	$ 28.04	$ 112.16
Total		**22**	**-**	**$ 609.48**

The additional direct and indirect costs associated with utilities located at the entrance to the Firebrook subdivision are summarized in Table 57.

Table 58: Summary of Direct and Indirect Costs Incurred for the Firebrook Entrance

Conflict	Direct Costs	Indirect Costs	Total
Utilities at Firebrook Entrance at Corner of Overlake Blvd. and Harrodsburg Rd.	$ 2,000.00	$ 609.48	$ 2,609.48
Total	**$ 2,000.00**	**$ 609.48**	**$ 2,609.48**

Phone Line Break:

There was one incident involving a phone line. The incident occurred near a restaurant located on Old Harrodsburg Road. The line was an underground line that the contractor hit after BUD marked the line incorrectly (Monohan, 2005). Since BUD incorrectly marked the line, the phone utility paid for the repairs and lost service associated with incident. The phone utility stated that its repairs and lost service totaled $12,000 (Dunn, 2005). The contractor and state did not sustain any additional costs from this particular conflict. The summary of the costs shown in Table 59 for the break to phone line only contains the single cost compensated by the phone utility for the repairs to their line (Dunn, 2005).

Table 59: Summary of Direct and Indirect Costs Incurred for the Phone utility Phone Break.

Conflict	Direct Costs	Indirect Costs	Total
Line Hit Near Restaurant off of Old Harrodsburg Rd.	$ 12,000.00	$ -	$ 12,000.00
Total	**$ 12,000.00**	**$ -**	**$ 12,000.00**

Gas Lines:

As mentioned previously in the description about the project, the conflict that was most detrimental to the project was delays due to relocation of a gas line by the gas utility company. The contractor estimated that he lost $150,000 from having to demobilize and move his crew and equipment to areas where he could work during the delay (Monohan, 2005). The state also had to expend additional time during this particular issue which produced additional costs. These indirect costs are outlined in Table 60. The Director of Utilities for District 7 approximated his time to total eight hours for the various issues with the gas line relocations (Lawson, 2005). The state's resident engineer that was on the project during the gas line relocations estimated that both him and the project's inspector spent twenty hours on all of the various issues with the gas line relocations (Sharp, 2005).

Table 60: Indirect Costs Spent on Resolving the Delays Created by the Columbia Gas Lines.

Affected Party	Job Title	Time Spent (hr)	Hourly Rate	Cost
State	Engineering Tech III	20	$ 28.04	$ 560.80
State	Engineering Tech III	8	$ 28.04	$ 224.32
State	Resident Engineer	20	$ 27.30	$ 546.00
Total		**48**	**-**	**$ 770.32**

Table 61 summarizes the direct and indirect costs that were accrued from the delays created by the gas utility during the relocation of its lines.

Table 61: Summary of Direct and Indirect Costs Incurred for the Columbia Gas Lines.

Conflict	Direct Costs	Indirect Costs	Total
Delays Created by Gas Line Relocations	$ -	$ 150,770.32	$ 150,770.32
Total	**$ -**	**$ 150,770.32**	**$ 150,770.32**

3.3.4.3 Summary of Results

The Harrodsburg Road project's main utility conflict was related to the delayed relocation of the gas lines. The contractor estimated the impact of these delays to be significant due to the reduced productivity he sustained. The state, contractor, and various utility companies also sustained significant additional costs from conflicts related to waterlines, fire hydrants, sanitary sewers, utility poles, utilities located at the entrance to the Firebrook subdivision, and phone lines. Table 62 summarizes the direct and indirect costs that each of the various conflicts incurred. Table 62 indicates that a total of $265,663.92 was accumulated by the various parties involved on the project. This total is equivalent to just over 1% of the project's $16,809,738.72 in total costs**.**

Table 62: Cost Breakdown of Utility Conflicts for the Harrodsburg Road Project.

Conflict	Direct Costs	Indirect Costs	Total
Waterline Incidents	$ 8,625.00	$ 1,148.96	$ 9,773.96
Fire Hydrant Relocations	$ 2,400.00	$ 221.36	$ 2,621.36
Sanitary Sewer Conflicts	$ 45,500.00	$ 12,709.88	$ 58,209.88
Utility Pole Relocations	$ 29,000.00	$ 678.92	$ 29,678.92
Firebrook Entrance Conflict	$ 2,000.00	$ 609.48	$ 2,609.48
Phone Line Break	$ 12,000.00	$ -	$ 12,000.00
Gas Lines	$ -	$ 150,770.32	$ 150,770.32
Total	**$ 99,525.00**	**$ 166,138.92**	**$ 265,663.92**

The total amount of time spent by various individuals involved with the numerous utility conflicts was also significant. The time accumulated by the various individuals is shown in Table 63. This number is likely low because most of the incidents did not quantify the time spent by the phone utility on the actual repairs.

Table 63: Summary of Time Spent Resolving Utility Conflicts on the Harrodsburg Road Project.

Conflict	Total Time (hr)
Waterline Incidents	28
Fire Hydrant Relocations	20
Sanitary Sewer Conflicts	68
Utility Pole Relocations	14
Firebrook Entrance Conflict	22
Phone Line Break	N/A
Gas Lines	48
Total	200

3.4 Case Study Results

The case studies identified numerous different conflicts with an abundance of various costs. These costs were classified as either direct or indirect based upon on the definitions outlined in Section 3.2. Table 64 summarizes the total direct and indirect costs identified for each of the projects evaluated in the case study analysis. Excluding the sizeable $1,000,000 change order for the additional waterline on the Cumberland River Bridge, it was determined that the Bryan Station Road project incurred the most direct and indirect costs. The conflict that contributed the greatest towards the $833,538.77 in total costs that were accumulated during the project was the numerous issues with the gas lines and change orders on this project.

Table 64: Summary of Direct and Indirect Costs Identified in the Case Study Analysis.

Project	Direct Costs	Indirect Costs	Total
US 27 Cumberland River Bridge Project	$ 1,061,700.00	$ 6,628.10	$ 1,068,328.10
US 27 Pitman Creek Bridge Project	$ 36,450.00	$ 109,499.75	$ 145,949.75
Richmond Rd. (US 25) Project	$ 161,630.95	$ 4,679.36	$ 166,310.31
Bryan Station Rd. (KY 57) Project	$ 346,470.92	$ 16,590.84	$ 363,061.76
Harrodsburg Rd. (US 68) Project	$ 99,525.00	$ 166,138.92	$ 265,663.92

To further examine the impact of these utility conflicts on the five projects analyzed, a comparison of the total project cost versus the total cost of utility conflicts is provided in Table 65. Table 65 indicates that the Bryan Station Road Project also sustained the greatest percentage of utility conflict costs as compared to its overall project cost. The utility conflict costs were equivalent to 6.86% of the project's total cost of $5,293,579.43.

It is important to note that the costs identified in the case study analysis likely underestimate the full extent of the total cost of the various utility conflicts. This is because it is virtually impossible to determine the time spent by every individual involved on each of the utility conflicts. Only the key individuals affected by these conflicts were incorporated into the costs outlined in the case studies. Similarly, documentation of these incidents also was scarce on some of the projects completed several years ago, thus further leaving the potential for the true magnitude of these conflicts to be underrated.

Table 65: Utility Conflict Costs as a Percentage of Project Costs.

Project	Project Cost	Cost of Utility Conflicts	Utility Conflict Costs as a Percentage of Project Costs
US 27 Cumberland River Bridge Project	$ 22,173,290.65	$ 1,068,328.10	4.82%
US 27 Pitman Creek Bridge Project	$ 11,267,193.02	$ 145,949.75	1.30%
Richmond Rd. (US 25) Project	$ 6,847,597.19	$ 166,310.31	2.43%
Bryan Station Rd. (KY 57) Project	$ 5,293,579.43	$ 363,061.76	6.86%
Harrodsburg Rd. (US 68) Project	$ 16,809,738.69	$ 265,663.92	1.58%

The analysis of the case studies suggested numerous different sources contributed to the utility conflicts. These causes were categorized into the general sources listed in Table 66. The number of conflicts that occurred as a result of each of the general sources was also included in Table 66. The number of conflicts indicated for each source is also underestimated as well because many of the case studies did not include a complete breakdown of all the incidents that occurred, such as the gas line relocations on the Harrodsburg Road Project. Table 66 indicates that an incorrect location of the utilities on the approved plans was responsible for most of the utility conflicts identified in the case studies. It is important to note that the sources identified in Table 66 were commonly determined by word of mouth and may have varied depending on the source interviewed. However, these determinations were made as objective as possible.

Table 66: Number of Conflicts per Source Identified in Case Study Analysis.

Source	# of Conflicts
Incorrect Location on Plans	18
Design Error	9
Damage to Utilities During Blasting	8
Contractor Negligence	8
Delays in Relocation of Utilities	5
Unanticipated Subsurface Conditions	3
Changes Made After Construction	3
Incorrect Locate by BUD	3
Abandoned Lines	3
Constructability Problems	3
Unknown Location of Service Lines	2
Unanticipated Environmental Requirements	1
Unforeseen Circumstances	1
Poor Existing Condition of Utilities	1
Utilities at Subdivision Entrance	1

4 Analysis of States Questionnaire

One goal of this study is to address utility relocation conflicts on highway construction projects and pursue practices that can aid in reducing their occurrence and impact. This goal was achieved by accomplishing the following objectives.

1. Identify the conflict frequency of various utility relocation problems on highway construction projects.
2. Identify the conflict impact of various utility relocation problems on highway construction projects.
3. Identify utility practices currently used by other state transportation agencies.
4. Identify practices to alleviate or minimize the impact of utility relocation problems.
5. Recommend utility practices for implementation on highway construction projects.

A national survey of state utility directors accomplished many of the above goals.

4.1 Data Collection

4.1.1 State Questionnaire

To gather a national representation of current utility conflicts and practices occurring on state construction projects, a survey was sent to each state utility director. Representatives from all 50 states were contacted and all agreed to complete and return the questionnaire. The final collection efforts resulted in 45 returned surveys (90% return rate); the responding states are listed below in Table 67.

Table 67: List of Responding States

Alabama	Louisiana	Ohio
Alaska	Maine	Oregon
Arizona	Maryland	Pennsylvania
California	Massachusetts	Rhode Island
Colorado	Michigan	South Carolina
Connecticut	Minnesota	South Dakota
Delaware	Missouri	Tennessee
Florida	Montana	Texas
Georgia	Nebraska	Utah
Hawaii	Nevada	Vermont
Idaho	New Hampshire	Virginia
Indiana	New Jersey	Washington
Iowa	New York	West Virginia
Kansas	North Carolina	Wisconsin
Kentucky	North Dakota	Wyoming

This purpose of this survey, found in Appendix A, is to identify the frequency and severity of utility conflicts and identify best practices used to avoid them. The questionnaire contains 75 questions, and encompasses four parts related to the utility process:

- **Frequency and Severity of Utility Conflicts:** This section identifies problems associated with utility relocation and identifies conflict frequency and severity for the different types of utilities encountered on construction projects. Financial constraints, scheduling conflicts, and the accuracy of utilities shown on construction plans are each examined in this section. The frequency and severity of utility conflicts involving different types of utilities on urban and rural projects are also identified in this section. Urban projects are those occurring in and immediately surrounding a city, while rural projects are those occurring outside the urban areas in the country.

- **Practices to Avoid Utility Conflicts:** Practices included in this section of the questionnaire were identified from literature reviews and meetings with utility officials as practices that aid in prevention of utility conflicts. Utility practices addressed in this section include: coordination, communication, utility involvement in the project development process, and methods of financial allocation for utility relocation. Allowing contractors to seek damages from utility companies when they are the cause of delay and to seek reimbursement for indirect costs associated with utility conflicts were practices also included. The emergence of subsurface utility engineering as a tool for avoiding utility conflicts is continually increasing; this section identifies the various elements of this process and its implementation and incorporation into the utility process.

- **One Call Center:** One call centers provide contractors and designers a single point of contact for participating utility companies, allowing utilities to be located for a specific project by one agency. The accuracy of utility locations performed by one call agencies for different types of utilities is examined in this part, along with utility company involvement in locating different utilities.

- **Right-of-Way:** Right-of-way can influence the ability of utility companies to complete relocations in a timely manner; this section of the questionnaire identifies right-of-way practices that influence utility relocation. Prioritizing parcel acquisition based on need for utility relocation, obtaining adequate space for relocation, and informing property owners of additional property that may be acquired beyond right-of-way for utility easements are practices examined in this section.

4.1.2 Methods of Analysis

Analysis of variance (ANOVA) is used to test the hypothesis that sample means of two or more groups come from the same population. To perform an ANOVA test of equality of population means, the total variation in the outcome measurements is subdivided into two parts. One part is attributable to differences between groups and another part is due to an inherent variation within the groups. The variation between groups and the variation within groups are used to obtain the F-test statistic. The F-test statistic is influenced by the degrees of freedom associated with each variation. It is used to identify the significant difference among the groups. For the purpose of this study, and given the small sample size, we will consider a p-value lesser than 0.20 as an index of significance, while a p-value greater than 0.20 will indicate no significance between groups. Moreover, a p-value less than 0.05 will indicate a highly significant difference between groups.

4.2 Frequency of Utility Conflict Descriptive Statistics

Utility conflicts can be attributed to contractors, state transportation agencies, utilities, or any combination of these stakeholders. Conflicts can also result from scheduling conflicts among these stakeholders or from an entity's lack of financial resources. Other issues can also attribute to utility conflicts, such as environmental issues, tree removal, and the accuracy of existing utilities shown on construction plans. This analysis section provides descriptive statistics for the observed survey results for questions pertaining to utility conflicts.

4.2.1 Frequency of Utility Conflicts Delays Due to Stakeholders

The questionnaire respondents were asked to rate how often utility relocation delays are a result of conflicts created by different project stakeholders. Respondents rated the frequency of each conflict on a scale of 1 to 7, with 1 indicating the conflict never occurs on construction projects and 7 indicating the conflict occur constantly on construction projects.

Table 68: Stakeholder Utility Relocation Delay Frequency

Question		N	Mean	Std. Deviation
1	How often is utility relocation delayed due to a lack of available financial resources on behalf of utility companies?	45	2.89	1.17
2	How often is utility relocation delayed due to a lack of available financial resources on behalf of your state transportation agency?	45	2.18	1.19
3	How often is utility relocation delayed due to a scheduling conflict on behalf of the utility companies?	45	4.38	0.94
4	How often is utility relocation delayed due to a scheduling conflict on behalf of the contractor?	44	3.50	0.98

Based on average frequency provided in Table 68, the most frequent result of utility relocation delays among these four possibilities can be attributed to scheduling conflicts on behalf of the utility companies (4.39). The second highest average frequency identified for utility relocation delays was a scheduling conflict on behalf of the contractor, which obtained an average rating of 3.49 indicating a rare occurrence on projects. A lack of financial resources on behalf of utility companies and a lack of financial resources on behalf of state transportation agencies resulted in utility relocation delays less frequently on projects, tallying average frequencies of 2.89 and 2.20 respectively.

4.2.2 Frequency of Other Sources Resulting in Utility Relocation Delays

Aside from the traditional project stakeholders contributing to utility relocation delays, there are also additional sources that can generate delays. The respondents were asked to respond yes or no to questions regarding other conflict sources. When indicating a delay conflict, the respondent was asked to list the sources of conflict contributing to delays. Table 69 shows the percentage of states responding yes and no to questions related to other sources initiating utility relocation delays.

Table 69: Percentage of State Responses to Sources of Utility Relocation Conflicts

Question		N	Yes (%)
5	Are there any other sources of scheduling conflicts attributing to delays of utility relocation?	45	75.6
6	Are there any other sources of financial conflicts attributing to delays of utility relocation?	43	27.9
7	Do utility companies only perform utility relocation certain times of the year?	45	62.2
8	Is their any restriction on tree removal in relation to utility relocation?	45	82.2
9	Are there any other environmental issues that pose problems in relation to utility relocation?	45	84.4

A majority of responding states indicate that environmental issues, tree removal, and other scheduling conflicts are a factor in relation to utility relocation. As can be seen in Table 69, 84% of responsive states indicate environmental issues pose problems in relation to utility relocation. Tree removal restrictions were a close second with 82% reporting these restrictions are related to their utility relocation efforts. Scheduling conflicts other than those on behalf of the contractor and utility were also identified by 75% of the responding states, while 61% indicated utility companies only perform relocations certain times of the year. Financial conflicts other than with utility companies or the state transportation agencies only attributed to delays in approximately 29% of the responding states.

4.2.3 Accuracy of Existing Utilities on Construction Plans

Utility conflicts are often a result of existing utilities being inaccurately represented on construction plans. The survey asked respondents to rate the accuracy of existing utilities as shown on construction plans on a scale of 1 to 7, with 1 indicating poor accuracy and 7 representing excellent accuracy. State responses to questions related to horizontal and vertical accuracy of existing utilities were averaged, with the descriptive statistics provided in Table 70.

Table 70: Accuracy of Existing Utilities on Construction Plans

	Question	N	Mean	Std. Deviation
10	How would you rate the accuracy of the horizontal location (i.e. x and y coordinates) of existing utilities as shown on construction plans?	44	3.98	1.37
11	How would you rate the accuracy of elevation (i.e. z coordinate) of existing utilities as shown on construction plans?	43	2.67	1.69

The average accuracy rating for horizontal location of existing utilities is greater than the average accuracy rating for elevation. This should be expected since the depths of some utilities are often not shown on prior construction documents, unlike the horizontal location which is shown for most utilities. These findings are also supported by a generally consensus that most as-builds are inaccurate, along with the fact that subsurface utility engineering enables horizontal data of existing utilities to be obtained more easily than vertical data. Subsurface utility engineering can provide a reasonably accurate line representing the horizontal location of some existing utilities by obtaining only Quality Level B information; while the only way to accurately show vertical data for most utilities is through Quality Level A data, which only represents a point and not a line.

4.2.4 Overall Frequency of Utility Conflicts

To obtain a general understanding of how often utility conflicts occur on construction projects, the respondents were asked to provide a frequency rating ranging from 1 to 7. A rating of 1 indicates utility conflicts never occur on projects, while a rating of 7 signifies constant occurrence of utility conflicts. The descriptive statistics for the responses are provided in Table 71. An average frequency value of 5.02 indicates that states experience utility conflicts often on projects.

Table 71: Frequency of Utility Conflicts

	Question	N	Mean	Std. Deviation
12	Overall, what is the frequency and severity of utility conflicts within your state transportation agency projects?	45	5.02	1.15

4.2.5 Urban Utility Conflict Frequency

Urban projects are those projects occurring in and immediately surrounding a city. The congestion of utilities present on urban projects generally differs from the congestion of utilities on rural projects. The respondents were asked to rate the frequency of utility conflicts on urban projects as a result of various types of existing utilities. The summary data obtained from the responses is provided in Table 72.

Table 72: Urban Utility Conflict Frequency

Question		N	Mean	Std. Deviation
13	Utility conflicts with existing gas pipelines?	44	4.84	1.08
14	Utility conflict with existing water pipelines?	44	5.14	1.06
15	Utility conflicts with existing storm sewer pipelines?	43	4.56	1.64
16	Utility conflicts with existing sanitary sewer pipelines?	44	4.55	1.21
17	Utility conflicts with existing underground telecommunication lines?	44	5.21	1.04
18	Utility conflicts with existing above ground telecommunication lines?	44	4.82	1.46
19	Utility conflicts with existing underground electrical lines?	44	4.09	1.17
20	Utility conflicts with existing above ground electrical lines?	44	5.14	1.26
21	Utility conflicts with existing underground cable lines?	43	4.42	1.25
22	Utility conflicts with existing above ground cable lines?	43	4.72	1.43

From Table 72, existing underground telecommunication lines generate utility conflicts most often (an average rating of 5.28) on construction projects in comparison to other existing utilities. Conflicts resulting from existing water pipelines and existing above ground electrical lines also occur often on projects, with average ratings of 5.14 and 5.12 respectively. Existing above ground telecommunication lines (4.81), existing gas pipelines (4.81), and existing above ground cable lines (4.69) each obtained an average frequency rating slightly below often. Very similar average frequencies of 4.55 and 4.53 were obtained, for existing storm sewer pipelines and existing sanitary sewer pipelines respectively. The lowest average frequency ratings were obtained for underground cable lines and underground electrical lines at 4.45 and 4.09 respectively.

4.2.6 Rural Utility Conflict Frequency

In addition to rating the frequency of conflicts on urban projects, the respondents were also asked to rate the frequency of conflicts encountered on rural projects as a result of various types of existing utilities. Rural projects are identified as those projects occurring outside the urban areas in the country. Once again, the respondents were asked to supply a rating from 1 to 7, with 1 indicating conflicts never occur on projects as a result of that type of existing utility and 7 representing constant occurrence due to that utility type. Table 73 are provides descriptive statistics for each different type of existing utility examined.

Table 73: Rural Utility Conflict Frequency

Question		N	Mean	Std. Deviation
23	Utility conflicts with existing gas pipelines?	44	3.75	1.06
24	Utility conflict with existing water pipelines?	44	3.77	1.17
25	Utility conflicts with existing storm sewer pipelines?	43	2.88	1.38
26	Utility conflicts with existing sanitary sewer pipelines?	44	2.93	1.04
27	Utility conflicts with existing underground telecommunication lines?	44	4.23	1.04
28	Utility conflicts with existing above ground telecommunication lines?	44	4.45	1.29
29	Utility conflicts with existing underground electrical lines?	44	3.25	1.14
30	Utility conflicts with existing above ground electrical lines?	44	4.70	1.24
31	Utility conflicts with existing underground cable lines?	43	3.40	1.19
32	Utility conflicts with existing above ground cable lines?	43	4.09	1.35

For rural projects, the highest average frequency rating for utility conflicts was due to existing above ground electrical lines (4.70). Existing above ground telecommunication lines, existing underground telecommunication lines, and above ground cable lines are each identified as contributing to utility conflicts on some projects with average frequency ratings of 4.44, 4.21, and 4.12 respectively. Conflicts related to existing water pipelines (3.77), existing gas pipelines (3.72), existing underground cable lines (3.43), and existing underground electrical lines (3.26) occurred less frequently on rural projects based on mean frequency ratings. The lowest average frequency ratings for rural utility conflicts was for existing sanitary sewer pipelines and existing storm sewer pipelines; these conflicts occurred rarely on rural projects with ratings of 2.93 and 2.88 respectively.

4.3 Severity of Utility Conflicts Descriptive Statistics

Examining the frequency of utility conflicts on construction projects provides insight to the regularity at which different sources of conflict create problems. While conflict frequency measures the rate at which conflicts occur, a measure is also needed to examine the level of impact a utility conflict has on projects. To identify the amount of impact associated with various utility conflicts, the surveyed respondents were asked to rate the severity of each utility conflict for which they supplied a frequency rating. This analysis section provides descriptive statistics for the survey results pertaining to questions examining the severity of utility conflicts.

4.3.1 Severity of Utility Relocation Delays due to Stakeholders

The respondents were asked to rate the severity of impact utility relocation delays have on projects as a result of conflicts created by different project stakeholders. Respondents rated the severity of each conflict on a scale of 1 to 7, with 1 indicating no impact on project schedule and 7 indicating extreme impact on schedule. The average severity rating for utility relocation delays as a result of various stakeholders is shown in Table 74.

Table 74: Stakeholder Utility Relocation Delay Severity

Question		N	Mean	Std. Deviation
1	How often is utility relocation delayed due to a lack of available financial resources on behalf of utility companies?	44	3.45	1.62
2	How often is utility relocation delayed due to a lack of available financial resources on behalf of your state transportation agency?	44	2.55	1.63
3	How often is utility relocation delayed due to a scheduling conflict on behalf of the utility companies?	44	4.70	1.34
4	How often is utility relocation delayed due to a scheduling conflict on behalf of the contractor?	42	4.12	1.27

Based on average severity as shown in Table 74, the most severe impact on project schedule can be attributed to scheduling conflicts on behalf of the utility companies (average rating of 4.67). It should be noted that scheduling conflicts on behalf of the utility company also received the highest average frequency rating for this group of questions. The second most severe impact on project schedule as identified by the average rating was due to scheduling conflicts on behalf of the contractor (4.13). A lack of financial resources on behalf of utility companies and a lack of financial resources on behalf of state transportation agencies resulted in less severe utility relocation delays, tallying average frequencies of 3.40 and 2.58 respectively. It should be noted that the ranking for this question set based on average severity is identical to the ranking order based on average frequency.

4.3.2 Overall Severity of Utility Conflicts

The respondents were asked to rate the overall impact utility conflicts have on their state transportation projects on a scale of 1 to 7, with 1 indicating no impact on project schedule and 7 signifying extreme impact on project schedule. An average severity rating of 4.82, as seen in Table 75, indicates utility conflicts have an overall moderate impact on project schedule.

Table 75: Severity of Utility Conflicts

Question		N	Mean	Std. Deviation
12	Overall, what is the frequency and severity of utility conflicts within your state transportation agency projects?	45	4.82	1.15

4.3.3 Urban Utility Conflict Severity

In addition to supplying frequency ratings for different types of utility conflicts on urban projects, respondents were also asked to rate the impact these conflicts had on project schedule. Respondents were given a sliding scale of 1 to 7 to rate the impact, with 1 signifying no impact and 7 representing extreme impact on project schedule. Table 76 contains the descriptive statistics for each type of utility conflict encountered on urban projects.

Table 76: Urban Utility Conflict Severity

Question		N	Mean	Std. Deviation
13	Utility conflicts with existing gas pipelines?	44	4.64	1.10
14	Utility conflict with existing water pipelines?	44	4.52	0.96
15	Utility conflicts with existing storm sewer pipelines?	42	4.00	1.40
16	Utility conflicts with existing sanitary sewer pipelines?	44	4.23	1.17
17	Utility conflicts with existing underground telecommunication lines?	44	5.00	1.26
18	Utility conflicts with existing above ground telecommunication lines?	44	4.25	1.44
19	Utility conflicts with existing underground electrical lines?	44	4.03	1.28
20	Utility conflicts with existing above ground electrical lines?	44	4.39	1.25
21	Utility conflicts with existing underground cable lines?	43	3.95	1.38
22	Utility conflicts with existing above ground cable lines?	43	4.00	1.40

Comparing average severity ratings, existing underground telecommunication lines have the highest impact rating (4.98), signifying moderate impact on project schedule. It should be noted that existing underground telecommunication lines also had the highest average frequency rating for urban utility conflicts. Existing gas pipelines and existing water lines had a less impact on project schedule, receiving severity ratings of 4.60 and 4.53 respectively. A slight to moderate impact on project schedule was determined for existing above ground electrical lines (4.35), existing sanitary sewer pipelines (4.23), existing above ground telecommunication lines (4.23), and existing storm sewer pipelines (4.00) based on average severity rating. Existing utilities obtaining the lowest average impact ratings are underground electrical lines (3.98), above ground cable lines (3.98), and underground cable lines (3.95).

4.3.4 Rural Utility Conflict Severity

In addition to ranking urban conflicts, the respondents were asked to rate the severity of conflicts encountered on rural projects as a result of various types of existing utilities on a similar scale of 1 to 7. On this scale, 1 indicates no impact on project schedule due to the utility conflict, while 7 indicates an extreme impact on project schedule. The descriptive statistics in Table 77 are provided for each different type of existing utility examined

Table 77: Rural Utility Conflict Severity

Question		N	Mean	Std. Deviation
23	Utility conflicts with existing gas pipelines?	42	3.95	1.27
24	Utility conflict with existing water pipelines?	42	3.88	1.22
25	Utility conflicts with existing storm sewer pipelines?	43	2.86	1.26
26	Utility conflicts with existing sanitary sewer pipelines?	44	3.23	1.34
27	Utility conflicts with existing underground telecommunication lines?	44	4.27	1.25
28	Utility conflicts with existing above ground telecommunication lines?	44	4.05	1.30
29	Utility conflicts with existing underground electrical lines?	44	3.36	1.28
30	Utility conflicts with existing above ground electrical lines?	44	4.18	1.23
31	Utility conflicts with existing underground cable lines?	43	3.30	1.20
32	Utility conflicts with existing above ground cable lines?	43	3.53	1.27

Utility conflicts associated with existing underground telecommunication lines had the greatest impact on project schedule for rural projects (4.26), based on average severity rating. It should be pointed out that utility conflicts due to existing underground telecommunication lines also had the largest impact on urban projects in comparison with other types of utilities. A slight to moderate average rating was observed for existing above ground electrical lines, existing above ground telecommunication lines, existing gas pipelines, and existing water pipelines, each obtained average ratings of 4.16, 4.02, 3.93, and 3.90 respectively. Existing above ground cable lines (3.55), existing underground electrical lines (3.35), existing underground cable lines (3.31), and existing sanitary sewer lines (3.23) obtained average ratings indicating a slight impact on project schedule. Yielding an average rating of 2.86, existing storm sewer pipelines obtained the lowest average severity rating for impacting project schedule on rural projects.

4.4 Utility Practices Descriptive Statistics

This section of the analysis aims at identifying practices that states are employing throughout the utility process to avoid conflicts. This section examines coordination and communication among stakeholders, utility involvement throughout project development, and the financial aspects of the utility process. Subsurface utility engineering practices are also summarized, providing insight to different functions of the process, how the process is being implemented, and how the data is used and stored. Identifying practices that are commonly implemented in the utility process will allow for a more detailed analysis of their effectiveness.

The following subsections contain descriptive statistics to inquiries related to utility practices executed to avoid utility conflicts.

4.4.1 Coordination and Communication

Coordination and communication are both key factors in assuring utility relocation efforts on a construction project are successful. Coordination among utility companies, state transportation agencies, and contractors is necessary to schedule utility relocations and to identify obstacles that may prevent a utility relocation. Utility companies must also coordinate with other utility companies to ensure they can complete their work; this is especially valid on joint use utility poles and trenches.

Respondents were asked to rate the level of coordination utility companies generally exhibit with various project stakeholders on a scale of 1 to 7, with 1 indicating poor coordination and 7 indicating excellent coordination. Table 78 displays the average coordination rankings for each coordination question; Coordination between utility companies and state transportation agencies (5.14) is good, while coordination between utility companies and designers (3.70) is only slightly above fair. Based on average coordination ranking, coordination is better between utility companies and state transportation agencies than coordination between utility companies and designers.

Table 78: Level of Coordination

Question		N	Mean	Std. Deviation
33	What is the level of coordination between utility companies and your state transportation agency?	45	5.16	0.98
34	What is the level of coordination between utility companies and designers outside your state transportation agency?	44	3.68	1.20

Survey respondents were also queried concerning various means of communication; they were asked to identify how their state transportation agency forecasts prospective transportation projects to utility agencies in order to discuss potential utility relocation needs. When responding yes to a particular mode of communication, the respondent was also queued for information concerning the regularity in which that form of communication is used. The observed communication statistics on states forecast prospective projects to facilitate discussion of potential utility relocation needs are included in Table 79.

Table 79: Communication Methods

Question		N	Yes (%)
35	face to face meetings	45	86.7
36	e-mail	45	80.0
37	letters	44	88.6
38	phone calls	44	84.1

The observations show that all forms of communication are widely used as discussion methods for potential utility relocation needs on upcoming projects. The most popular form of communication was letters (88.6%). Face to face meetings was the second most used form (, with 86.7% of states implementing this method. States reported using phone calls and email frequently as well, 84.1% and 80.0% reported using these methods respectively.

4.4.2 Utility Involvement

Utility involvement throughout project development generally varies from project phase to project phase. The respondents were asked to identify the project phase in which different utility activities occur. The utility activities examined include: when utility companies generally get involved with the project, when utility design is typically performed, and when funds are typically allocated for design. The four project development phases include for this analysis are: planning, preliminary line and grade, right-of-way plans development, and final design. The planning phase involves: determining project purpose and needs; establishing project timing requirements; conducting environmental overview; and identifying project special problems and limitations. Preliminary line and grade involves: determining if project objectives are being met; developing environmental documents; selecting a corridor for the project with alignment and grade; and identify critical right-of-way issues. Right-of-way plans development phase consists of: preliminary quantities; bridge requirements; construction erosion control plans; right-of-way, drainage, structure, and geotech plans are finalized. Final design phase includes: reviewing bridge design and requirements; finalizing maintenance of traffic plans, signalization, signs and striping plans; finalizing construction restrictions (timing, work requirements); and review of traffic and community impact studies.

Respondents were first asked to identify the project phase in which utility companies typically get involved. Table 80 summarizes the percentage of states responding to each project phase; it should be noted that the percentages do not sum 100, because some states indicated multiple project stages for when utility companies get involved. Examining the results, right-of-way plans development phase was the most reported phase for when utility companies get involved (45%). Preliminary line and grade phase was a close second, with 43% of the states indicating utility companies generally get involved during this phase.

Table 80: When Utility Companies get Involved

Project Phase	States Responding (%)
Planning Phase	28.9
Preliminary Line and Grade Phase	42.2
Right of Way Plans Development Phase	44.4
Final Design Phase	33.3
Other	13.0

N = 45

The second utility involvement query involved determining the project stage at which utility design is typically performed. The percentage of responding states for each phase is summarized below in Table 81; the percentages do not sum to 100, because some states indicated multiple phases for which utility design is typically performed. As seen in Table 81, final design (50%) is the phase in which utility design generally occurs for a project. Right-of-way plans and development was the second most observed phase, with 38% of responding states identifying this stage.

Table 81: Utility Design

Project Phase	States Responding (%)
Planning Phase	4.4
Preliminary Line and Grade Phase	6.7
Right of Way Plans Development Phase	37.8
Final Design Phase	48.9
Other	25.0

N = 45

The final utility involvement question identified the project phase in which utility funds are generally allocated for utility design. The observations for each phase are provided below in Table 82, it should be noted that the responding percentages to not tally 100, because some states responded to more than one phase. From the results, it can be seen that right-of-way plans development is the stage in which most states allocate utility design funds (40%). Final design and planning phases were reported by approximately one fourth of the responding states, at 26% and 24% respectively.

Table 82: Utility Funds Allocated for Design

Planning Phase	25.6
Preliminary Line and Grade Phase	16.3
Right of Way Plans Development Phase	39.5
Final Design Phase	25.6
Other	0.1

N = 43

4.4.3 Utility Financing Issues

Financial aspects of utility relocation are examined in this subsection; these aspects include: financing utility design, contractors seeking reimbursement for damages, and financing the actual relocation. Table 83 summarizes the observations for issues pertaining to the first two aspects. Respondents were queried to identify if their state pays for the design of private and public utilities; they were also asked to identify a contractor's ability to seek reimbursement for indirect costs and to recognize a contractor's ability to seek damages from utility companies in their state. They were also prompted for more information concerning some of their financial practices, if they indicated a yes answer to certain financial issues.

Table 83: Financing Utility Design and Contractor Reimbursement

Question		N	Yes (%)
42	Does your state pay for utility design of private utilities?	45	86.7
43	Does your state pay for utility design of public utilities?	45	91.1
44	Does your state reimburse contractors for indirect costs associated with utility conflicts?	43	25.6
45	Does your state allow contractors to seek damages from utility companies when utility companies are the cause of construction delay?	43	41.9

As seen in Table 83, a slightly greater percentage of states pay for the design of public utilities in comparison to private utilities at rates of 91.1% and 86.7% respectively. Only 25.6% of the responding states reimburse contractors for indirect costs associated with utility conflicts. A larger percentage of responding states, 40%, allow contractors to seek damages from utility companies when utility companies are the cause of construction delay.

Methods of financing local municipality (e.g. water district, water association, sanitary sewer) utility relocations are examined in Table 84; respondents were prompted to indicate the type of program they implement to finance local municipality relocations. A majority of states, 59% indicated some type of program that finances local municipality utility relocation. The directly fund program (where the state pays for relocation without requiring repayment) was indicated by 37.0% of the responding states with a program that finances local municipality utility relocation. Low interest loan was another alternative that 19% of responding states utilized.

Table 84: Local Municipality Financial Program

Financal Program	States Responding (%)
Directly fund	37.0
Low interest loan	18.5
No interest loan	3.7
Other	40.7

The final utility financial issue examined, is when state transportation agencies reimburse relocation of private utilities. The survey observations are included in Table 85; respondents were asked in indicate all scenarios in which private utility relocations are reimbursable. The results indicate that almost all (93.3%) of responding states reimburse private utility companies when they had prior rights to construction of the roadway. A large majority, 68.9%, also indicated they reimburse private utilities when they relocate prior to construction and are required to relocate a second time during the same project.

Table 85: Reimbursable Scenarios for Private Utility Relocations

Reimbursable Scenario	States Responding (%)
Utility company had prior rights in right-of-way to the construction of roadway	93.3
Utility is relocated prior to construction and then required to relocate a second time during the project	68.9
If the state transportation agency deems it in the best interest of the state	25.6
Other	33.3

4.4.4 Subsurface Utility Engineering Frequency

The questionnaire respondents were asked to rate the frequency of subsurface utility engineering use on urban and rural projects, along with providing a frequency rating for its use by utility companies for design. The respondents were asked to rate the frequency on a scale of 1 to 7, with 1 indicating no use of subsurface utility engineering services on projects and 7 indicating constant use of the service. Table 86 summarizes the observation data by providing average frequency ratings for each subsurface utility engineering implementation question.

Table 86: Frequency of Subsurface Utility Engineering Use

Question		N	Mean	Std. Deviation
48	What is the frequency of SUE use on Urban Projects?	44	4.18	1.99
49	What is the frequency of SUE use on Rural Projects?	44	3.20	1.89
50	To the best of your knowledge, how often do utility companies in your state use SUE for design?	43	2.86	1.57

Based on average frequency, subsurface utility engineering services are used more on urban projects than rural projects. Subsurface utility engineering is used often on urban projects (4.12) according to the average frequency rating, with the service implemented rarely on rural projects (3.19). The average frequency rating also shows that utility companies are reluctant to use SUE for design, respondents supplied an average of 2.86 indicating it is employed less than rarely on projects.

4.4.5 Subsurface Utility Engineering Practices

This subsection identifies preferences associated with the subsurface utility engineering process and provides descriptive statistics for each survey question related to the process. The first issue of this subsection is shown in Table 87; it shows the percentage of responding states that have a subsurface utility engineering policy. As can be seen from Table 87, the majority of responding states have some form of SUE policy (62.2%).

Table 87: Subsurface Utility Engineering Policy

Question		N	Yes (%)
51	Has your state adopted some form of SUE policy?	45	62.2

States were also queried concerning whether they perform different Quality Level "A" SUE services in-house or contract out the services. Table 88 shows the frequency of state responses for both excavation and surveying services performed in-house and contracted out. It should be noted that some states indicated using both in-house crews and contracting out the services, therefore, the excavation and surveying percentages do not tally to 100. As seen from Table 88, excavation services are contracted out more often than performed by in-house crews at frequency rates of 96.7% and 6.7% respectively. Surveying services are also contracted out at greater regularity (86.7%), while only 28% of the respondents indicated using in-house survey crews.

Table 88: Subsurface Utility Engineering Quality Level A Services

Quality Level "A" SUE Service	States Responding (%)
Excavation in-house	6.7
Excavation contracted out	96.7
Surveying in-house	26.7
Surveying contracted out	86.7

N = 30

Providing a list of preconstruction projects utilizing subsurface utility engineering allows bidding contractors to more accurately assess the risk associated with utility relocation efforts on a project. Respondents were asked to identify if their state provides a list of preconstruction projects utilizing SUE, the results are summarized in Table 89. Only 41% of responsive states supply a list of preconstruction projects utilizing SUE, while 59% of responding states indicated they do not provide such a list.

Table 89: List of Preconstruction Projects utilizing SUE

Question		N	Yes (%)
53	Does your state provide a list of preconstruction projects utilizing SUE?	30	43.3

Respondents were asked to identify what quality level of subsurface utility engineering information is generally required before a project can be let for construction. It should be noted that some states indicated multiple quality level requirements; therefore, the sum of states responding does not yield 100 percent. As seen in Table 90, the largest percentages of states (50%) indicate no requirement for SUE information before a project can be let. However, 32.1% of the states indicate they require Quality Level B information before a project can let and 17.9% indicate a requirement for Quality Level C information.

Table 90: SUE Quality Level Information for Project Letting

Quality Level Information	States Responding (%)
Quality Level A	10.7
Quality Level B	32.1
Quality Level C	17.9
Quality Level D	3.6
No requirement	50.00

N = 28

Locations where Quality Level A information is required may be identified as a result of utility company input, to confirm a conflict between existing and proposed utilities, or other methods. Table 91 summarizes how state transportation agencies identify locations where Quality Level A information is needed for a project. Make note that respondents were asked to check all that apply, so the percentages will not sum 100 percent. As seen from the results, 69.0% of responding states identify locations where Quality Level A information is needed to confirm utility conflicts between existing and proposed utilities. Utility company input is used by 48.3% of the responding states to identify locations for information, while 51.9% of the states identified other means of identifying locations.

Table 91: Identifying Locations for Quality Level A Information

Locations for QL A Information	States Responding (%)
Utility company input	48.3
To confirm conflict between existing and proposed utilities	69.0
Other	51.9

N = 29

Excavation for Quality Level A work can be done via means of hydro or vacuum excavation. Respondents were asked to identify the excavation method they preferred when excavation is required to obtain Quality Level A work. The observations are summarized in Table 92, which shows the excavation method and corresponding percentage of states preferring that method. Vacuum excavation was overwhelming preferred to hydro excavation, with 79.3% of states indicating preference for vacuum excavation while 0% preferred hydro excavation; no preference was supplied by 20.7% of responsive states.

Table 92: SUE Excavation Preference

Excavation Method	States Responding (%)
Hydro excavation	0.0
Vacuum excavation	79.3
No preference	20.7

N = 29

Surveyed respondents were also queried concerning the type of quality assurance they use to assure the subsurface information they acquire is accurate. Table 93 shows the percentage of states responding to each type of quality assurance standard. The results show that 72.4% of respondents indicate the SUE data must adhere to ASCE standards, while 20.7% of reporting states have their own quality specifications for the SUE data.

Table 93: SUE Quality Assurance

Quality Assurance	States Responding (%)
SUE data must adhere to ASCE standards	72.4
SUE data must meet state quality specifications	20.7
Other	6.9

N = 29

Subsurface information is obtained on a project to identify utility conflicts or to aid designers in their efforts. After a project is complete, the subsurface information should be retained for use on future projects that may involve the same utility facilities. Respondents were asked if their state archives SUE information in a central location for future use on other projects; their responses are summarized in Table 94. Overwhelmingly, 68% of responding states do not store SUE information in a central location for future use on other projects. Not storing the information may require the data to be obtained again, resulting in more money and time expended to obtain the data.

Table 94: Archiving SUE Information

Question		N	Yes (%)
58	Does your state archive SUE information in a central location for future use on other projects?	29	34.5

4.4.6 Utility Location Descriptive Statistics

One call centers provide contractors and designers a single point of contact when inquiring about utility facilities located on or near a project. Most states have laws requiring contractors to contact one call centers prior to excavating; the one call center then notifies the proper entities responsible for marking various utilities in the proximity of the proposed excavation. When existing utility facilities are not marked within reasonable limits, utility conflicts can easily emerge. These conflicts often have negative consequences, often resulting in injury, increased project delays, and increased costs. This section examines the accuracy of location data provided by one call agencies, inspects the liability and quality of information provided by the centers, and surveys utility company involvement in actually performing utility locates.

4.4.7 Location Accuracy Assessment

Respondents were asked to rate the accuracy of location data provided for various types of utilities by the one call agency in their state on a scale of 1 to 7, with 1 indicating poor accuracy of location data and 7 representing excellent data. The observation results are recapped in Table 95. Based on average accuracy rating, location data provided by one call centers for gas has the greatest accuracy; obtaining a rating of 4.18. Underground electrical (4.13), underground telecommunications (4.03), and water (3.97) obtained average ratings representing fair to good location accuracy. Average ratings of 3.89 and 3.81 were obtained for underground cable and sanitary sewer. The lowest average rating for location data provided by one call centers was for storm sewer, obtaining a 3.50 rating signifying fair accuracy.

Table 95: One Call Center Location Accuracy for Various Utilities

Question		N	Mean	Std. Deviation
59	Gas	39	4.21	1.13
60	Water	39	4.03	1.14
61	Storm sewer	33	3.58	1.32
62	Sanitary sewer	37	3.86	1.08
63	Underground telecommunications	39	4.05	1.12
64	Underground electrical	39	4.15	1.06
65	Underground cable	39	3.92	1.16

While contractors are generally required by law to contact one call centers before they perform excavation activities, what type of assurance do they have that the utility markings of the one call centers within required range. Without repercussions for one call centers' markings outside the allowable range, contractors are forced to accept the liability of assuring existing facilities are not damaged. To examine the number of states holding one call centers liable for their markings, respondents were asked to indicate if their centers are held liable for their utility markings. As seen in Table 96, only 17.5% of responding states hold one call centers liable for the accuracy of utility markings.

Table 96: One Call Center Liability

Question		N	Yes (%)
66	Is the one call center in your state held liable for the accuracy of utility markings?	40	17.5

Respondents were also asked to identify if their state transportation agency accepts utility markings of one call centers to be accurate enough for SUE Quality Level B information. Table

97 contains a summary of the states responding to this question, providing percentages of states responding yes, no, and not applicable. As the results show, 51.2% of states indicated that they do not accept one call center markings to be accurate enough for SUE Quality Level B information. Only 17.1% of responding states indicated they do accept one call markings to be accurate enough for SUE Quality Level information.

Table 97: Acceptance of One Call Center Markings for SUE Quality Level B Information

Question		N	Yes (%)	No (%)	N/A (%)
67	Does your state transportation agency accept utility markings by a one call center to be accurate enough for SUE quality level "B" marking?	41	17.1	51.2	32.5

4.4.8 Utility Involvement in Performing Utility Locates

Respondents were also queried to examine the level of utility involvement in performing utility location requests received by one call centers, they were also asked to provide data on locates performed by one call centers. States were asked to provide a percentage of locates performed by each entity for various types of utilities, the results are provided in Table 98. The descriptive statistics under the utility company column represents the percentage of locates performed by utility companies for each utility, while the one call center column contains the percentage of locates performed by one call centers for different types of utilities.

Table 98: Percentage of Locates Performed by Entities for Different Utility Types

	Entity Performing Utility Location					
	Utility Company			One Call Center		
Utility Type	N	Mean (%)	Std. Deviation	N	Mean (%)	Std. Deviation
Gas	25	79.3	33.82	18	12.6	26.42
Water	25	77.2	35.30	18	16.1	31.46
Storm sewer	21	62.4	45.49	17	12.4	33.08
Sanitary sewer	25	72.8	38.35	18	21.7	36.82
Underground telecommunications	25	58.0	44.30	18	26.9	42.15
Underground electrical	25	65.6	41.74	18	22.8	38.97
Underground cable	25	62.6	47.72	18	27.2	42.64

Based on average percentage, gas utilities (79.3%) recorded the highest percentage for utility locates performed by utility companies. Water and sanitary sewer also obtained high marks in this category, with 77.2% and 72.8% respectively. The lowest average for utility type located by utility company was for storm sewer and underground telecommunications. It should be noted that comparing average percentages of locates performed by utility companies with average percentages of locates performed by one call centers, indicate that utility companies on average perform more locates that one call centers for all types of utilities.

Reviewing the average percentage of utility locates performed by one call centers, indicate that underground cable lines (27.2%) and underground telecommunication lines (26.9%) are located more often by one call centers than any other type of utility. Gas and storm sewer recorded the lowest averages for locates by one call centers at 12.5% and 12.4% respectively.

4.4.9 Right-of-Way Descriptive Statistics

Right-of-way activities have major influence on the ability of utility relocation activities to commence, therefore, projects that experience delays from right-of-way may also experience utility delays. This subsection examines practices that can alleviate some utility setbacks generally experienced when right-of-way acquisition is prolonged. How states prioritize parcel acquisition, the information they supply property owners, and how right-of-way issues impact utility relocation are each investigated below.

Survey respondents were first queried to identify if their state transportation agency prioritizes parcels for right-of-way acquisition based on their need for utility relocation. The respondents' observations are included in Table 99. Only 43.2% of responding states indicated they prioritize parcel acquisition based on their need for utility relocation, while the majority (56%) of responding states stated they do not prioritize based on need for relocation efforts.

Table 99: Prioritize Parcel Acquisition for Utility Relocation

Question		N	Yes (%)
70	Does your state transportation agency prioritize parcels for ROW acquisition based on their need for utility relocation?	44	43.20

Right-of-way is often acquired from property owners only to see utility companies require additional easements beyond the initial right-of-way to relocate their utilities. States were asked to identify if they inform property owners of additional property that may be acquired beyond right-of-way for utility easements when acquiring right-of-way for road construction. As seen in Table 100, only 29.3% of states indicated they do inform property owners of additional land that may be acquired.

Table 100: Inform Property Owners of Addition Property for Utility Easements

Question		N	Yes (%)
72	Do you inform property owners of additional property that may be acquired beyond right-of-way for utility easements when acquiring right-of-way for road construction?	41	29.3

States were also asked to identify if they have acquired additional property beyond that required for road construction limits to provide additional room for utility relocation. The survey results are summarized in Table 101, a percentage is listed for states answering yes to the inquiry. As the results show, 61.4% of responding states indicated they have bought additional property for utility relocation.

Table 101: Acquiring Additional Property for Utility Relocation

Question		N	Yes (%)
73	Has your state acquired additional property beyond that required for road construction limits to provide additional room for utility relocation?	44	61.4

As mentioned previously, right-of-way has the ability to impact utility relocation efforts on construction projects. Respondents were asked to identify the percentage of projects in which utility relocations were impacted as a result of different right-of-way issues. As seen in Table 102, state responses indicate that 37.8% of projects have utility relocations impacted by acquisitions taking longer than expected. Respondents also indicate slightly less utility relocations impacted by not enough right-of-way being procured for utility relocation (22.5%) and break downs in negotiations between private land owners and state transportation agencies (19.8%).

Table 102: Percentage of Projects that Right-of-Way Issues Impact Utility Relocation

Right-of-Way Impact	N	Mean (%)	Std. Deviation
Not enough right-of-way procured for utility relocation	34	22.5	25.42
Break down between negotiations of private land owners	33	19.8	3.92
ROW acquisitions take longer than expected	33	37.8	27.25

The final right-of-way topic examined was the use of utility corridors to support existing and future utilities. States were queried to determine the percentage of states using utility corridors, the results are shown in Table 103. Examining the results, 69.8% of responding states indicated they do not use utility corridors to support existing and future utilities.

Table 103: Utility Corridors

Question		N	Yes (%)
75	Does your state transportation agency use utility corridors to support existing and future utilities?	43	30.2

4.5 Comparing Urban and Rural Utility Conflict Frequency

The average frequencies for utility conflicts on urban and rural projects related to various types of existing utilities have already been discussed. A comparison between the frequency of utility conflicts on urban and rural projects was completed for each different type of existing utility. The comparison results are presented in Table 104, which provides the average frequencies for utility conflicts on urban and rural projects of each type of utility along with the level of significance difference between the project types. As mentioned previously in the method of analysis section, all significance values are based on a 95% confidence interval unless otherwise noted. Examining the table, a significance value less than 0.05 indicates there is a significant difference in the frequency of utility conflicts on urban and rural projects, while a significance value less than 0.01 indicates a very significant difference between utility conflicts on urban and rural projects.

Reviewing the results from Table 104, there is a very significant difference between all types of utility conflicts on urban and rural projects except for existing above ground telecommunication lines, which indicates only a significant difference. The average frequency for utility conflicts associated with existing gas pipelines on urban projects was 4.81 in comparison to only 3.72 for rural projects; the significance value for this comparison indicates a very significant difference between the two types of projects. Mean frequencies for existing water utility conflicts were 5.14 and 3.77 on urban and rural projects respectively; this comparison indicates a very significant difference. Existing storm sewer pipelines obtained an average frequency rating of 4.55 for urban projects and 2.88 for rural projects; a very significant difference was observed between urban and rural projects for this conflict. Utility conflicts with existing sanitary sewer pipelines on urban were found to have very significant difference in comparison to similar conflicts on rural project, the average conflict frequencies for urban (4.53) was greater than rural (2.93) projects. Conflicts with existing underground telecommunication lines on urban projects were also identified as very significant in comparison to rural projects. Urban projects had an average rating of 5.28, while rural projects only recorded an average of 4.21. The mean frequency rating for utility conflicts as a result of existing above ground telecommunication lines was 4.81 on urban projects in comparison to 4.44 on rural projects. The data indicates only a significant difference between urban and rural projects for this conflict, while the other types of utility conflicts were determined to have very significant difference between the two types of projects. The average frequency of utility conflicts associated with existing underground electrical lines was observed as 4.09 for urban projects and 3.26 for rural projects, with a very significant difference identified between the two types of projects.

Table 104: Urban and Rural Utility Conflict Frequency Comparison

Utility Conflict	Urban			Rural			df	t - value	Sig.
	N	Mean		N	Mean				
Utility conflicts with existing gas pipelines	44	4.84		44	3.75		43	7.35	0.000
Utility conflict with existing water pipelines	44	5.14		44	3.77		43	8.55	0.000
Utility conflicts with existing storm sewer pipelines	43	4.54		43	2.88		42	7.44	0.000
Utility conflicts with existing sanitary sewer pipelines	44	4.55		44	2.93		43	8.74	0.000
Utility conflicts with existing underground telecommunication lines	44	5.27		44	4.22		43	7.39	0.000
Utility conflicts with existing above ground telecommunication lines	44	4.82		44	4.45		43	2.44	0.019
Utility conflicts with existing underground electrical lines	44	4.09		44	3.25		43	4.65	0.000
Utility conflicts with existing above ground electrical lines	44	5.14		44	4.70		43	3.39	0.002
Utility conflicts with existing underground cable lines	43	4.42		43	3.40		42	6.48	0.000
Utility conflicts with existing above ground cable lines	43	4.72		43	4.00		42	3.77	0.001

Furthermore, existing above ground electrical lines was determined to have a very significant difference between utility conflicts on urban and rural projects, with average frequency values of 5.12 and 4.70 respectively. Moreover, mean frequency ratings were obtained for urban (4.45) and rural (3.43) utility conflicts linked to existing underground cable lines to indicate a very significant difference between the two types of projects. Finally, utility conflicts related to existing above ground cable lines were also determined to have a very significant difference between urban and rural projects; the average frequency ratings were 4.69 for urban and 4.12 for rural.

As Table 104 indicates, urban projects experience a significant difference in utility conflict frequency for all types of utilities in relation to rural projects. This could be a result of limited right-of-way space on urban projects in comparison to rural projects. As a result of limited space, utilities are often required to locate very close to one another, sometimes even in the same trench. Placing utilities in tight spaces increases the likelihood of impacting other types of utilities throughout the relocation process. When utilities occupy individual trenches as typical in rural areas, utility companies are less likely to influence the relocation efforts of other utilities, and conflicts are less likely to occur.

4.6 Comparing Urban and Rural Utility Conflict Severity

Comparing the differences in utility conflict frequency on urban and rural projects provides information on the difference in regularity of conflicts associated with various utilities, but it is also important to understand the different impacts conflicts have on urban and rural projects. To facilitate this comparison, average severity ratings for urban and rural conflicts were compared for various types of utilities. Table 105 summarizes the comparison results, providing the mean severity ratings for each type of utility on urban and rural projects. The significant value for each conflict is also presented in the table; this value represents the significant a difference between utility conflict impact on urban and rural projects.

From the results, each type of utility has a very significant difference between urban and rural projects for conflict impact except for existing above ground telecommunication lines and existing above ground electrical lines, these two utilities have no significant difference between urban and rural projects. Existing above ground telecommunication lines have an average impact rating of 4.23 on urban projects and 4.02 on rural projects; furthermore, there is no significant difference between utility conflict impacts on urban and rural projects. Likewise, existing above ground electrical lines was also determined to have no significant difference between conflict impact on urban and rural projects. The average severity rating observed for urban projects was 4.35, while rural projects obtained a rating of 4.16. A similar significance evaluation for above ground telecommunication lines and above ground electrical lines could be a result of their facility similarities. Often these facilities are located on the same pole; therefore, one could expect the impact significance on urban and rural projects to be similar for the two types of utilities.

Table 105: Urban and Rural Utility Conflict Severity Comparison

Utility Conflict	Urban			Rural			df	t - value	Sig.
	N	Mean		N	Mean				
Utility conflicts with existing gas pipelines	44	4.61		42	3.95		41	4.09	0.000
Utility conflict with existing water pipelines	44	4.55		42	3.88		41	4.02	0.000
Utility conflicts with existing storm sewer pipelines	42	4.00		3	2.86		41	5.27	0.000
Utility conflicts with existing sanitary sewer pipelines	44	4.23		44	3.23		43	5.20	0.000
Utility conflicts with existing underground telecommunication lines	44	5.00		44	4.27		43	5.22	0.000
Utility conflicts with existing above ground telecommunication lines	44	4.25		44	4.05		43	1.39	0.173
Utility conflicts with existing underground electrical lines	44	4.02		44	3.36		43	4.43	0.000
Utility conflicts with existing above ground electrical lines	44	4.39		44	4.18		43	1.42	0.162
Utility conflicts with existing underground cable lines	43	3.95		43	3.30		42	4.63	0.000
Utility conflicts with existing above ground cable lines	43	4.00		43	3.53		42	3.57	0.001

While above ground telecommunication and electrical lines did not differ significantly from urban to rural projects, their underground facilities indicated a very significant difference between projects. Existing underground telecommunication lines registered average frequency ratings of 4.98 for urban projects and 4.26 for rural projects, which indicated a very significant difference between project types. Likewise, underground electric lines also indicated a very significant difference between project types, recording average frequencies of 3.98 and 3.35 for urban and rural projects.

Furthermore, the remaining types of utilities experienced a very significant difference in impact from urban to rural projects. Mean severity ratings of 4.60 for urban and 3.93 for rural indicated a very significant difference in impact between the two project categories for conflicts related to existing gas pipelines. Similarly, conflicts associated with existing water pipelines also reported a very significant difference between urban and rural projects, tallying average impact ratings of 4.53 and 3.90 respectively. Additionally, existing storm sewer pipeline conflicts obtained average ratings of 4.00 on urban projects and 2.86 on rural projects, indicating a very significant difference between project categories. A very significant difference was also yielded for existing sanitary sewer pipelines between urban and rural projects, with average ratings of 4.23 and 3.23 respectively. Moreover, utility conflicts related to existing underground cable lines also indicated a very significant difference between urban and rural projects, with average impact ratings of 3.95 on urban projects and 3.31 on rural projects. Conflicts with existing above ground cable lines returned an average severity rating of 3.98 on urban projects and 3.55 on rural projects; this indicates a very significant difference between urban and rural projects for this type of utility conflict.

4.7 Best Practices to Avoid Utility Conflicts

4.7.1 Identify the Severity-Impact Rate and Frequency Rate of Utility Conflicts for Each State

In the survey, utility directors from different transportation agencies were asked to provide a frequency and severity-impact rate ranging from 1 to 7 to the following question: “Overall, what is the frequency and severity of utility conflicts within your state transportation agency projects?” A rating of 1 indicates utility conflicts never occur on projects, while a rating of 7 signifies constant occurrence of utility conflicts. The descriptive statistics for the responses are provided in Figure 18.

Figure 18 shows that Florida has the lowest product of severity-impact rate and frequency rate while Kentucky is ranked 15 among the 45 states that have replied to the survey.

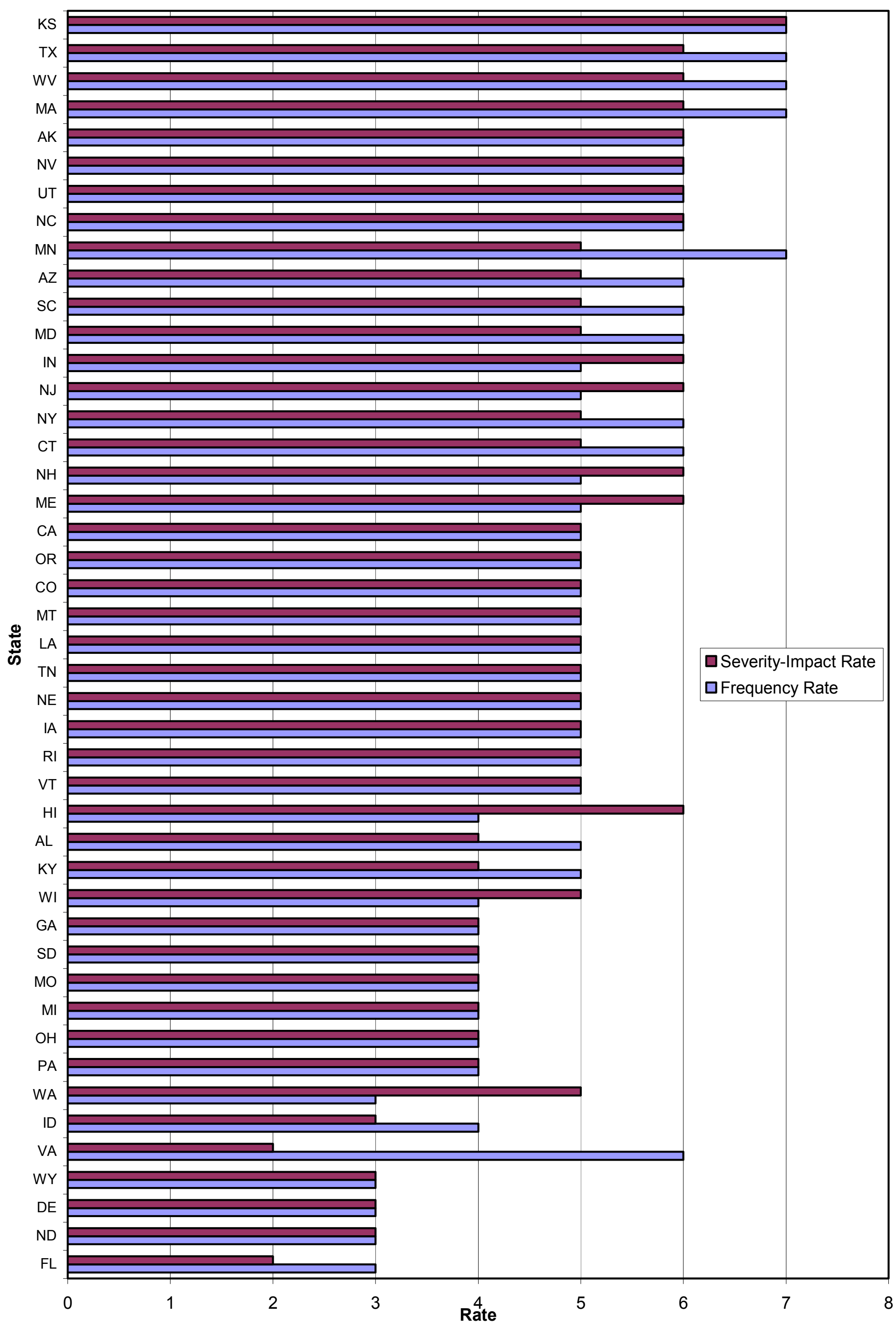


Figure 18: Severity-impact rate and frequency rate for responding states.

Table 106 indicates an average frequency rate of conflicts of 5.02 for all 45 states depicted in Figure 18. The lowest rate among the 45 states is that of Florida (FL; frequency rate = 3) while Kentucky's frequency rate is equal to 5.

Table 106: Mean of frequency rate of all states

	Frequency Rate
Mean	5.02
Std. Deviation	1.16
N	45

Figure 19 shows a normal frequency distribution of the frequency rate with an average of 5.02 and a standard deviation of 1.16.

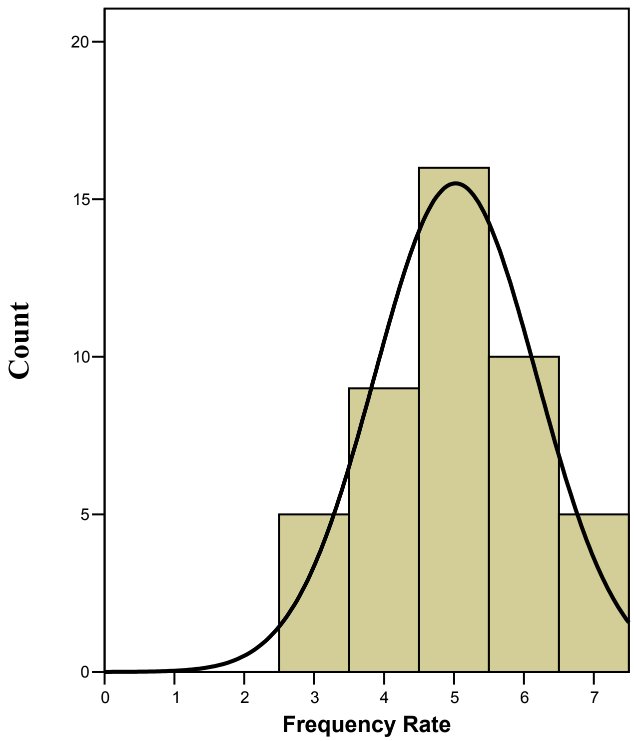


Figure 19: Frequency distribution of the frequency rate of all states

Table 107 indicates the mean and standard deviation of the severity-impact rate. Florida exhibits the lowest rate (=2). Kentucky's rate is equal to 4 which is lower than the mean of the 45 states (mean=4.82).

Table 107: Mean of severity-impact rate of all states.

	Severity-Impact Rate
Mean	4.82
Std. Deviation	1.13
N	45

Figure 20 reveals a modest skewing to the right of severity-impact rating distribution. It is noticeable that the average of the severity-impact rate is higher than the frequency rate. Thus, the report will focus more on identifying practices that can reduce the severity of conflicts between utility and transportation agencies.

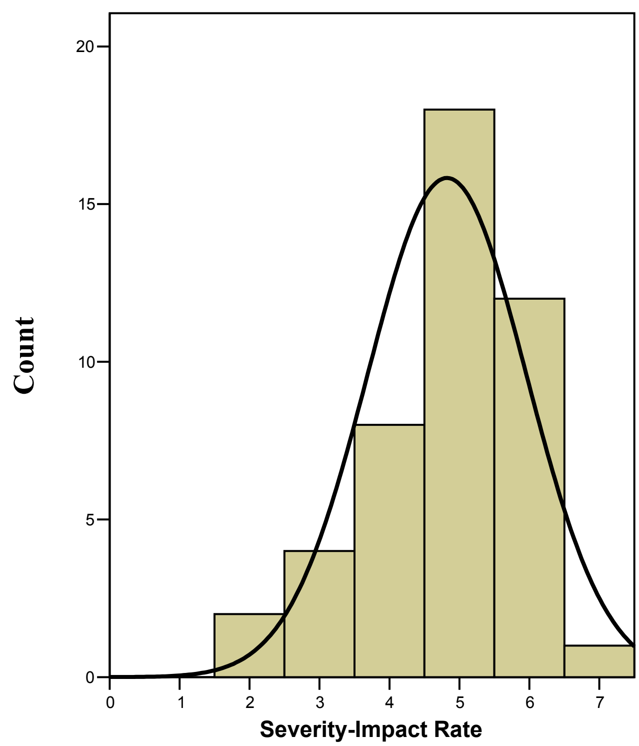


Figure 20: Frequency distribution of the severity-impact rate of all states

4.7.2 Identify the Practices that Have the Greatest Impact on the Severity and Frequency of Conflicts

4.7.2.1 Improve the Utility Relocation Communication

Advance notice allows utility companies to allocate financial and human resources to relocation efforts and reduces the likelihood of relocation delays due to scheduling conflicts and financial constraints. In the survey sent out to transportation agencies, their representatives were asked to mention **how often** agencies forecast prospective transportation projects to utility agencies in advance through:

- Face to face meeting
- E-mail
- Letters
- Phone calls

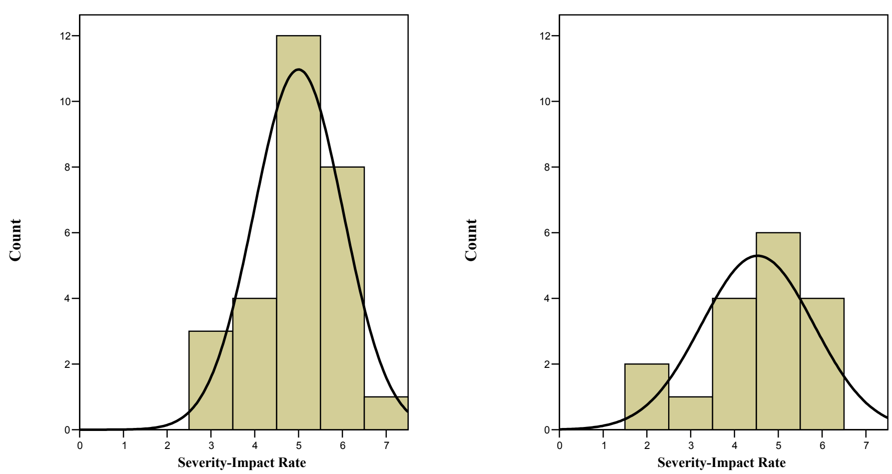
4.7.2.1.1 Face to Face Meeting

From the surveys, an analysis of variance (ANOVA) was made to find out the relationship between the severity of the conflict and the regularity of the face to face meeting.

The Null hypothesis was:

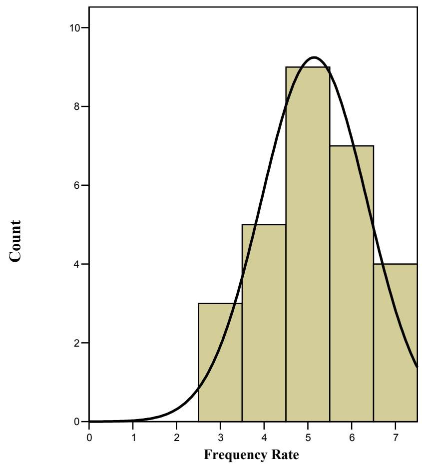
The average severity-impact rate (frequency rate) of the states whose representative meet less often than monthly or after the design phase = the average severity-impact rate (frequency rate) of the states whose representatives meet at least monthly or from the start of the design phase.

The alternate hypothesis was that the two averages were different

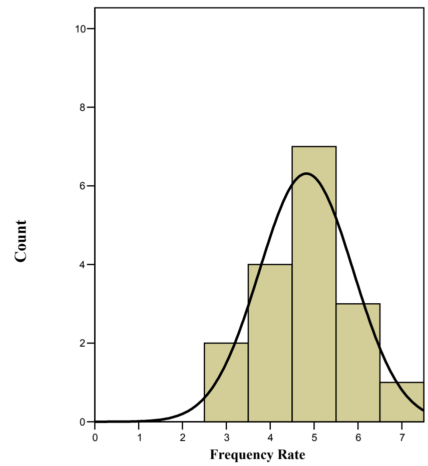


Less often than monthly or after end of phase

At least monthly or from start of design phase



Less often than monthly or after end of phase



At least monthly or from start of design phase

Figure 21: Frequency distribution of the severity-impact rate and frequency rate of the two groups segregated according to the time frame of their representatives face to face meetings.

Figure 21 shows that states whose representative meet frequently have a severity-impact rate and frequency rate lower than states whose representatives meet less often than monthly.

Table 108: Mean, size, standard deviation and p-value of the severity-impact rate and frequency rate of the 2 groups of states that have different time frames of face to face meeting

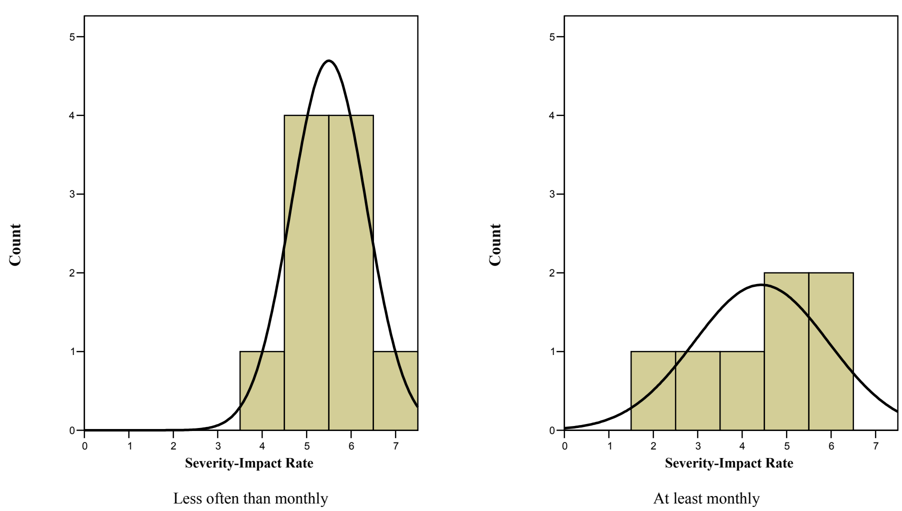
	Severity-Impact Rate				Frequency Rate			
Face to face meeting	**Mean**	**N**	**Std. Deviation**	**P-value**	**Mean**	**N**	**Std. Deviation**	**P-value**
Less often than monthly or after the end of design phase	5	28	1.02	**0.18**	5.14	28	1.2	**0.37**
At least monthly or form start of the design phase	4.52	17	1.28		4.82	17	1.07	

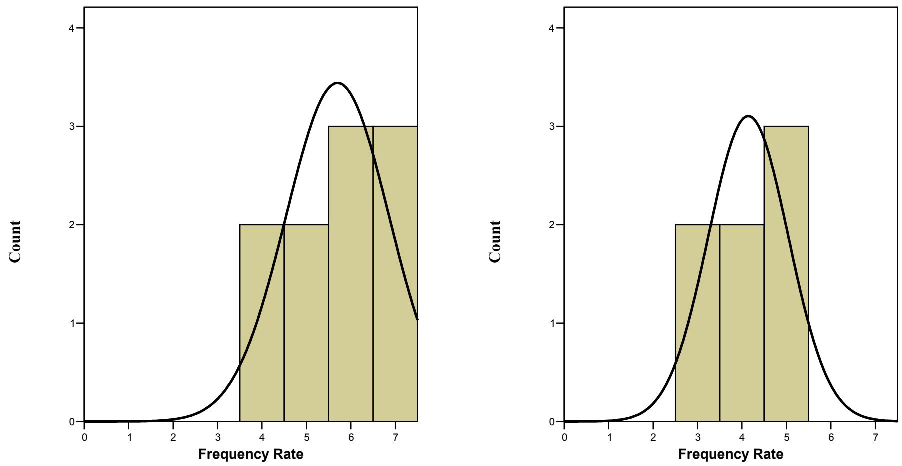
Table 108 indicates the different means, number of respondents, standard deviations and p-value of the 2 groups. The mean of the severity-impact mean of states whose representatives meet frequently is lower by 9.6 % from the mean of states whose representatives meet at least monthly. The mean of the frequency rate of the first group was higher only by 6.2%. Table 108 also indicates a p-value of 0.18 for the severity-impact rate between the two groups and a p-value of 0.37 for the frequency rate between the same two groups. As already mentioned in 4.1.2, and because the p-value of the frequency rate is equal to 0.37 (> 0.20), it can be concluded that there is not enough data to demonstrate that regular face to face meetings will decrease the frequency rate of the utility conflicts.

Finally, because p-value for the severity-impact rate is less than 0.18, we can reject the null hypothesis and conclude that the average severity-impact rate of states whose representatives have at least monthly meetings or from the start of the design phase is lower compared to that of the states whose representatives meet less often than monthly starting at the end of the design phase.

4.7.2.1.2 Official Letters

Another good way to forecast a future project is through sending official letters to utility companies. An ANOVA analysis was performed to compare the severity-impact rate and frequency rate of the states that send official letters at least once a month and the states that send official letters less often than monthly. Figure 22 indicates that official monthly letters (or letters sent at least once a month) are efficient in decreasing the severity-impact rate. Figure 22 also shows that the states that send official letters to utility companies at least monthly have a better frequency rate than the states that send official letters less often than monthly.





Less often than monthly　　　At least monthly

Figure 22: Frequency distribution of the severity-impact rate and frequency rate between states that send at least monthly mail and states that send official mail less often than monthly.

Table 109 indicates the mean of the severity-impact rate of the states whose representatives send at least monthly mail to utility companies is lower by 19.6% from the mean of the states whose representatives send official letters less often than monthly. Table 109 also indicates that the mean of frequency rate of the states that send official letters at least monthly is lower by 27.3% from the mean of the states that send official letters more often than monthly.

Table 109: : Mean, size, standard deviation and p-value of the severity-impact rate and frequency rate of the 2 groups of states that have different time frames of official mail.

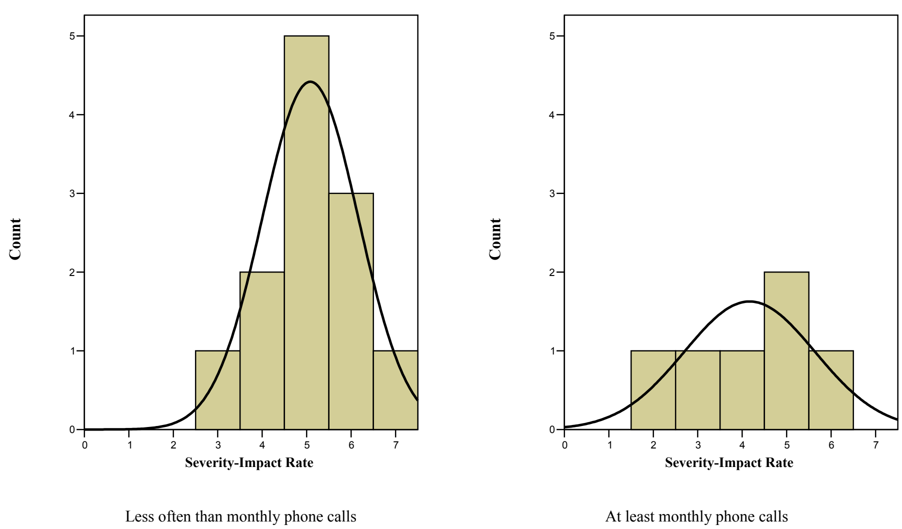
	Severity-Impact Rate				Frequency Rate			
Forecasting future projects to utility through letters	**Mean**	**N**	**Std. Deviation**	**P-value**	**Mean**	**N**	**Std. Deviation**	**P-value**
Sending letters less often than monthly	5.5	10	0.85	**0.081**	5.7	10	1.16	**0.1**
Sending letters at least monthly.	4.42	7	1.51		4.14	7	0.9	

The p-value of the severity-impact rate and frequency rate are respectively 0.081 and 0.1, leading us to the conclusion that the average severity-impact rate and frequency rate of states whose representative from the cabinet send official mail at least monthly to utility companies are lower than the states that do not.

4.7.2.1.3 Phone Calls

Regular phone calls improve communication and coordination between transport agencies and utilities, and thus can reduce the severity of utility conflicts. Improving the utility relocation coordination and communication can be easily achieved if the engineers of the transportation agencies and utilities can call each other as much as it is needed to plan and coordinate the relocation process. An ANOVA was performed between the state engineers that had at least one phone call per month with the utility engineers in a month and the engineers that had one phone call less often than monthly.

Figure 23 shows that the severity-impact rate and frequency rate of the group of states whose representatives had at least one phone call per month are lower compared to the group of states whose representatives did not.



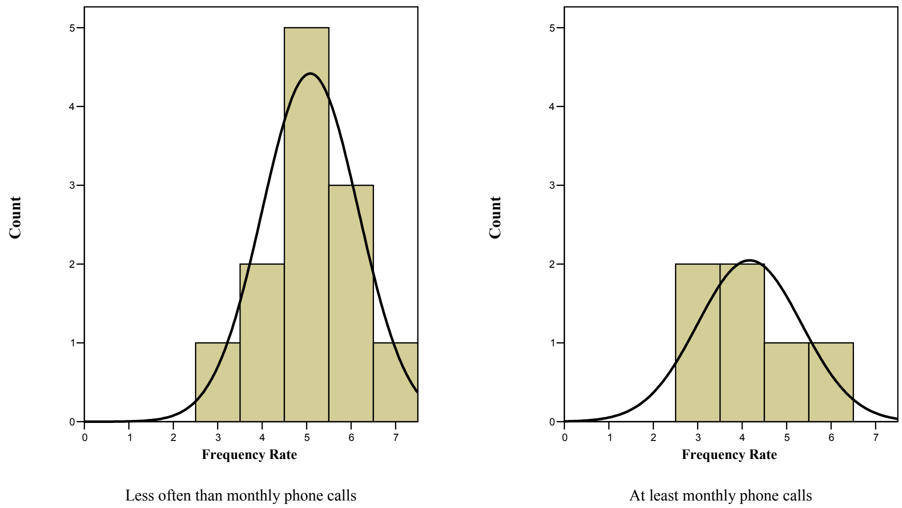


Figure 23: Frequency distribution of the severity-impact rate and frequency rate between states whose representatives had at least one phone call per month with utility companies and the states whose representatives did not have.

Table 110 indicates the mean of the severity-impact rate and frequency rate of the states whose representatives call at least monthly to utility companies are lower by 18.1% from the mean of the states whose representatives call less often than monthly.

Table 110: : Mean, size, standard deviation and p-value of the severity-impact rate and frequency rate of the 2 groups of states that have different time frames of phone calls.

	Severity-Impact Rate				**Frequency Rate**			
Forecasting future projects to utility through phone calls	**Mean**	**N**	**Std. Deviation**	**P-value**	**Mean**	**N**	**Std. Deviation**	**P-value**
Less often than monthly phone calls	5.08	12	1.08	**0.15**	5.08	12	1.08	**0.118**
At least monthly phone calls	4.16	6	1.47		4.16	6	1.16	

Since the p-value of the severity-impact rate and frequency rate are lower than 0.15, it can be concluded that their averages are reduced when the communication by phone calls occurs at least monthly.

4.7.2.2 Improve Coordination among Public Agencies and Utilities throughout the Design Phase

As the project design is developed, utility companies are contacted for input. When preliminary design information is available, plans are submitted for their review. As the preliminary design becomes a final product, utility companies are invited to attend field checks at the project site and other coordination meetings to discuss potential conflicts and relocation issues. These opportunities for coordination are critical and should be fully utilized for a highway project to be successful.

However, not all utility companies respond to correspondence related to the utility coordination process or attend on-site field checks or coordination meetings. These opportunities to communicate are vital for the design and utility coordination and accommodation process.

When the impact on utility facilities is not considered early in the design process, delays likely occur later, either at the end of the design phase or after the beginning of the construction phase. This may result in setbacks waiting for the redesign of the highway work to avoid relocation of utility facilities or holdups during construction while waiting for utility companies to finish their relocation work. The costs of relocating utility facilities increase significantly when not considered during the early design process. In fact, these costs are extensive when discovered after construction begins. The utility company must have time to prepare construction drawings, obtain the required materials for relocation and mobilize its crews for traffic control and construction.

In the survey, respondents were to mention when and in which stage their utilities get involved in the project:

- Planning: Determining project purpose and needs, establishing project timing requirements, conducting environmental overview, and identifying project specific problems and limitations.
- Preliminary line and grade: Determining if projects objectives are being met, developing environmental documents, selecting a corridor for the project with alignment and grade and identifying critical right of ways issues.
- Right of way plans development: Preliminary quantities, bridge requirements, construction erosion control plans, right of way, drainage, structure and geotechnical plans are finalized.
- Final design phase: Reviewing bridge design and requirements, finalizing maintenance of traffic plans, signalization, signed and striping plans, finalizing construction restrictions and review of traffic and community impact studies.

Involvements will be classified as “early” when they occur during the planning or the preliminary line and grade phase. In contrast, involvements are considered “late” when they occur during the right of way plans development or final design phase.

To demonstrate that the early involvement of the utility in a project has a tremendous effect on the severity of utility conflict an ANOVA analysis was performed between the states whose utility companies get involved during right of way plans development or final design phase and the states whose utility agencies get involved during planning phase or preliminary design phase.

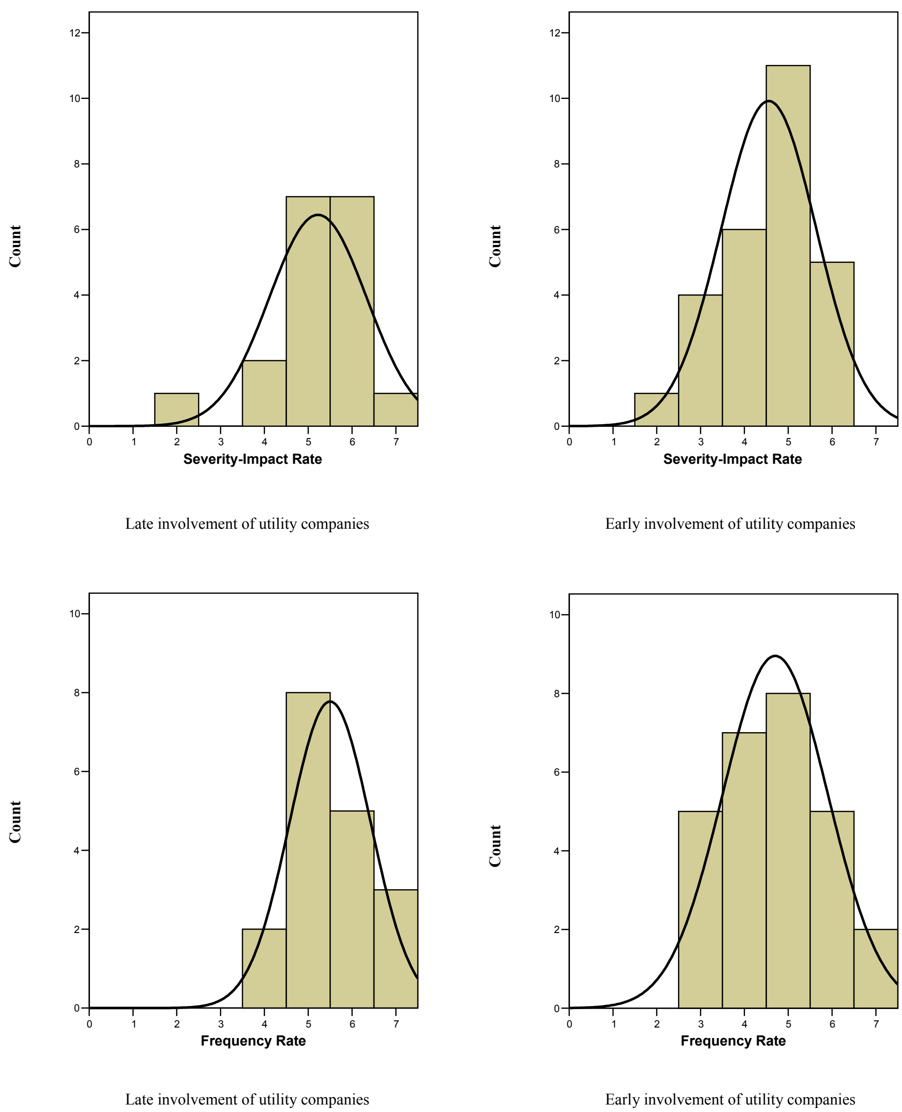


Figure 24: Frequency distribution of the severity-impact rate and frequency rate between states whose utility companies get involved in early stages and those whose utility companies get involved in later stages

Figure 24 shows that the severity-impact rate and frequency Rate of states whose utility companies are involved early on are lower than the states that delay the involvement of their utility companies.

Table 111 indicates that the mean of the severity-impact rate and frequency rate are reduced respectively by 12.7% and 14.5% if the states' representatives improve coordination among public agencies and utilities throughout the design phase.

Table 111: Mean, size, standard deviation and p-value of the severity-impact rate and frequency rate of the 2 groups of states with different time frames of involving utility companies.

	Severity-Impact Rate				Frequency Rate			
Improve Coordination	**Mean**	**N**	**Std. Deviation**	**P-value**	**Mean**	**N**	**Std. Deviation**	**P-value**
Involvement of utility during right of way plans development phase or final design or later	5.22	18	1.11	**0.05**	5.5	18	0.92	**0.02**
Involvement of utility during planning phase and preliminary line and grade phase	4.55	27	1.09		4.7	27	1.2	

Since table 111 indicates a p-value ≤ 0.05 for the severity-impact rate and frequency rate between the 2 groups , it can be concluded that the averages of severity-impact rate and frequency rate of the states whose representatives involve their utility companies during planning or the preliminary line and grade phase are lower compared to that of the states whose representatives do involve their utility company during right of way plans development or final design phase or later. The difference between groups was highly significant as expressed by a p-value <0.05, emphasizing the importance of the early involvement of utility companies.

4.7.2.3 Improve the process of obtaining information on the location of underground utility facility

Accurately locating underground utility facilities during the initial design stage of a highway improvement project is vital for coordinating the needs of the highway project with the needs of the underground utility operators. The lack of reliable information on the location of utility facilities during the design phase of a public works project may result in the needless relocation of those facilities. Identifying the location of all utility facilities during the early design stages allows the design of highway improvements around those facilities.

We sought to demonstrate that improving the process of obtaining information on the location of underground utility facility can reduce the severity-impact rate of utility conflicts. For this purpose, an ANOVA analysis was performed to compare the severity-impact rate between the states that had a good to excellent accuracy of the horizontal location and the states that had a poor to fair accuracy of the horizontal location.

Table 112 indicates that the mean of the severity-impact rate of the state that had a poor to fair accuracy of horizontal location will be higher than the mean of the sates that had a good to excellent accuracy of horizontal location by 11.6%. Table 112 also shows that improving the process of obtaining information on the location of underground utility facility will only affect the severity of the conflict, not the frequency. Finally, it can be depicted from table 112 that the mean of severity-impact rate for the sates that had a good to excellent accuracy of vertical location is lower than the states that had a good to excellent accuracy of horizontal location.

Table 112 Mean, size, standard deviation and p-value of the severity-impact rate and frequency rate of the groups of states that had different levels of accuracy of horizontal and vertical locations

	Severity-Impact Rate				Frequency Rate			
Improve information on the location of underground utilities	**Mean**	**N**	**Std. Deviation**	**P-value**	**Mean**	**N**	**Std. Deviation**	**P-value**
States that had a poor to fair accuracy of horizontal location	5.1111	18	0.83	**0.125**	5.0556	18	1.1	**0.879**
States that had a good to excellent accuracy of horizontal location	4.5769	26	1.27		5	26	1.23	
States that had a good to excellent accuracy of vertical location	4.9355	31	1.03	**0.209**	5.0968	31	1.13	**0.524**
States that had a good to excellent accuracy of vertical location	4.4615	13	1.33		4.8462	13	1.28	

Table 112 indicates a p-value < 0.125. This lead to the conclusion that the mean of the severity-impact rate can be lower for the states that have a better accurate horizontal location.

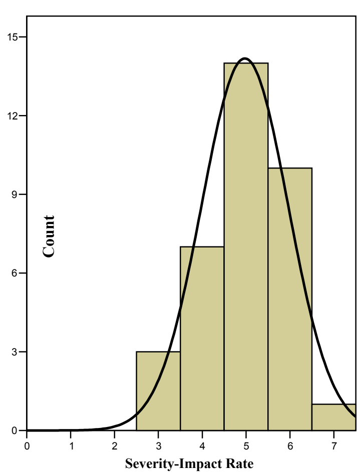
The same ANOVA analysis was performed to compare the severity-impact rate of the states that had a good to excellent accuracy of vertical locations and the states that had a fair to poor accuracy of vertical locations. The results showed also a p value equal to 0.209. This also supports the impact of the accuracy of vertical locations on the severity of the conflicts.

Table 112 shows also that improving information on the location of underground does not affect the frequency rate.

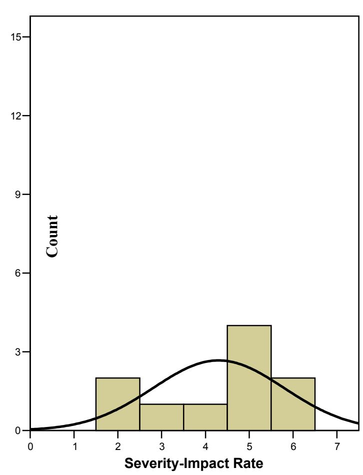
In part 4 of the survey, representatives from transportation agencies were asked to assess the accuracy of location provided by the One-Call agency. The location accuracy of One-Call centers has already been summarized to provide average accuracies for each type of utility. It should be noted that there was no significant difference for any type of utility location accuracy between states that do hold liable One-Call centers and those that do not. In order to determine the reliability of the One-Call locate system, an ANOVA analysis was performed to compare the means of the severity-impact rate and frequency rates among the states that had a poor to fair assessment of accuracy of location data provided by the One-Call agency and the states that had a good to excellent assessment of location by the One-Call agency. This analysis gave a p-value of 0.5 that lead to the conclusion that the accuracy of location by One-Call center does not appear to reduce the severity and frequency of utility conflicts. Moreover, in the survey, numerous transportation agencies did not appear to rely on the One-Call locate system to locate utilities for relocation purposes.

Identifying the location of all utility facilities during the early design stages may make it possible to design highway improvements around those facilities. From the survey, 62% of the states have initiated the Subsurface Utility Engineering (SUE) program on urban highway reconstruction projects where multiple underground utility facilities may be present. SUE assists the designer and utility companies in determining potential conflicts between a utility facility and construction activities required for the highway improvement. Identifying and remedying the conflicts during the design phase of the highway project can minimize or eliminate costly delays during construction.

In the survey, respondents were asked to identify what quality level of subsurface utility engineering information is generally required before a project can be let for construction. Because of the small number of states, an ANOVA analysis was performed to compare the mean of the severity-impact rate between the states that use SUE of quality level A or B and the second states that use SUE of quality level C or D.



SUE of quality C or D



SUE of quality A or B

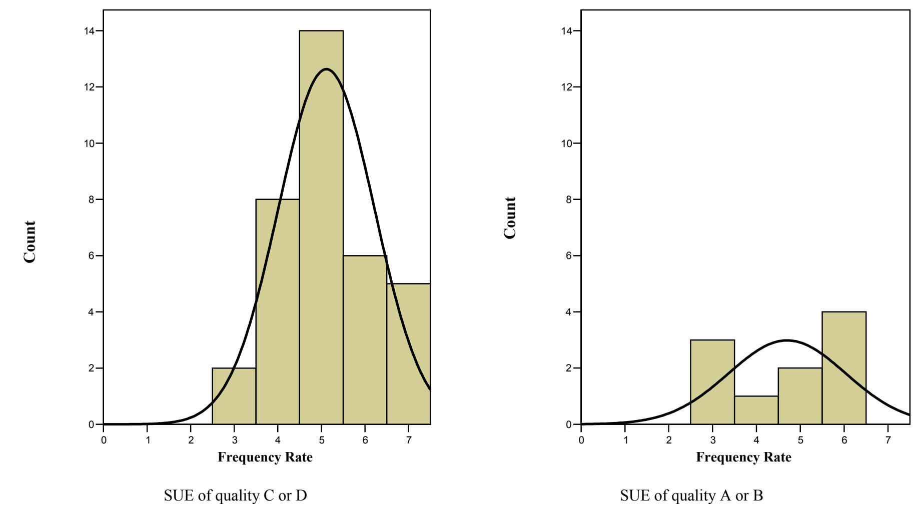


Figure 25: Frequency distribution of the severity-impact rate and frequency rate between states that use a SUE of quality A or B and states that use SUE of quality C or D

Figure 25 shows that states that use a SUE of quality A or B have a better severity-impact rate and frequency rate than others.

Table 113 summarizes the means of the two groups. It is noticed that the states that use a SUE of quality level A or B have reduced the severity-impact rate by13.4% and the frequency rate by 8.02%.

Table 113: Mean, size, standard deviation and p-value of the severity-impact rate and frequency rate of the 2 groups of states that use different levels of SUE

	Severity-Impact Rate				Frequency Rate			
Use of SUE	**Mean**	**N**	**Std. Deviation**	**P-value**	**Mean**	**N**	**Std. Deviation**	**P-value**
Use SUE of quality level C or D or other	4.97	35	0.98	**0.09**	5.11	35	1.1	**0.32**
Use SUE of quality level A or B	4.3	10	1.49		4.7	10	1.33	

Finally, since the p-value for the severity-impact rate between the 2 groups is less than 0.09, it is concluded that the average impact rate of the states that use SUE quality level A and B are lower than the rates of the states that do not. But because the p-value for the frequency rate between the 2 groups is 0.32, it can be concluded that there is not enough evidence to prove that the use of SUE quality level A and B can reduce the frequency rate of the conflicts.

4.7.2.4 Improve the Process of Funding Utility Agencies

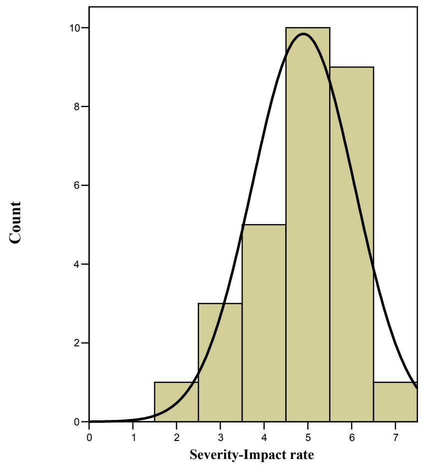
This report has already discussed that improving coordination among public agencies, designers and utilities throughout the design phases can reduce the frequency and severity of conflicts between them. In fact, giving utility companies access to a current list of upcoming construction projects should allow them to better plan their relocations activities and to properly budget for the relocation work.

But sometimes, the budget is not big enough to cover all the relocation work, thus paralyzing the job of the utility companies. In fact, funding utility companies at the beginning of the project or during its design phase is as important as all the other policies already discussed in this report. From the utility company, a request to move a facility that cannot be funded means that supplies and materials cannot be available and equipments cannot be mobilized.

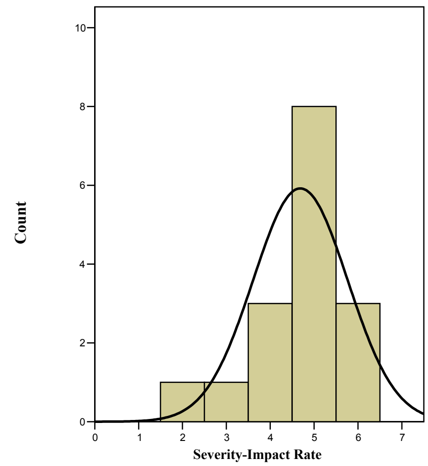
4.7.2.4.1 Early Funding

In the survey that was sent to all states, some questions were included to analyze the effect of early funding to the frequency and severity-impact rate. The respondents were to answer "At what project stage are funds typically allocated for utility design?"

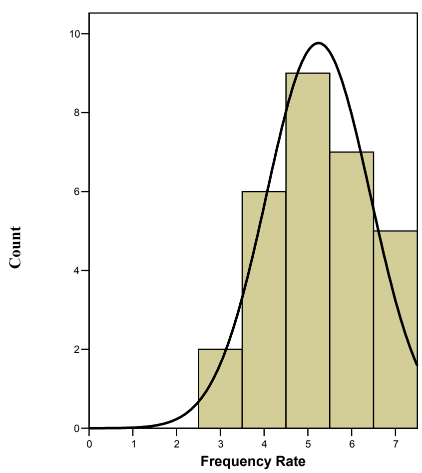
After receiving all the results, an ANOVA analysis was performed to compare the mean of the severity-impact rate and frequency rate between states whose funds were allocated during planning phase and preliminary line and grade phase and the states whose funds were allocated during right of ways plans development phase, final design phase and other.



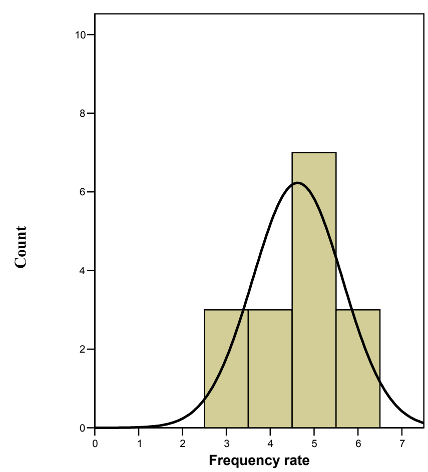
Late funding of utility companies



Early funding of utility companies



Late funding of utility companies



Early funding of utility companies

Figure 26: Frequency distribution of the severity-impact rate and frequency rate between states whose utility companies get funded in early stages and those whose utility companies get funded in later stages.

Table 114 indicates that the mean of frequency rate off the states that early fund their utility companies is lower by 11.7% from the states that delay the funding of the utility companies.

Table 114: Mean, size, standard deviation and p-value of the severity-impact rate and frequency rate of the 2 groups of states with different time frames of funding utility companies.

	Severity-Impact Rate				Frequency Rate			
Early Funding	**Mean**	**N**	**Std. Deviation**	**P-value**	**Mean**	**N**	**Std. Deviation**	**P-value**
Funding of utility during right of way plans development phase or final design or later	4.89	29	1.17	**0.56**	5.2414	29	1.18488	**0.08**
Funding of utility during planning phase and preliminary line and grade phase	4.68	16	1.07		4.625	16	1.0247	

Table 114 indicates a p-value equal to 0.08, demonstrating that the mean of the frequency rate of conflicts of states that early fund their utility companies is better than the mean of the states that delay the funding of their utility companies. Table 114 also shows a p-value of 0.56 leading to conclude that there is not enough data to prove that funding of utilities during the planning or preliminary or grade phase will reduce the severity-impact rate.

4.7.3 Analysis Results

The analysis identified numerous practices that can reduce the severity-impact rate and frequency rate of utility conflicts. These practices are summarized in table 115.

Table 115: Best practices that have the greatest impact on severity-impact rate and frequency rate.

	Effect on severity-impact rate	**Effect ob frequency rate**
Involvement of utility during planning or preliminary line or grade phase	Highly significant	Highly significant
Sending official letters at least monthly.	Significant	Significant
Use of SUE of quality level A or B	Significant	Not significant
Obtain a good to excellent accuracy of horizontal location	Significant	Not significant
Perform At least monthly phone calls	Significant	Significant
Hold face to face meeting at least monthly or form start of the design phase	Significant	Not significant
Funding of utility during planning or preliminary or grade phase	Not significant	Significant

This analysis has proved that using the above-mentioned methods can reduce the frequency and severity of conflicts. Most importantly, these practices are easily applicable and do not require significant expenses by the state.

5 Prioritizing Best Practices

This portion of the research project consisted of compiling a list of suggestions to alleviate utility conflicts, which were then voted on by the research committee in terms of each suggestion's potential impact and investment requirement. Next, the research team performed an analysis of the voting results using statistical control process charts. The final phase consisted of creating a list of viable recommendations to support a Cabinet's implementation plan on reducing the frequency and severity of utility conflicts on state roadway projects.

5.1 Data Collection

The suggestions contained in this portion of the report were collected from many sources through extensive literature review. These sources include: scholarly journals, reports from professional associations, reports from STA's, and the research team's state questionnaire.

5.2 Voting Procedure

On March 2, 2006 the committee for this KTC Project entitled "Direct and Indirect Costs of Utility Relocation and Right-of-Way Acquisition" met at the University of Kentucky. The purpose of the meeting was to vote on the list of suggestions aimed at reducing the frequency and severity of utility conflicts on roadway projects. First, the project scope was discussed to re-familiarize the committee with the research objectives. Then, each suggestion's description was read and the committee voiced a list of positive and negative aspects for each. The advantages and disadvantages were recorded on large sheets of adhesive paper that were posted around the room for viewing during the voting process. The committee members were given hand-held voting transmitters for the electronic polling process. Each method was voted on according to their investment and impact on the Cabinet's ability to avoid future utility conflicts. Following the voting process, the research team recapped the results and discussed the project's path forward. The voting scale was as follows:

1. Impact: **1** (no impact on the Cabinet's ability to avoid future utility conflicts), **5** (moderate impact), and **10** (extremely high impact on the Cabinet's ability to avoid future utility relocations).

2. Investment: **1** (no added investment needed in terms of time, additional personnel, or money in order to implement), **5** (moderate investment), and **10** (extremely high investment needed in order to implement).

5.3 Control Charts

After the committee voted on each of the suggestions, the results were tallied and given to the research team for evaluation. Next, they were analyzed using SPSS, Statistical Package for the Social Sciences, which can perform highly complex data manipulations allowing the team to make tables for analysis based on each suggestions impact and investment. Then, the team utilized process control charts to measure the parameters of the suggestions' quality characteristics. These parameters were devised from the voting results of the committee members. According to Swift (1998), the choice of quality characteristics for control charts should be based on two criteria. First, the quality characteristics must be measurable, such as impact and investment. Secondly, the study of each particular quality characteristic should lead to a positive gain, such as reduced costs and delays to roadway projects (Swift, 1998). Since utility relocations experience many delays and costs, they are ideal candidates for this type of analysis. It is important to note that the voting process and analysis are based on expert opinion provided by industry experts.

Control charts measure the mean value and the variability of the quality characteristics. The mean value is depicted by an X-bar chart, while the variability is portrayed by a standard deviation chart or S-chart (Swift, 1998). Control charts are actually bar charts with three superimposed lines:

1. The line in the middle is the mean value for that characteristic;
2. The line below the mean is the lower control limit; and
3. The line above the mean is the upper control limit.

The upper and lower control limits were calculated by multiplying the average of the standard deviations for each suggestions quality characteristic (impact, investment, score), by the constant value of 0.766. This number was extracted from an X-bar control chart table of constants that is based on the numeric values for sample sizes Swift, 1995). Next, this value was added to or subtracted from the overall mean, which produces the upper and lower boundaries (Swift, 1995). The following outlines the information obtained from viewing the charts based on each characteristic's impact, investment, and score.

5.3.1 Impact

1. If a suggestion's average impact score exceeds the upper control limit, it is classified as having a **high impact** on reducing the frequency and severity of utility conflicts. Any suggestion that falls in this category would immediately benefit the Cabinet upon implementation. However, even though a method may have high impact, it still may not be reasonable to implement because of a high investment cost.
2. If a suggestion's average impact score is below the lower control limit, it is classified as having a **low impact** on reducing the frequency and severity of utility conflicts. Any suggestion that falls in this category would not likely produce significant benefits upon implementation.
3. If a suggestion's average impact score falls between the upper and lower control limits, it is classified as having a medium impact on reducing the frequency and severity of utility conflicts. Any suggestion that falls in this category has a moderate potential for savings and would benefit the Cabinet if implemented.

** Note: The values obtained for impact are based on expert opinion. **

5.3.2 Investment

For the purpose of using control charts, the investment voting scale was reversed so that **1** became an "extremely high investment" and **10** became "no needed investment in terms of time, money, or personnel." A time investment refers to the duration of time spent on implementing each of the suggested methods from a utility, contractor, and STA point of view. A money investment refers to the monetary value each of these parties will forego in order to implement a proposed method. A personnel investment refers to the number of personnel needed to exercise a proposed method. This last type of investment also includes the amount of time each of these personnel spends not performing other necessary duties.

1. If a suggestion's average investment score exceeds the upper control limit, it is classified as having a **low implementation cost** and could be enacted for a reasonable price without a special budget. However, some suggestions in this

category may have low impacts on reducing utility conflicts and will not benefit the Cabinet.

2. If a suggestion's average investment score falls below the lower control limit, it is classified as having a **high implementation cost** and cannot be enacted for a reasonable price. In addition, suggestions in this category may require special budgets to enact. However, long-term implementation of these suggestions could be considered if the proposed impacts reveal positive benefits to the Cabinet.
3. If a suggestion's average investment score falls between the upper and lower control limits, it is classified as having a **medium implementation cost** and could be enacted for a reasonable price with or without a special budget. However, some suggestions in this category may have low impacts on reducing utility conflicts and will not benefit the Cabinet.

** Note: The values obtained for investment are based on expert opinion. **

5.3.3 Score

The score value for each method was devised by multiplying the suggested impact for each method by its proposed investment. The motivation for doing this comes from the need to pinpoint methods that offer a high impact on reducing utility relocation conflicts at a low investment cost.

1. If a suggestion's average score value exceeds the upper control limit, it is classified as having both a **low implementation cost and a high impact** on reducing the frequency and severity of utility relocation conflicts. Any suggestion that falls in this category has a great deal of impact potential with low implementation costs. The Cabinet would benefit from enacting these suggestions as part of a short-term implementation plan.
2. If a suggestion's average score value falls below the lower control limit, it is classified as having both a **high implementation cost and a low impact** on reducing the frequency and severity of utility relocation conflicts. Any suggestion that falls in this category is likely to have little benefit.
3. If a suggestion's average score value falls between the upper and lower control limits, it is classified as having a **medium implementation cost and a medium impact** on reducing the frequency and severity of utility relocation conflicts. These

suggestions have a moderate potential for savings and could be enacted for a reasonable price.

** Note: The values obtained for score are based on expert opinion. **

5.4 Suggestions

This section of the report lists and describes the suggestions expected to alleviate the frequency and severity of utility conflicts on roadway projects. The methods are divided into five categories: cultural, communication, legislation, technology, and contractual. In addition, each suggestion has a list of advantages and disadvantages that were proposed by industry experts during the committee's March 2, 2006 meeting.

5.4.1 Cultural

1. Change the culture:

There exists a need to change the culture regarding the approach towards utility relocations on roadway projects. Many projects have been awarded without properly addressing utility relocations, which many times lead to costly delays. This push to award jobs and repair roadways and bridges sometimes results in plans that contain errors and omissions. Whenever feasible, there can be a minimum timeframe or specific standard of care applied to utility relocation design efforts. The time and money spent to thoroughly address all required utility relocations will save project stakeholders (utilities, contractors, and the STA's) money in the end (USGAO 1999).

Advantages:

- The committee of industry experts felt that this suggestion would save the cabinet valuable time and money by making utility relocations more of a priority among the stakeholders.

Disadvantages:

- It is difficult to change attitudes toward utility companies and relocation efforts without benefits being recognized by the stakeholders.

- Political issues and loss of federal funding make it difficult to change the culture regarding utility relocations.
- Defining the real problem regarding the current culture is a difficult task. The current state of the culture regarding utility relocations must be presented in detail in order to provoke this change.
- To change the culture, there exists a need to communicate the degree of inefficiency of the overall program.
- There is a lack of stakeholder willingness to invest time and money in order to improve the current state of affairs.
- The current culture portrays utilities as a secondary issue. This can be attributed to lack of legislation regarding relocations and the absence of incentives and disincentives for performing this work in a timely manner.

2. Set a time limit that plans can be kept on file:

Many times highway project plans are filed away for many years before the actual project is awarded for construction. This suggestion proposes a time limit for the amount of time these plans can be kept on file (Committee Meeting 9-21-2005). This method will reduce the number of conflicts that arise due to new structures and utilities being present in the project's proposed site location that were not present during the initial design of the project. If design plans are kept too long, there exists a need to redesign the project before the construction letting.

<u>Advantages:</u>

- Limiting the amount of time plans can be kept on file will help avoid costly delays associated with obvious changes to the site description that occurred after the design was filed away.
- Establishing this method will lead to benefits such as reduced change orders and more accurate utility construction/relocation schedules.
- This method may ensure that projects will not be designed that are not going to be executed within the established timeframe. This would save time and money associated with designing projects too early in the planning stages and free up employees to work on more pressing projects.
- Many times, plans are filed away that are not complete and will be selected from the file and let for construction. This results in a multitude of errors and change orders. This

method would help avoid this issue by keeping the plans current and at the forefront of the design process.

Disadvantages:

- It is difficult to define the length of time that would trigger a need for design review.
- It is difficult to identify the type of review needed for each reevaluation. This need would fluctuate based on criteria pertaining to the various types of highway projects and according to project size, location, and complexity.
- It is difficult to hold the design consultants accountable for the necessary changes without some sort of new contract stipulation that holds the consultant accountable for redesign over a given timeframe.

3. Excellence in Highways Utilities Award:

Kentucky could consider developing a state award program similar to the Excellence in Highway Utilities Award, which is conducted biennially by the FHWA to encourage excellence in the Highway Utility area. The purpose of this award is to honor those who excel in improving utility relocations and the accommodation process and ensuring utilities owners', stakeholders' and tenants' rights are protected. Anyone may nominate an outstanding highway project, process, person, contractor, or group involved in a project that has used Federal Highway Administration (federal-aid) funding that made an outstanding contribution to transportation within a three year period. Awards consist of appropriate recognition to the owner(s), person(s), contractor(s), or group(s) involved in a project or process that wins outstanding entry in each category. The following list describes the award criteria:

1. Level of category costs: Projects over $100 million and projects less than $100 million.
2. Categories: Innovation, Leadership, Subsurface Engineering, and Relocation.
3. General Criteria: Compatibility with/or adaptation to the environment, visual appeal, safety and traffic operation factors, functional efficiency, quality of construction, and pleasing stakeholder experience.

Advantages:

- This suggestion helps recognize those who have excelled on highway projects in terms of utility relocations and could motivate them and others to keep up the good work.

Disadvantages:

- Some committee members felt that this suggestion is only valuable from the consultant's standpoint, meaning that this award would only improve a consultant's business reputation. However, they felt that there exists a need for monetary incentives for this method to be effective among the other project stakeholders.

5.4.2 Communication

1. Development and Dissemination of Five-Year Work Programs:

Utility companies need to be routinely provided with master plans and meeting agendas so that they can determine which projects are most important and allocate the necessary resources for attending the significant meetings. Limited staffing makes it impossible for utilities to attend all public meetings for projects within their service territories. Advance notice allows utility companies to allocate financial and human resources to relocation efforts and reduces the likelihood of relocation delays due to scheduling conflicts and financial constraints. In addition, advance notice provides utility companies with the opportunity to program upgrades or expansions to their facilities. In an effort to give utility companies adequate time to plan the infrastructure, Florida communicates its 5-year program to utility companies and provides quarterly updates. Some districts in Florida have monthly mail-out listings of all projects in the letting cycle. Florida Department of Transportation also has legislation in place that requires it to liaison with utility companies (AASHTO 2004).

Advantages:

- This suggestion may be more beneficial to implement on a district basis rather than a statewide basis. This will ensure that each district is communicating with the utilities in its area. This would help encourage cooperation and communication among stakeholders throughout the district.

Disadvantages:

- In many cases, there exists a need for final design to be nearly complete before utilities can plan their work. Therefore, advance notice may not be beneficial because utilities will not know the scope of their relocation requirements.

2. Formation of Utility Coordination Councils:

Many states have formed utility coordinating councils (UCC) as a forum for discussion of master plans and general utility issues. The UCC includes representatives from utility companies, governmental agencies, and contractors who meet regularly to discuss mutual problems, work programs and planning issues. The UCC members are appointed by their respective agencies and meet regularly for an agreed upon timeframe to discuss general utility matters in addition to specific projects. This allows the utility company to provide more up to date information regarding the status of utility relocations than what is typically included in a project proposal. UCC's have the ability to increase the level of cooperation, coordination, and communication between the Cabinet and utility companies (AASHTO 2004).

The main objectives of these councils are:

1. To recognize the shared goals of the stakeholders and act as a team to accomplish these goals (FHWA 2002).
2. To identify proposed highway projects that affect existing utility facilities and allow planners/designers to explore alignment alternatives to avoid major utility relocations prior to project design (FHWA 2002).
3. To identify alignment alternatives that will minimize utility impact and relocations on highway projects already in the design stages (FHWA 2002).
4. To coordinate the construction schedule for utility work with the highway construction schedule to reduce disruptions to the public and prevent conflicts between contractors and utility companies (FHWA 2002).

For example, A Florida Utility Coordination Committee meets quarterly at different locations around the State. This ensures that various representatives have the ability to attend meetings closer to the geographic area they represent. In another example, Nevada holds monthly UCC meetings with local utility companies and local entities in the Las Vegas area in order to enable participants to address upcoming project needs and identify better ways to improve future projects when dealing with utility relocations. This provides an opportunity for the Nevada DOT to better coordinate efforts with county officials and utilities in order to prevent project delays and costly mitigation (AASHTO 2004).

Advantages:

- This approach would work well in urban areas where there are fewer utility companies to involve with the committee.
- UCC's could be implemented on a district by district basis so that each district in the state has its own forum to discuss master plans and utility issues as they arise.
- UCC's could be implemented on a project level, so that all key stakeholders are focused on one particular project.

Disadvantages:

- This approach may be difficult to implement in rural areas where there are a multitude of smaller utility companies.
- Many of the smaller districts have numerous utility companies, thus it was suggested that UCC's would only be able to meet with the major utility companies in these smaller areas.
- It may be difficult to have all UCC members present at every meeting, especially utility company representatives. This is due to the fact that most utility companies lack the personnel resources to attend all necessary meetings in their service territories.

5.4.3 Legislation

1. Minimum Utility Coordination Requirements:

Wisconsin DOT has enacted prescribed minimum utility coordination requirements to prevent utility relocations from delaying highway work. The regulation requires Wisconsin DOT to provide utility companies with a notice of proposed highway improvements and preliminary plans as early in the development of the highway project as possible. Within 60 days, the utilities are required to respond to the notice and provide description of the facilities to remain in place or be relocated. After each utility responds, Wisconsin DOT mails each utility a set of preliminary plans that show all existing utility facilities known to the DOT. These preliminary plans show the utility companies the proposed roadway project and where their utilities were reported to be located (FHWA 2002). This method allows WisDOT to share the design burden with the utility companies.

Advantages:

- This method helps ensure coordination and communication between the utility companies and STA's by requiring the exchange of project and utility plans early in a project's design phase.

Disadvantages:

- This method has proven to be very bureaucratic in other states with a great deal of additional paperwork. STA employees would be required to fill out a different form for every decision made and could divert personnel from more pertinent duties.

2. Utility Corridor/Utility Preservation:

Utility Corridors are capable of enhancing the relocation process and reducing delays by housing utilities in a common area. Theses corridors are actually large diameter pipes or box culverts that house utilities that run across highways or run longitudinally along the highway right-of-way. Utility Corridors and Utility Preservation both help to consolidate utility locations, maximize use of limited available land, and minimize road openings (FHWA 2002).

Advantages:

- According to the committee experts, utility corridors would work well in subdivisions because these systems are better suited for distribution lines.
- Louisville is already using the joint trenching method with success. The degree of success with this approach could support the development of utility corridors throughout the state.

Disadvantages:

- Utility corridors would be very expensive to construct and requires new legislation.
- The suggestion would require the Cabinet to purchase larger areas for highway right-of-ways.
- This method would be difficult to implement for transmission lines due to there locations and tremendous size.
- It would be very difficult for the Cabinet to acquire easements from property owners if utilities are not ready to go in the ground. At this time, the Kentucky court system will not uphold condemnation procedures for this suggestion without utilities on the verge of being put in place.

- Currently, the Cabinet does not have the authority to purchase utility corridors without highways funds.

5.4.4 Technology

1. Maintaining a Utility Web Page:

Each utility company can provide contact information on a website, a brochure, or other convenient format that contains contact information for all agencies to access. However, utility companies would need to constantly update this information and keep it current. In addition, the Cabinet could create a link in their website with direct contact information for utility companies. Currently, some STA's maintain a utility web page containing their five-year work programs, names, addresses, and contact numbers of district utility engineers, advice on obtaining permits, and permit forms and agreements (AASHTO 2004).

<u>Advantages:</u>

- A utility web page could make it possible to share design files, which would be beneficial to all stakeholders.
- The committee felt that this method could reduce research time if contracts were identified by county instead of by district.

<u>Disadvantages:</u>

- This method could have some limitations since there is no established format for sharing CAD files.
- There exists a need to create password protected files if implementing this suggestion to prevent malicious activity from occurring.

2. Common Database of Utility Locations/GIS and GPS used for utility mapping:

The lack of a common platform on which to collect, report, and disseminate records makes the search for utility information very time consuming and often incomplete. There are many different types or records, both public and private, contained on many different formats (paper, mylar, maps, books, electronic, etc.) with many diverse types of details (location, depth, material, size, slope, etc.) (FHWA 2002). This suggestion recommends the use of satellites, software, and various mapping techniques to develop a common information database for utility locations. Utility companies and design engineers must rely on utility records and as-builts to determine the location of existing utilities within the project corridor. This suggestion will save time by allowing a designer to know what utilities to expect in a certain area, making the design much more efficient and avoid many delays associated with utility relocation efforts. These maps could be utilized to route new utilities and should be updated with new as-builts as construction continues (USGAO 1999).

Advantages:

- This suggestion will be demanded in the future as our highways and utility infrastructures continue to change and grow and the need for a common information database increases.

Disadvantages:

- This suggestion would be very expensive and would require highly trained personnel to implement.
- The government has similar systems already established, but currently they are fragmented and difficult to access.
- Some utility companies lack the technology to be able to support this capability because many are still using paper plans for design and relocation purposes.
- Security would be a key issue if this suggestion were implemented. All files would require secured password protection and continuous monitoring to prevent any malicious activities.

5.4.5 Contractual

1. Maintain a Pre-Qualified List of Utility Contractors and/or Allow Contractors to Perform Relocation Work Whenever Possible:

This method helps the contractor incorporate utility work into the project's scope and places any scheduling problems in their hands. The contractor who is awarded the project can choose a sub-contractor who has been pre-approved by the utility companies to perform the relocation work. This suggestion will insure that qualified and experienced contractors are used to perform the relocation work. The method also suggests that the Cabinet can incorporate the utility relocation work into a highway contract, making the contractor responsible for relocations. This increases the contractor’s control of the relocation efforts and clearly defines the contractor's responsibilities (USGAO 1999). Although this agreement may contain provisions for dealing with unknown utilities encountered during the construction process, the primary purpose is to facilitate the relocation of facilities that were identified during design, which were incorporated into the competitive bid package. This has been shown to work well for sewer, gas, and water (Committee Meeting 9-21-2005).

Advantages:

- This method would give the General Contractor more control over the timing and relocation of utilities.
- This method would reduce the relocation responsibilities of utility companies.
- Since this approach places the relocations in the contractor's scope of work, the Cabinet could pay for the relocation work if necessary.

Disadvantages:

- Sometimes a pre-qualified utility contractor may not have the capacity to do the highway work or are not willing to work on highway projects.
- Many times contractors are pre-qualified by utility companies, but not by the Cabinet and therefore cannot perform the work.
- Sometimes a pre-qualified utility contractor will sublet a portion of their work to a subcontractor, which creates a high probability for disputes.
- This method would not work well for overhead transmission lines due to communication splicing and pole sharing, which takes a great deal of coordination with many possible delays.

2. Require the Contractor to Submit As-Built Drawings For New and Relocated Utilities and for all Utilities Uncovered Throughout a Project:

Many times new and relocated utilities are not placed according to their designed positions and the changes are not accurately recorded (Committee Meeting 9-21-2005). Requiring contractors to submit as-built drawings for new and relocated utilities will make future design and relocations easier. In addition, contractors should submit as-builts for any unmarked utilities uncovered throughout the project.

Advantages:

- Currently there is no process requiring contractors to perform this method, but it would be very beneficial to future design and relocation efforts.
- This method would help address long-term inaccuracies for Before U Dig (BUD) locations.
- This suggestion would record unmarked utilities that otherwise go unrecorded.

Disadvantages:

- It could be difficult to enforce this suggestion upon every contractor participating on a project.

3. Utilize Unit Price Contracts When Rock is Expected in Contracts where Utilities are Relocated:

Unit price contracts would help to avoid shallow placement of utilities. It has been discovered through extensive literature review and case studies that some contractors will place utilities closer to the surface than specified in the contract documents. This is partly due to the soil containing more rock than expected, causing the cost of excavation to increase greatly over the contracted bid amount (Committee Meeting 9-21-2005).

<u>Advantages:</u>

- Utilities will be placed at recommended depths, which makes future design and relocation efforts more efficient.

<u>Disadvantages:</u>

- This suggestion would require more inspectors who are qualified to do quantity take-offs in order to get accurate unit price amounts.

4. Contract Start Date Pending Complete Utility Relocation:

This suggestion changes the approach to initiating a contract's start date. This suggestion, also know as Special Note #1 within the Cabinet, states that a contract is awarded, but the contract time does not start until all utilities have been relocated. The goal is to send a signal to the utility companies that the Cabinet is serious about the project and the utility companies need to move forward with their work. The Cabinet would not begin to charge working days to the contractor until 14 calendar days after all utilities have been relocated (Central Office Meeting 10-25-2005).

<u>Advantages:</u>

- This method could benefit the Cabinet by avoiding disputes regarding the actual contract start date when utilities fail to relocate as scheduled.

<u>Disadvantages:</u>

- Labor and material costs can fluctuate, meaning the cost to the contractor to complete the project may increase while waiting for utilities to relocate.

5. Pending Contract in Anticipation of Utility Relocation:

This suggestion changes the approach to awarding highway contracts if utilities are to be relocated. This suggestion, also know as Special Note #2 within the Cabinet, states that a contract is not awarded immediately to the low bidder. The contract is placed on a pending award list until the utilities are relocated. If the utility companies do not meet the required relocation work as agreed upon in the work schedules they have provided, the contractor and the Cabinet will each be allowed to cancel the contract at no cost to either party. If both parties wish to maintain the contract, the pending award list process can be extended another 30 days and each party once again will have the right to cancel the contract. This process will continue as long as both parties are willing to accept all original contract bid prices (Central Office Meeting 10-25-2005).

Advantages:

- This suggestion would give the contractor more time to assess the risks involved with a project.
- This method gives the contractor the ability to get out of the contract if utility relocations are not completed as scheduled.

Disadvantages:

- It is very difficult for a contractor to maintain their workforce and material costs while waiting for projects to start.
- There needs to be adjustments for price changes incorporated into this suggestion.
- Most contractors cannot afford to lose a job in which they were low bidder, especially due to utilities being behind with their relocation efforts.

6. Use of Monetary Incentives or Penalties for (un)Timely Completion of Utility Relocations:

This suggestion assumes that utilities are reimbursed for relocation work, which would require the government to adopt new legislation. The Cabinet could make these reimbursements contingent upon timely relocation of utilities and for each day the utility company falls behind schedule, the state reduces the amount being reimbursed. Sometimes delays from relocating utilities cause a contractor to be delayed, which leads to a claim being filed by the delayed contractor and/or subcontractors. This method also suggests that the cost of these claims be deducted from the utility's reimbursement amount (USGAO 1999). However, this suggestion will need to allow for circumstances involving justified delays.

Advantages:

- This suggestion would force the contractors and utility companies to meet there deadlines.

Disadvantages:

- This method would require the state government to enact new legislation.
- If this method were implemented, there would exist a need to address delays that are outside the control of utility companies.
- Penalties may not accelerate timely relocations and could hurt future coordination efforts.

7. Cost-Sharing:

Cost-sharing has two approaches: The first approach requires utility companies to pay a certain percentage of the relocation costs and the STA would pay the remaining percentage. This method assumes that utilities are more likely to relocate in a timely manner if the state pays a portion of the cost. A cost sharing arrangement could be useful in advancing projects to construction and avoiding unnecessary disagreements over who has prior rights, the highway or the utility (Moeller 2002). The second approach would give utility companies the opportunity to pay for increased design and construction costs which would avoid utility relocations. The utility provider benefits by having no service interruptions for its customers and the DOT benefits by not having to bear the added costs or having to force the utility to relocate (FHWA 2002).

Advantages:

- This suggestion is more applicable to private utilities, since there are already cost-sharing policies on some public projects.
- This method is working well on an Interstate Highway 65 project that involves private utility companies.

Disadvantages:

- This implementation of this method would require new legislation.

5.5 Analysis

The following section contains an analysis of results from the voting process. The subsequent pages show the voting results and can be used to compare and contrast the following groupings: (1) the entire committee, (2) utility and contractor representatives, and (3) federal and state workers. These groups have different viewpoints regarding utility conflicts, thus, they will have a varying degree of differences regarding each proposed suggestion to alleviate the problems.

5.5.1 Impact

Table 116 on the following page shows the voting results for each suggestion's impact taken from all 15 members of the committee. The individual and overall means and standard deviations were calculated for these suggestions and the upper and lower limits were created.

Table 116: Proposed Impact of Suggestions from Committee Voting

Method	Mean	N	Std. Deviation
Excellence in Highway Utilities Award	2.53	15.00	1.85
Contract start date pending complete utility relocation	4.60	15.00	2.29
Utilize unit price contracts when rock is expected	4.67	15.00	1.41
Development and dissemination of Five-Year Work Programs	5.27	15.00	2.87
Minimum Utility Coordination Requirements	5.47	15.00	2.35
Maintain a pre-qualified list of utility contractors	5.60	15.00	1.96
Formation of Utility Coordinating Councils	5.67	15.00	2.24
Maintaining a utility web page	5.67	15.00	2.32
Pending contract in anticipation of utility relocation	5.73	15.00	1.73
Utility Corridors/Utility Preservation	5.80	15.00	2.20
Cost Sharing	5.93	15.00	2.85
Set time limits for plans that are kept on file	6.40	15.00	2.29
Require the contractor to submit as-built drawings	6.60	15.00	2.69
Common Database of Utility Locations	7.13	15.00	2.76
Use of monetary incentives or penalties	7.47	15.00	1.30
Change the Culture	8.53	15.00	2.69
Total	5.82	240.00	2.57

** Lower Limit = 3.85, Upper Limit = 7.79, and Overall Mean = 5.82 **

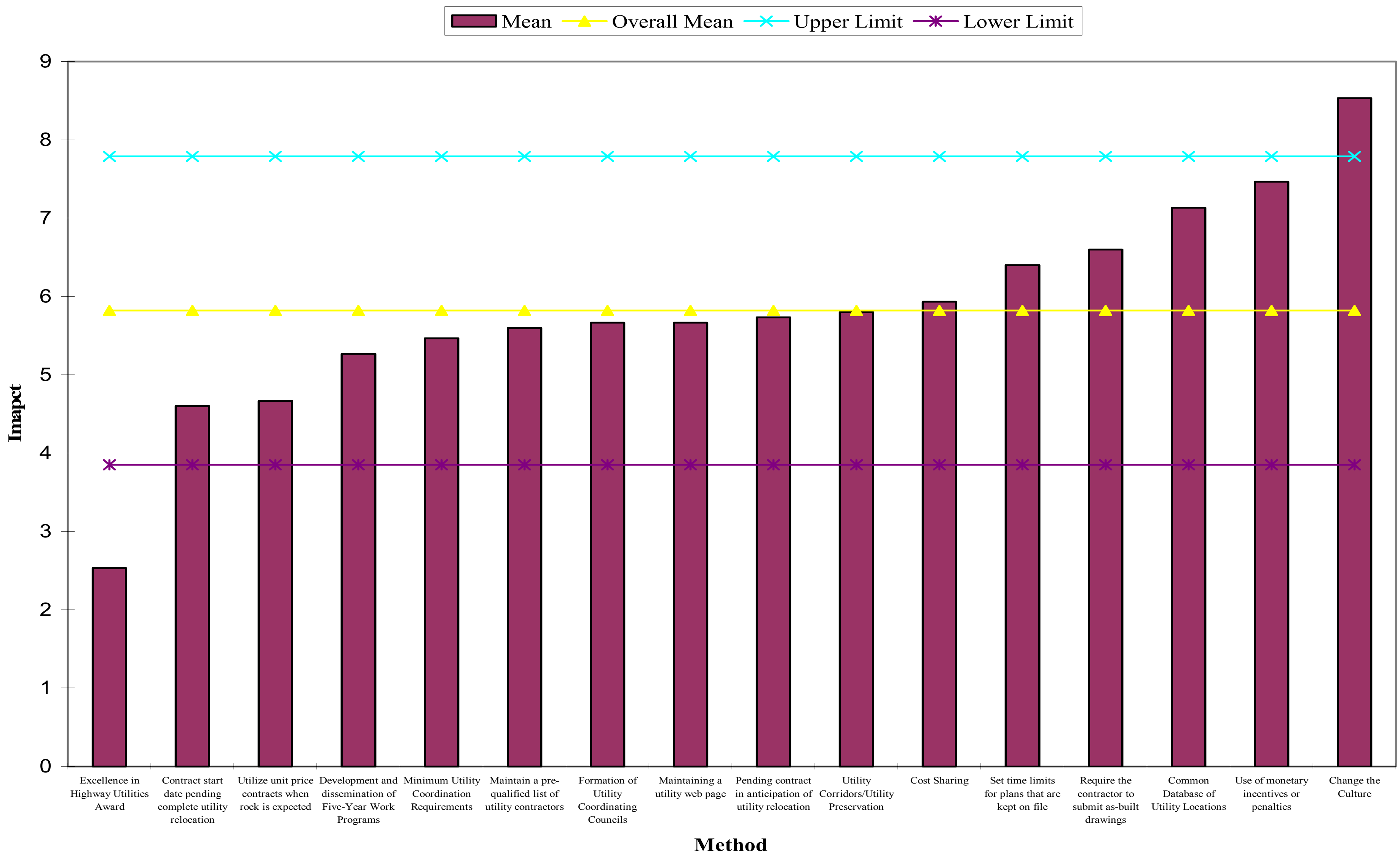
5.5.1.1 Impact Control Chart Results for Entire Committee

The control chart on the following page (Figure 27) shows that changing the culture is perceived as having the highest impact on reducing the frequency and severity of utility conflicts. This method is proceeded by these suggestions in order of decreasing impact:

1. Use of monetary incentives or penalties for (un)timely completion of utility relocations;
2. Common database of Utility/GIS and GPS used for utility mapping; and
3. Require the contractor to submit as-built drawings for new and relocated utilities and for all utilities uncovered throughout the project.

The “Excellence in Highways Utility Award” is perceived to have the lowest potential impact on reducing the frequency and severity of utility conflicts.

Figure 27: Control Chart of Impact vs. Method for Entire Committee



5.5.2 Investment

Table 117 shows the voting results for each suggestion's investment taken from all 15 members of the committee. The individual and overall means and standard deviations were calculated for these suggestions and the upper and lower limits were created. The total mean and total standard deviation given in this table are the overall average values for the mean and standard deviation columns.

Table 117: Proposed Investment of Suggestions from Committee Voting

Method	Mean	N	Std. Deviation
Utility Corridors/Utility Preservation	1.67	15.00	2.70
Common Database of Utility Locations	2.00	15.00	1.86
Use of monetary incentives or penalties	3.80	15.00	2.27
Maintaining a utility web page	4.67	15.00	1.77
Minimum Utility Coordination Requirements	5.07	15.00	1.49
Cost Sharing	5.07	15.00	1.94
Change the Culture	5.80	15.00	0.72
Require the contractor to submit as-built drawings	6.00	15.00	2.16
Formation of Utility Coordinating Councils	6.07	15.00	1.31
Development and dissemination of Five-Year Work Programs	6.13	15.00	2.36
Utilize unit price contracts when rock is expected	6.33	15.00	2.04
Pending contract in anticipation of utility relocation	6.53	15.00	1.99
Contract start date pending complete utility relocation	6.67	15.00	2.35
Set time limits for plans that are kept on file	6.80	15.00	1.92
Maintain a pre-qualified list of utility contractors	6.87	15.00	1.97
Excellence in Highway Utilities Award	7.20	15.00	2.55
Total	5.42	240.00	2.53

** Lower Limit = 3.48, Upper Limit = 7.36, and Overall Mean = 5.42 **

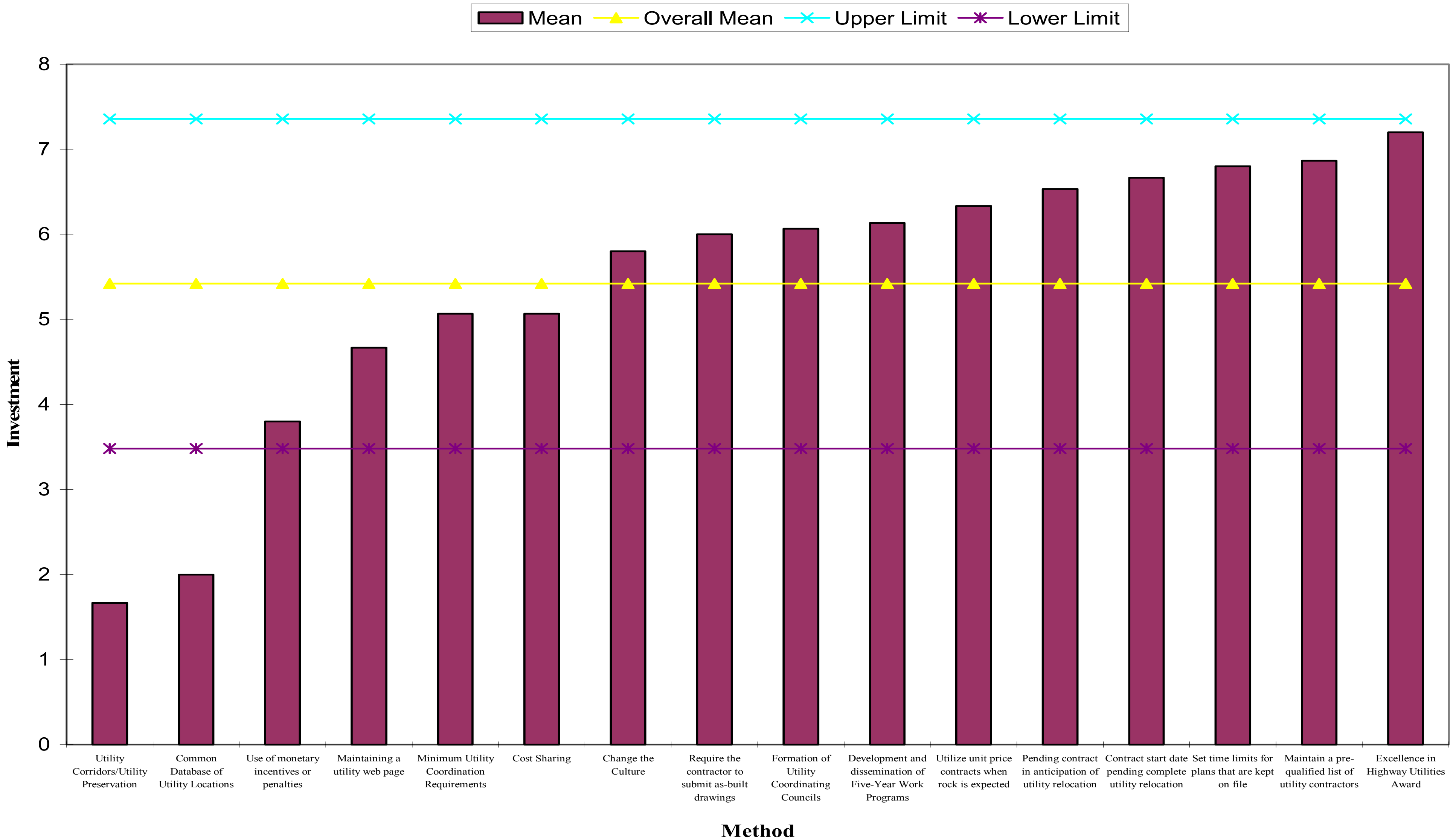
5.5.2.1 Investment Control Chart Results for Entire Committee

The control chart on the following page (Figure 28) shows that utility corridors/utility preservation and common database of utility locations/GIS and GPS used for mapping have the highest perceived implementation costs. These two methods are preceded by the following suggestions in order of decreasing investment:

1. Use of monetary incentives or penalties for (un)timely completion of utility relocations;
2. Maintaining a utility web page; and
3. Minimum utility coordination requirements.

The "Excellence in Highways Utility Award" is perceived to have the lowest implementation cost.

Figure 28: Control Chart of Investment vs. Method for Entire Committee



5.5.3 Score

Table 118 shows the voting results for each suggestion's score derived from the voting results of all 15 members of the committee. The individual and overall means and standard deviations were calculated for these suggestions and the upper and lower limits were created. The total values for mean and standard deviation given in this table are the overall averages for the mean and standard deviation columns.

Table 118: Score from the Product of Impact and Investment

Method	Mean	N	Std. Deviation
Utility Corridors/Utility Preservation	9.20	15.00	25.77
Common Database of Utility Locations	14.33	15.00	14.12
Excellence in Highway Utilities Award	18.60	15.00	11.86
Cost Sharing	25.73	15.00	15.60
Utilize unit price contracts when rock is expected	26.33	15.00	14.10
Maintaining a utility web page	27.00	15.00	14.34
Minimum Utility Coordination Requirements	27.07	15.00	4.41
Development and dissemination of Five-Year Work Programs	29.33	15.00	17.73
Use of monetary incentives or penalties	29.40	15.00	10.79
Contract start date pending complete utility relocation	30.87	15.00	18.34
Formation of Utility Coordinating Councils	33.47	15.00	23.97
Maintain a pre-qualified list of utility contractors	36.73	15.00	11.50
Pending contract in anticipation of utility relocation	38.67	15.00	23.06
Require the contractor to submit as-built drawings	40.60	15.00	24.19
Set time limits for plans that are kept on file	40.73	15.00	17.14
Change the Culture	48.80	15.00	14.42
Total	29.80	240.00	19.43

** Lower Limit = 14.92, Upper Limit = 44.68, and Overall Mean = 29.80 **

5.5.3.1 Score Control Chart Results for Entire Committee

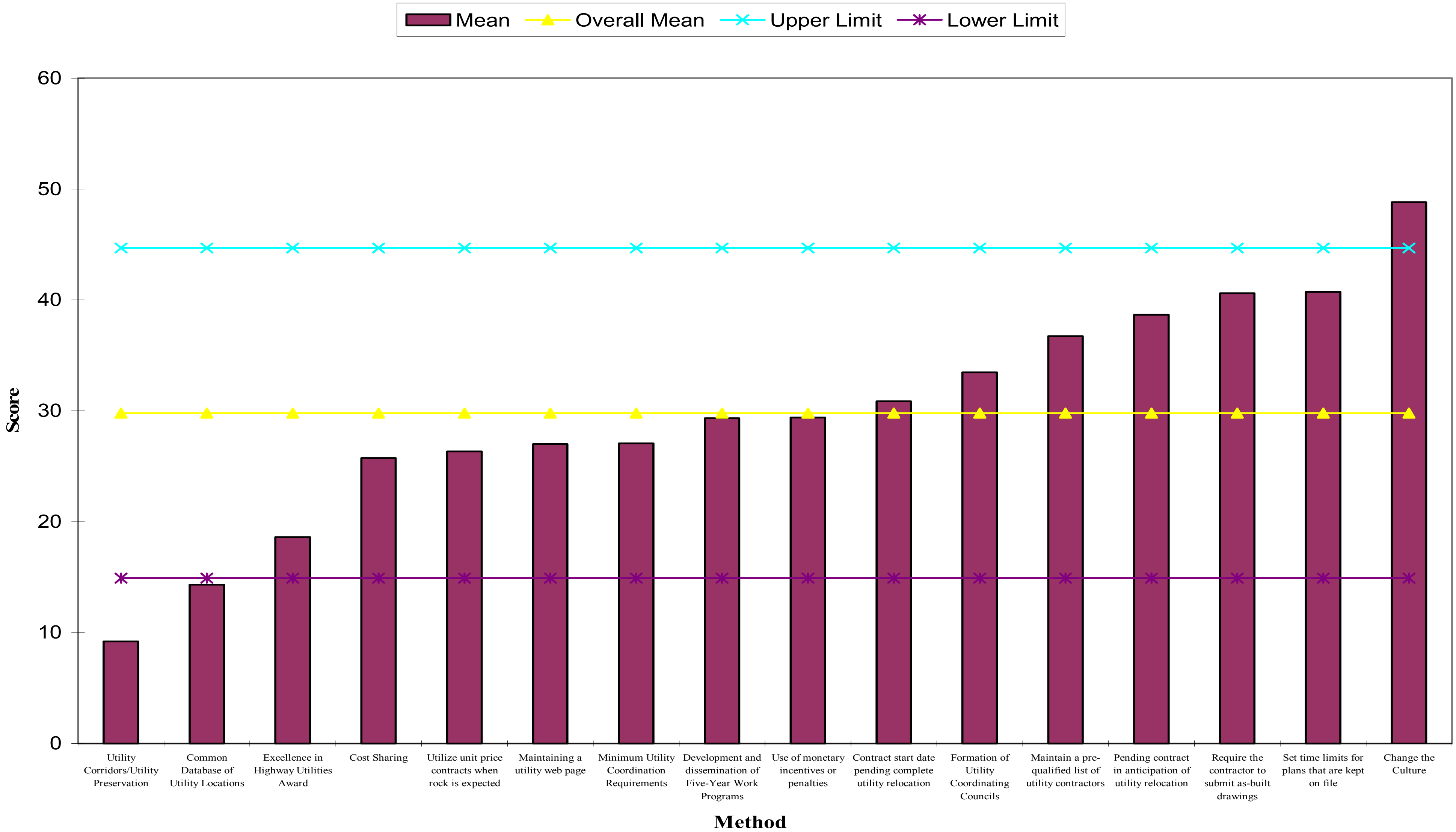
The control chart on the following page (Figure 29) shows that changing the culture is perceived as having the highest impact and lowest cost for reducing the frequency and severity of utility conflicts. This method is proceeded by these suggestions in order of decreasing score:

1. Set time limits for plans that are kept on file;
2. Require the contractor to submit as-built drawings for new and relocated utilities and for all utilities uncovered throughout the project; and
3. Pending contract in anticipation of utility relocation.

Utility Corridors/Utility preservation is perceived to have the lowest impact and highest cost for reducing the frequency and severity of utility conflicts. This suggestion is preceded by the following suggestions in order of increasing score:

1. Common database of utility locations/GIS and GPS used for utility mapping;
2. Excellence in Highway Utilities Award; and
3. Cost Sharing.

Figure 29: Control Chart of Score vs. Method for Entire Committee



5.5.4 Utility and Contractor Representatives

The following section isolates the voting results from the utility and contractor representatives, ignoring the federal and state workers. This has been done in order to gain a better understanding and realize the perspective from those who are in the field on a regular basis. These people experience utility relocation conflicts directly at the workface during construction and relocation.

Table 119 on the following page shows the voting results for each suggestion's impact taken from the 4 members of this grouping. The individual and overall means and standard deviations were calculated for these suggestions and the upper and lower limits were created. The total values for mean and standard deviation given in this table are the overall averages for the mean and standard deviation columns.

Table 119: Proposed Impact of Suggestions from Utility and Contractor Representatives

Method	Mean	N	Std. Deviation
Excellence in Highway Utilities Award	2.75	4.00	1.71
Development and dissemination of Five-Year Work Programs	3.75	4.00	3.40
Utilize unit price contracts when rock is expected	4.75	4.00	3.50
Pending contract in anticipation of utility relocation	5.25	4.00	3.40
Formation of Utility Coordinating Councils	5.50	4.00	1.29
Minimum Utility Coordination Requirements	5.75	4.00	3.20
Contract start date pending complete utility relocation	5.75	4.00	3.77
Maintaining a utility web page	6.00	5.00	2.24
Set time limits for plans that are kept on file	6.25	4.00	2.36
Cost Sharing	6.25	4.00	3.50
Utility Corridors/Utility Preservation	6.50	4.00	1.00
Common Database of Utility Locations	6.50	4.00	1.91
Maintain a pre-qualified list of utility contractors	6.50	4.00	3.00
Use of monetary incentives or penalties	6.50	4.00	1.29
Require the contractor to submit as-built drawings	7.25	4.00	2.87
Change the Culture	8.75	4	0.5
Total	5.88	65.00	2.65

** Lower Limit = 3.85, Upper Limit = 7.91, and Overall Mean = 5.88 **

5.5.4.1 Impact Control Chart Results for Utility and Contractor Representatives

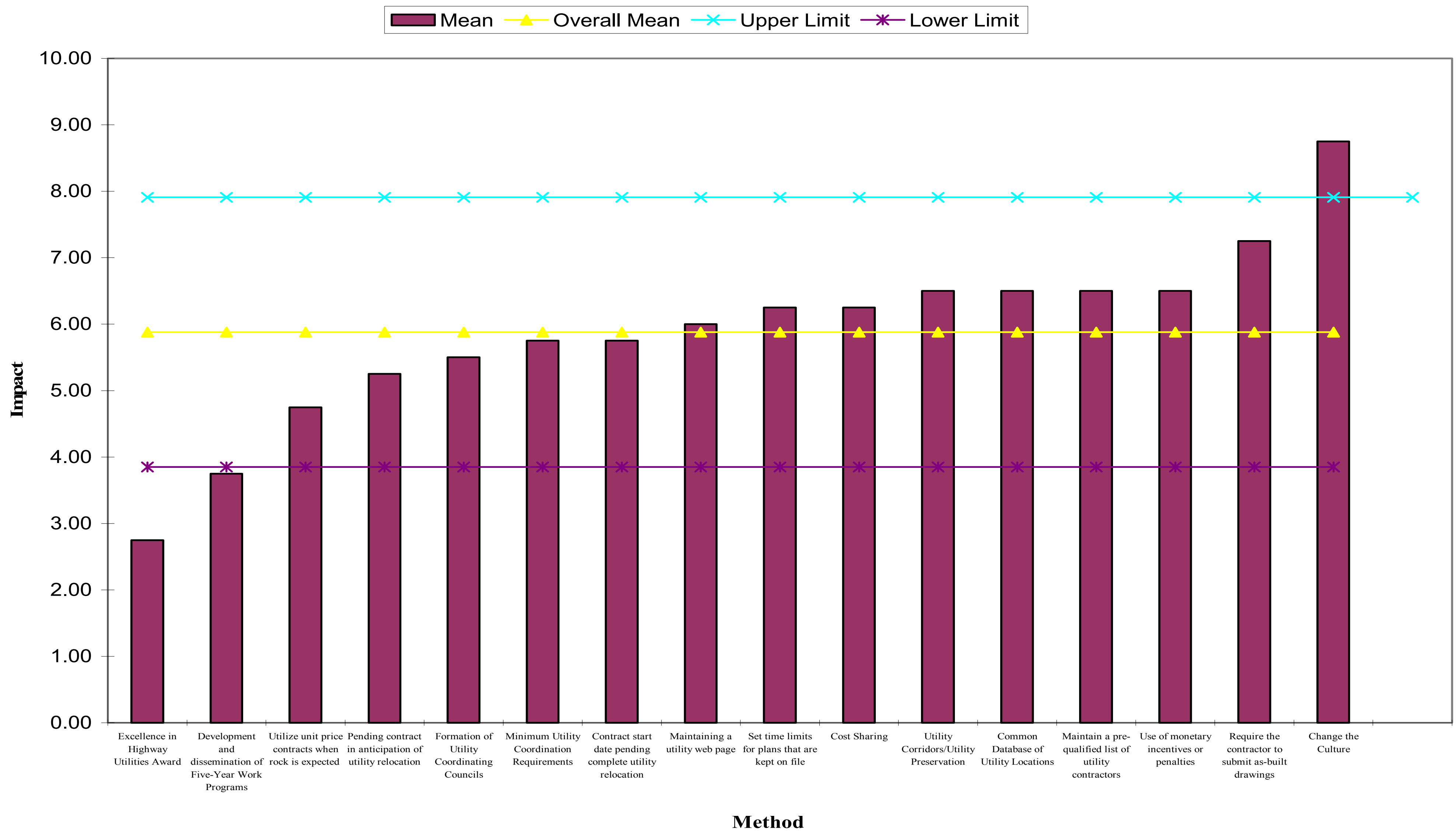
The control chart on the following page (Figure 30) shows that changing the culture is perceived as having the highest impact on reducing the frequency and severity of utility conflicts according to utility and contractor representatives. This method is proceeded by these suggestions in order of decreasing impact:

1. Require the contractor to submit as-built drawings for new and relocated utilities and for all utilities uncovered throughout the project.
2. Use of monetary incentives or penalties for (un)timely completion of utility relocations; and
3. Maintain a pre-qualified list of utility contractors and allow contractors to perform relocations.

The "Excellence in Highways Utility Award" and Development and dissemination of five-year work programs are perceived to have the lowest potential impacts on reducing the frequency and severity of utility conflicts according to utility and contractor representatives. These suggestions are preceded by the following suggestions in order of increasing impact:

1. Utilize unit price contracts when rock is expected in contracts where utilities are relocated;
2. Pending contract in anticipation of utility relocation; and
3. Formation of utility coordinating councils.

Figure 30: Control Chart of Impact vs. Method from Utility and Contractor Representatives



The following table (Table 120) shows the voting results for each suggestion's investment taken from the 4 members of this grouping. The individual and overall means and standard deviations were calculated for these suggestions and the upper and lower limits were created. The total values for mean and standard deviation given in this table are the overall averages for the mean and standard deviation columns.

Table 120: Proposed Investment of Suggestions from Utility and Contractor Representatives

Method	Mean	N	Std. Deviation
Common Database of Utility Locations	1.50	4.00	0.58
Utility Corridors/Utility Preservation	1.75	4.00	0.96
Use of monetary incentives or penalties	1.75	4.00	0.96
Cost Sharing	4.25	4.00	3.40
Maintaining a utility web page	5.00	5.00	2.12
Pending contract in anticipation of utility relocation	5.00	4.00	1.41
Minimum Utility Coordination Requirements	5.50	4.00	1.73
Excellence in Highway Utilities Award	5.75	4.00	2.75
Contract start date pending complete utility relocation	5.75	4.00	2.63
Formation of Utility Coordinating Councils	6.00	4.00	0.82
Maintain a pre-qualified list of utility contractors	6.00	4.00	1.15
Require the contractor to submit as-built drawings	6.25	4.00	1.50
Utilize unit price contracts when rock is expected in contracts where utilities are relocated	6.25	4.00	3.50
Set time limits for plans that are kept on file	6.75	4.00	2.06
Development and dissemination of Five-Year Work Programs	7.25	4.00	2.75
Change the Culture	7.75	4.00	2.22
Total	5.15	65.00	2.62

** Lower Limit = 3.14, Upper Limit = 7.16, and Overall Mean = 5.15 **

5.5.4.2 Investment Control Chart Results for Utility and Contractor Representatives

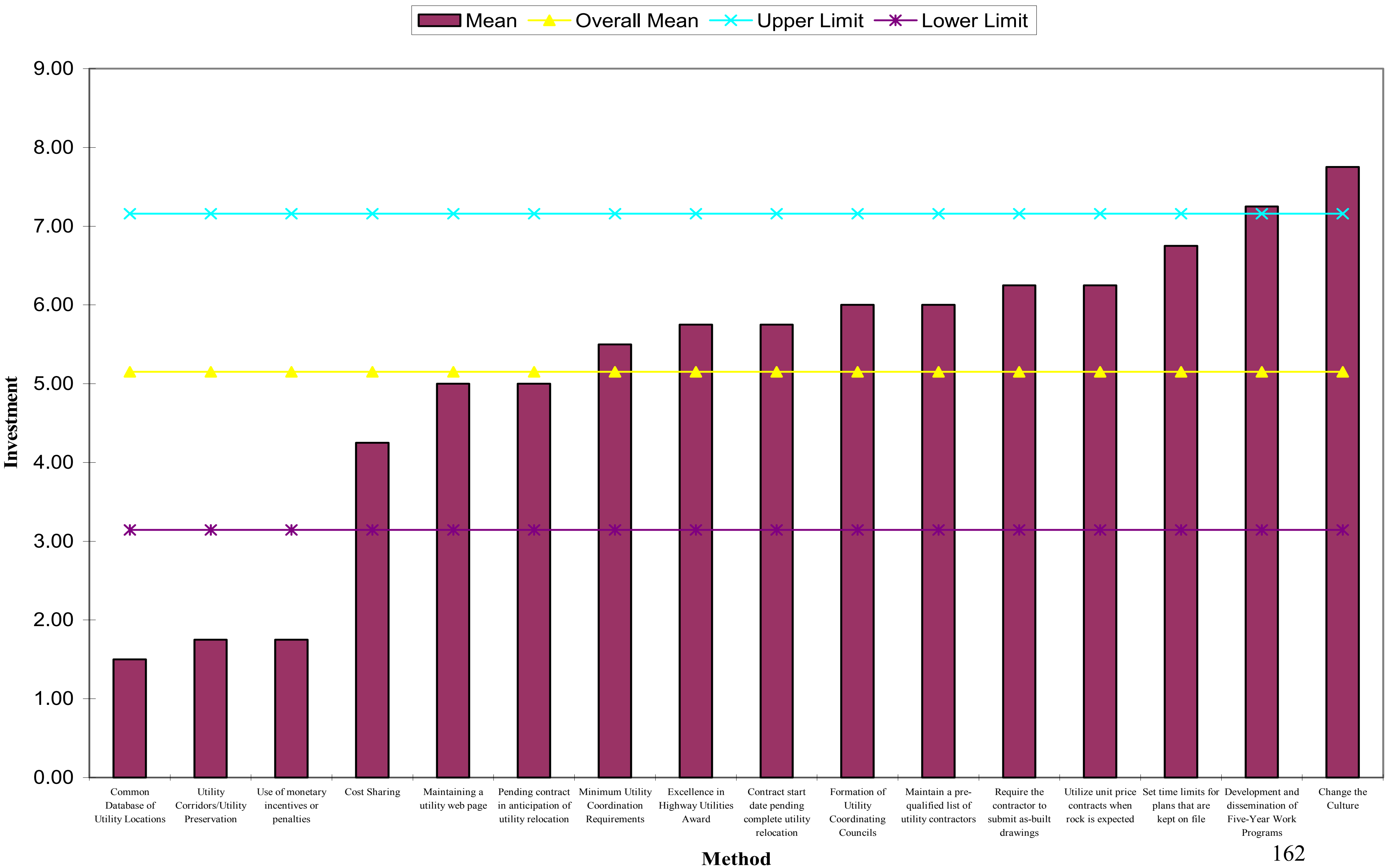
The control chart on the following page (Figure 31) shows that common database of utility locations/GIS and GPS used for mapping, utility corridors/utility preservation, and use of monetary incentives or penalties for (un)timely completion of relocations have the highest perceived implementation costs according to utility and contractor representatives. These three methods are preceded by the following suggestions in order of decreasing investment:

1. Cost sharing;
2. Maintaining a utility web page; and
3. Pending contract in anticipation of utility relocation.

Change the culture and development and dissemination of five-year work programs are perceived to have the lowest implementation costs according to utility and contractor representatives. These suggestions are proceeded by the following suggestions in order of increasing investment:

1. Set time limits for plans that are kept on file;
2. Utilize unit price contracts when rock is expected in contracts where utilities are relocated; and
3. Require the contractor to submit as-built drawings for new and relocated utilities and for all utilities uncovered throughout the project.

Figure 31: Control Chart of Investment vs. Method from Utility and Contractor Representatives



The following table (Table 121) shows the voting results for each suggestion's score derived from the voting results from the 4 members of this grouping. The individual and overall means and standard deviations were calculated for these suggestions and the upper and lower limits were created. The total values for mean and standard deviation given in this table are the overall averages for the mean and standard deviation columns.

Table 121: Score from the Product of Impact and Investment from Utility and Contractor Representatives

Method	Mean	N	Std. Deviation
Common Database of Utility Locations	10.00	4.00	5.72
Utility Corridors/Utility Preservation	10.75	4.00	4.35
Use of monetary incentives or penalties	11.50	4.00	6.45
Excellence in Highway Utilities Award	17.00	4.00	13.49
Cost Sharing	18.00	4.00	5.89
Development and dissemination of Five-Year Work Programs	20.25	4.00	12.45
Utilize unit price contracts when rock is expected	20.50	4.00	8.54
Pending contract in anticipation of utility relocation	23.50	4.00	13.89
Minimum Utility Coordination Requirements	31.25	4.00	22.14
Maintaining a utility web page	32.40	5.00	23.75
Formation of Utility Coordinating Councils	33.50	4.00	10.63
Contract start date pending complete utility relocation	33.75	4.00	33.17
Maintain a pre-qualified list of utility contractors	37.50	4.00	17.39
Set time limits for plans that are kept on file	39.25	4.00	12.79
Require the contractor to submit as-built drawings	42.50	4.00	13.38
Change the Culture	67.25	4.00	16.98
Total	28.12	65.00	20.01

** Lower Limit = 12.79, Upper Limit = 43.45, and Overall Mean = 28.12 **

5.5.4.3 Score Control Chart Results for Utility and Contractor Representatives

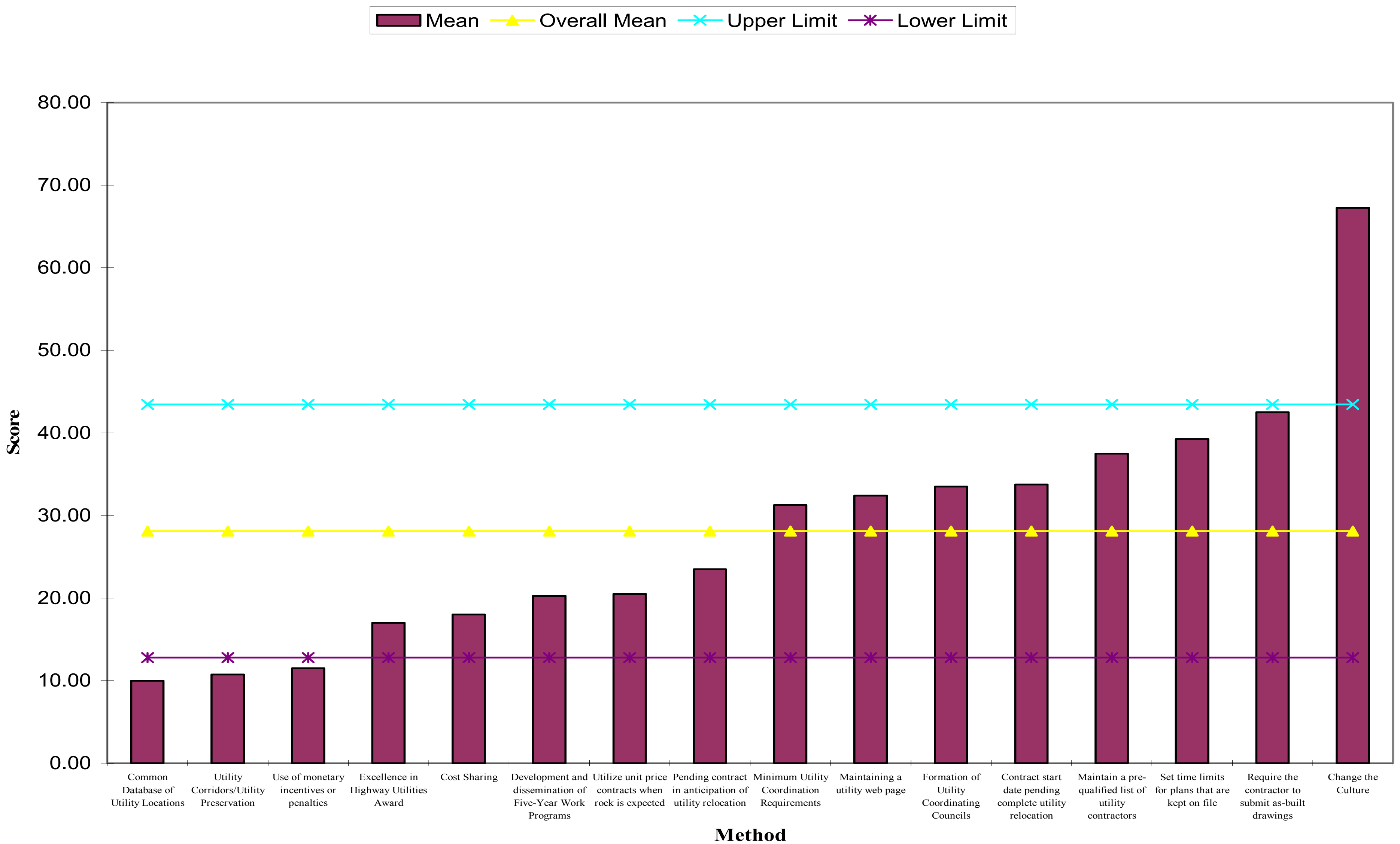
The control chart on the following page (Figure 32) shows that changing the culture is perceived as having the highest impact and lowest cost for reducing the frequency and severity of utility conflicts according to utility and contractor representatives. This method is proceeded by these suggestions in order of decreasing score:

1. Require the contractor to submit as-built drawings for new and relocated utilities and for all utilities uncovered throughout the project;
2. Set time limits for plans that are kept on file; and
3. Maintain a pre-qualified list of utility contractors and allow contractors to perform relocations.

Common database of utility locations/GIS and GPS used for utility mapping, utility corridors/utility preservation, and use of monetary incentives or penalties for (un)timely completion of utility relocations are perceived to have the lowest impacts and highest costs for reducing the frequency and severity of utility conflicts according to utility and contractor representatives. These suggestions are preceded by the following suggestions in order of increasing score:

1. Excellence in Highway Utilities Award;
2. Cost Sharing; and
3. Development and dissemination of five-year work programs.

Figure 32: Control Chart of Score vs. Method from Utility and Contractor Representatives



5.5.5 Federal and State Workers

The following section isolates the voting results from the federal and state workers, ignoring the utility and contractor representatives. This has been done to gain a better understanding of the owner's perspective regarding these suggestions. These people may or may not experience many of the previously mentioned conflicts directly at the workface, but they work for the owners who are paying for the projects and have a great deal at stake regarding the relocation process.

Table 122 on the following page shows the voting results for each suggestion's impact taken from the 7 members of this grouping. The individual and overall means and standard deviations were calculated for these suggestions and the upper and lower limits were created. The total values for mean and standard deviation given in this table are the overall averages for the mean and standard deviation columns.

Table 122: Proposed Impact of Suggestions from Federal and State Workers

Method	Mean	N	Std. Deviation
Excellence in Highway Utilities Award	2.00	7.00	0.58
Contract start date pending complete utility relocation	4.14	7.00	2.48
Utility Corridors/Utility Preservation	4.43	7.00	1.81
Utilize unit price contracts when rock is expected	4.57	7.00	2.44
Formation of Utility Coordinating Councils (UCC)	5.00	7.00	2.58
Minimum Utility Coordination Requirements	5.14	7.00	1.77
Maintain a pre-qualified list of utility contractors	5.43	7.00	1.72
Cost Sharing	5.71	7.00	2.36
Development and dissemination of Five-Year Work Programs	5.86	7.00	2.61
Pending contract in anticipation of utility relocation	5.86	7.00	2.73
Maintaining a utility web page	6.14	7.00	2.54
Require the contractor to submit as-built drawings	6.14	7.00	3.02
Set time limits for plans that are kept on file	6.57	7.00	2.30
Common Database of Utility Locations	7.00	7.00	1.41
Use of monetary incentives or penalties	7.57	7.00	0.79
Change the Culture	9.14	7.00	0.69
Total	5.67	112.00	2.51

** Lower Limit = 3.74, Upper Limit = 7.60, and Overall Mean = 5.67 **

5.5.5.1 Impact Control Chart Results for Federal and State Workers

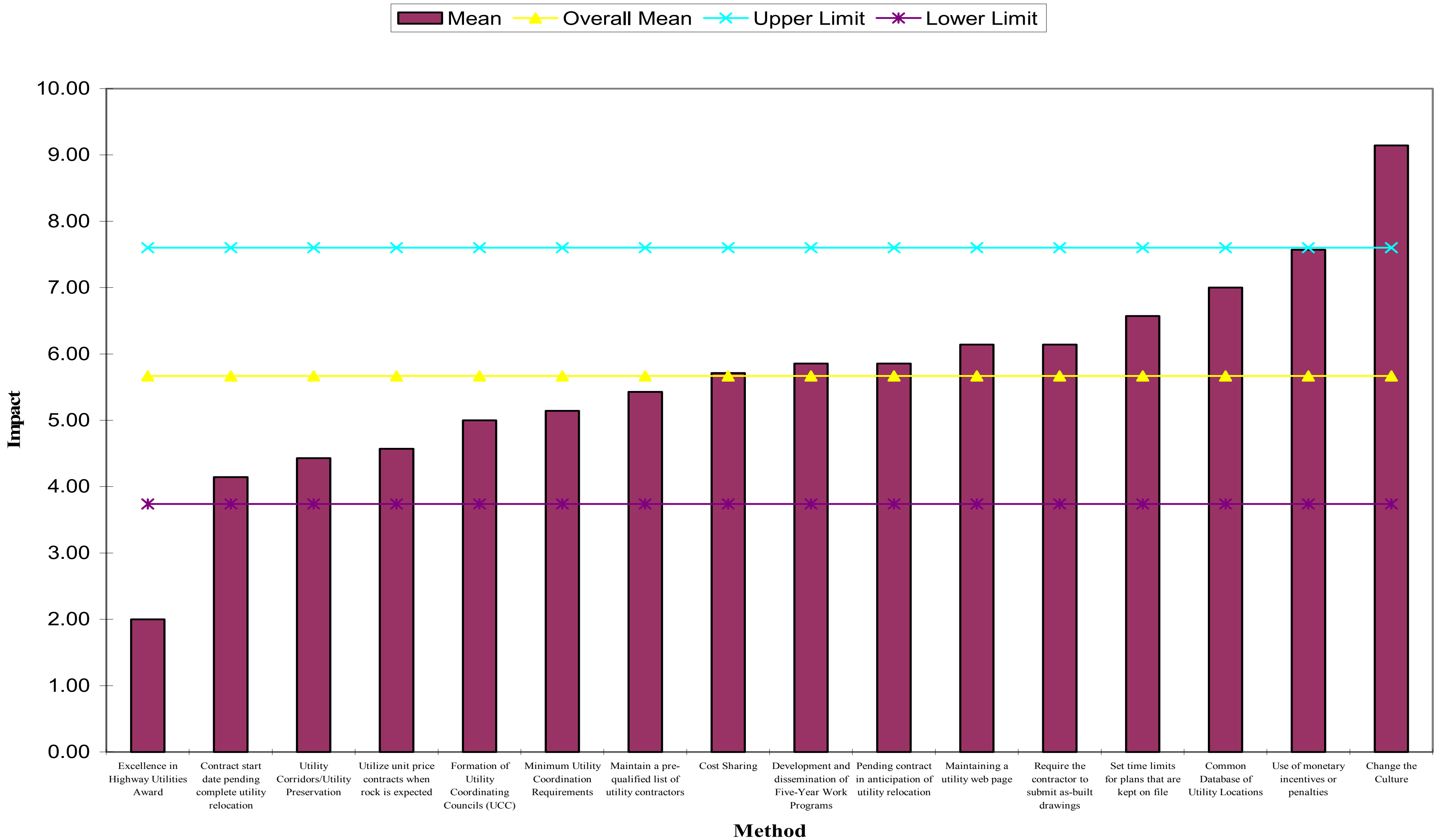
The control chart on the following page (Figure 33) shows that changing the culture and use of monetary incentives or penalties for (un)timely completion of utility relocations are perceived as having the highest impacts on reducing the frequency and severity of utility conflicts according to federal and state workers. These methods are proceeded by these suggestions in order of decreasing impact:

1. Common database of utility locations/GIS and GPS used for utility mapping;
2. Set time limits for plans that are kept on file; and
3. Require the contractor to submit as-built drawings for new and relocated utilities and for all utilities uncovered throughout the project.

The "Excellence in Highways Utility Award" is perceived to have the lowest potential impact on reducing the frequency and severity of utility conflicts according to federal and state workers. This suggestion is preceded by the following suggestions in order of increasing impact:

1. Contract start time pending complete utility relocation;
2. Utility corridor/utility preservation; and
4. Utilize unit price contracts when rock is expected in contracts where utilities are relocated.

Figure 33: Control Chart of Impact vs. Method from Federal and State Workers



The following table (Table 123) shows the voting results for each suggestion's investment taken from the 7 members of this grouping. The individual and overall means and standard deviations were calculated for these suggestions and the upper and lower limits were created. The total values for mean and standard deviation given in this table are the overall averages for the mean and standard deviation columns.

Table 123: Proposed Investment of Suggestions from Federal and State Workers

Method	Mean	N	Std. Deviation
Common Database of Utility Locations	1.71	7.00	1.11
Utility Corridors/Utility Preservation	1.86	7.00	0.69
Maintaining a utility web page	3.86	7.00	1.95
Minimum Utility Coordination Requirements	4.57	7.00	1.99
Use of monetary incentives or penalties	4.57	7.00	2.07
Change the Culture	5.57	7.00	2.76
Cost Sharing	5.57	7.00	2.76
Require the contractor to submit as-built drawings	5.71	7.00	2.81
Development and dissemination of Five-Year Work Programs	6.00	7.00	1.29
Formation of Utility Coordinating Councils (UCC)	6.29	7.00	1.50
Set time limits for plans that are kept on file	6.43	7.00	1.90
Maintain a pre-qualified list of utility contractors	6.43	7.00	3.10
Contract start date pending complete utility relocation	6.71	7.00	2.75
Utilize unit price contracts when rock is expected	6.86	7.00	1.35
Pending contract in anticipation of utility relocation	7.14	7.00	2.12
Excellence in Highway Utilities Aw	7.71	7.00	2.29
Total	5.44	112.00	2.61

** Lower Limit = 3.44, Upper Limit = 7.44, and Overall Mean = 5.44 **

5.5.5.2 Investment Control Chart Results for Federal and State Workers

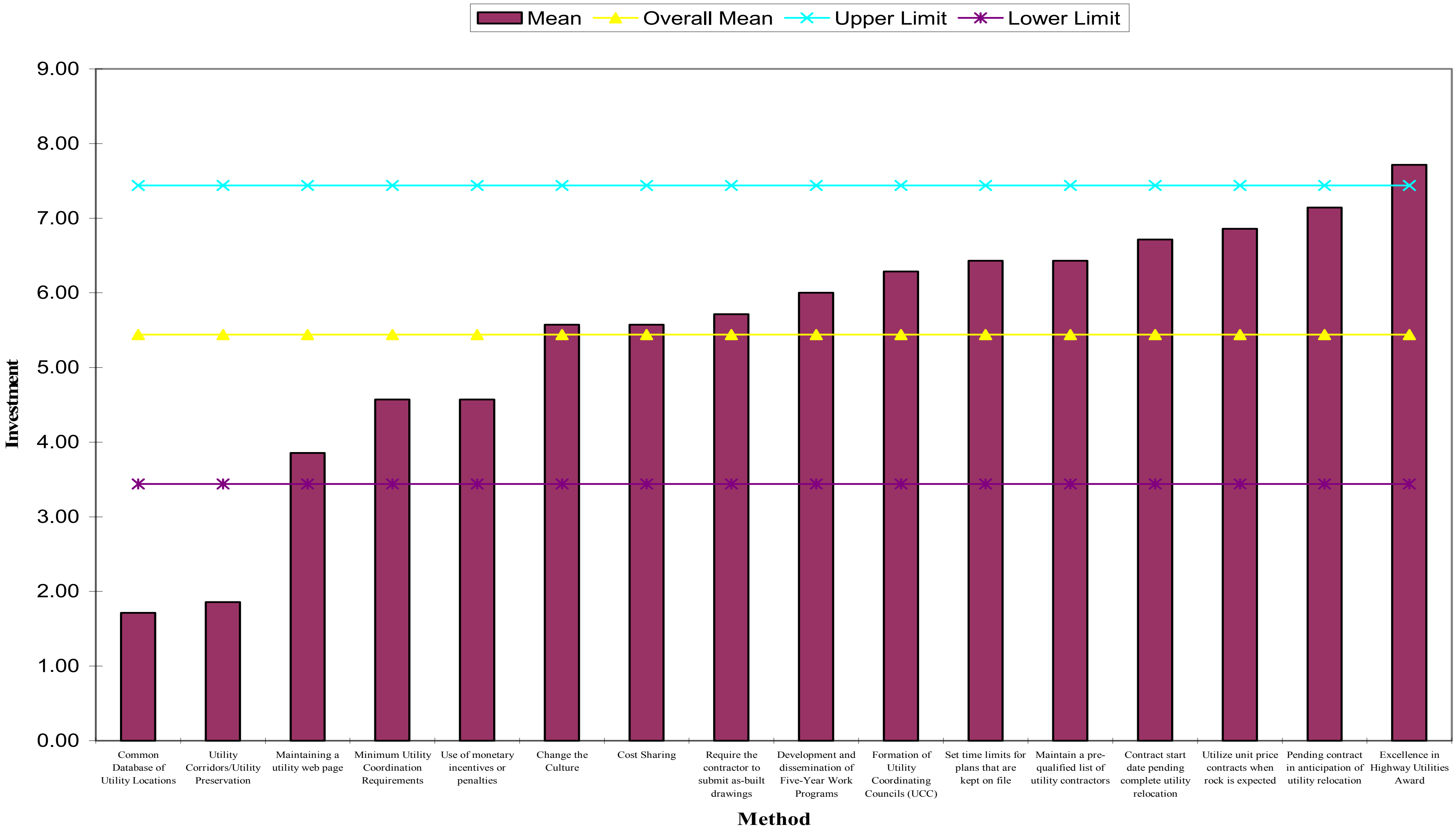
The control chart on the following page (Figure 34) shows that common database of utility locations/GIS and GPS used for mapping and utility corridors/utility preservation have the highest perceived implementation costs according to federal and state workers. These methods are preceded by the following suggestions in order of decreasing investment:

1. Maintaining a utility web page;
2. Minimum utility coordination requirements; and
3. Use of monetary incentives or penalties for (un)timely completion of utility relocations.

The "Excellence in Highway Utility Award" is perceived to have the lowest implementation cost according to federal and state workers. This suggestion is proceeded by the following suggestions in order of increasing investment:

1. Pending contract in anticipation of utility relocation;
2. Utilize unit price contracts when rock is expected in contracts where utilities are relocated; and
3. Contract start time pending complete utility relocation.

Figure 34: Control Chart of Investment vs. Method from Federal and State Workers



The following table (Table 124) shows the voting results for each suggestion's score derived from the voting results from the 7 members of this grouping. The individual and overall means and standard deviations were calculated for these suggestions and the upper and lower limits were created. The total values for mean and standard deviation given in this table are the overall averages for the mean and standard deviation columns.

Table 124: Score from the Product of Impact and Investment from Federal and State Workers

Method	Mean	N	Std. Deviation
Utility Corridors/Utility Preservation	8.29	7.00	4.99
Common Database of Utility Locations	11.29	7.00	6.13
Excellence in Highway Utilities Award	15.29	7.00	5.91
Minimum Utility Coordination Requirements	22.86	7.00	11.17
Maintaining a utility web page	24.00	7.00	15.15
Contract start date pending complete utility relocation	28.14	7.00	21.19
Cost Sharing	29.29	7.00	18.57
Utilize unit price contracts when rock is expected	29.86	7.00	14.93
Formation of Utility Coordinating Councils (UCC)	31.57	7.00	17.01
Maintain a pre-qualified list of utility contractors	33.14	7.00	20.05
Development and dissemination of Five-Year Work Programs	35.14	7.00	18.24
Use of monetary incentives or penalties	35.43	7.00	17.84
Require the contractor to submit as-built drawings	37.57	7.00	31.20
Set time limits for plans that are kept on file	40.29	7.00	15.93
Pending contract in anticipation of utility relocation	44.43	7.00	25.94
Change the Culture	51.29	7.00	26.86
Total	29.87	112.00	20.52

** Lower Limit = 14.15, Upper Limit = 45.59, and Overall Mean = 29.87 **

5.5.5.3 Score Control Chart Results for Federal and State Workers

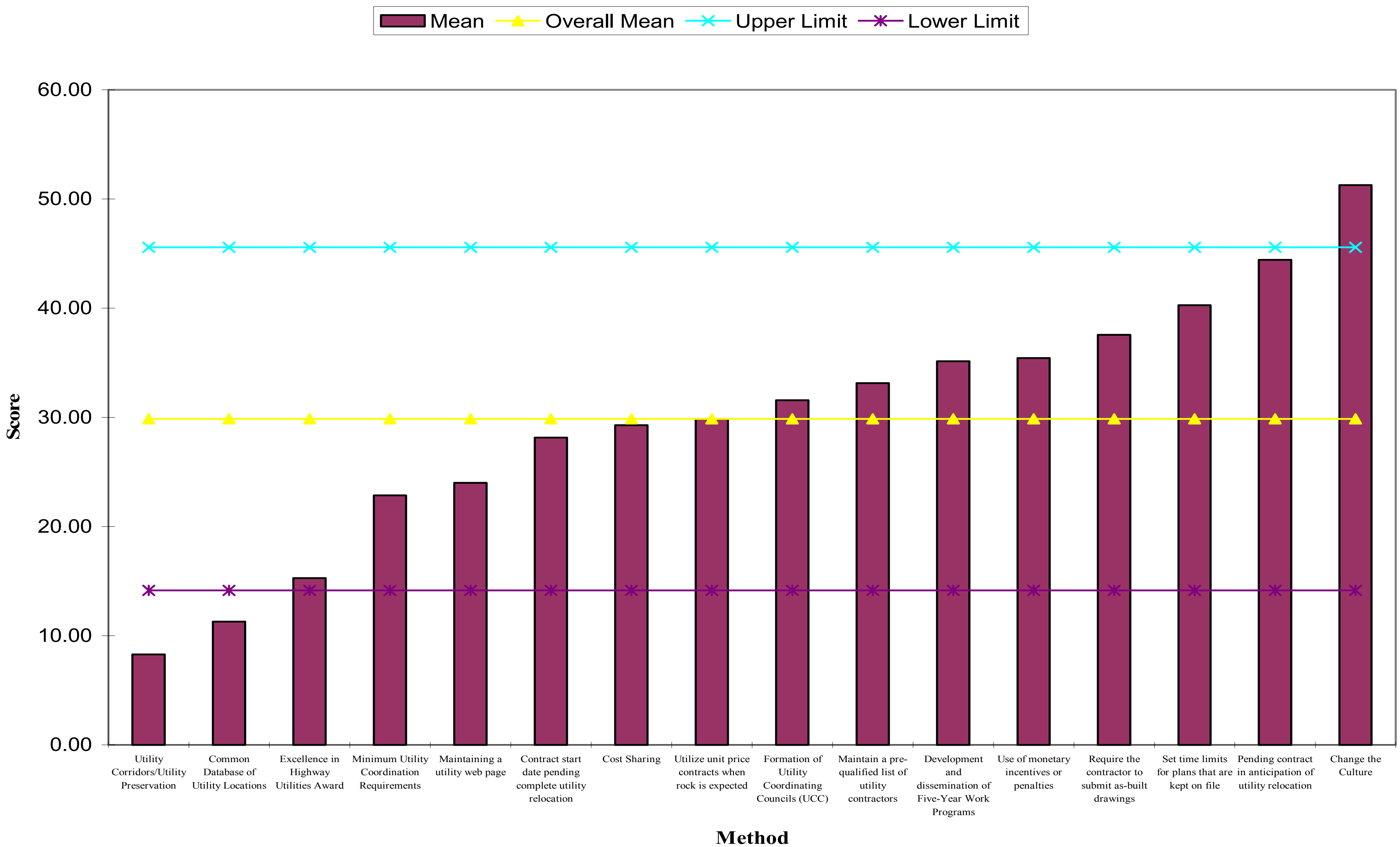
The control chart on the following page (Figure 35) shows that changing the culture is perceived as having the highest impact and lowest cost for reducing the frequency and severity of utility conflicts according to federal and state workers. This method is proceeded by these suggestions in order of decreasing score:

1. Pending contract in anticipation of utility relocation;
2. Set time limits for plans that are kept on file; and
3. Require the contractor to submit as-built drawings for new and relocated utilities and for all utilities uncovered throughout the project.

Utility corridors/utility preservation and common database of utility locations/GIS and GPS used for utility mapping are perceived to have the lowest impacts and highest costs for reducing the frequency and severity of utility conflicts according to federal and state workers. These suggestions are preceded by the following suggestions in order of increasing score:

1. Excellence in Highway Utilities Award;
2. Minimum utility coordination requirements; and
3. Maintaining a utility web page.

Figure 35: Control Chart of Score vs. Method from Federal and State Workers



6 Recommendations

Throughout this project, the research team compiled and analyzed a vast amount of data concerning conflicts associated with utility relocations. Resolving these conflicts requires a great deal of time and money, resulting in project delays and cost overruns. This chapter suggests a list of recommendations proposed by this research team to help avoid many of these conflicts on future projects.

6.1 Case Studies

Throughout the case study analys3s, numerous utilities conflicts were identified with corresponding common sources. Specific recommendations for the sources of the utility conflicts identified in the case study analysis include the following:

- **Incorrect Location on Plans**
  - Greater care and precision are needed to make sure that utility lines are being installed in the correct location and at the correct depth..
  - Utilize SUE and GIS to identify utility location when possible.

- **Design Error**
  - Verifying precise field location, for example through SUE QL A work, will help reduce many design errors involving utility lines.

- **Delays in Relocation of Utilities**
  - Utilities should be given ample time to relocate their facilities.
  - Utilities should try and relocate their facilities in accordance with the dates set forth by the Kentucky Transportation Cabinet as much as possible.

- **Incorrect Locate by BUD**
  - Provide better training for BUD locators.
  - Ensure all installed piping that is non-metallic contains tracer wire that is of sufficient quality.

- **Abandoned Lines**

•Identification of abandoned lines is particularly problematic on many utility projects, especially in urban areas. While there is no immediate resolution to this problem, developing a GIS of known abandoned lines could provide a significant improvement.

•**Unknown Location of Service Lines**

•While main utility lines understandably receive more attention when utilities are located, conflicts often occur due to service lines, which if disrupted can have a serious impact on local business and the citizens of the Commonwealth. More effort is needed in locating service lines during construction.

Although no valid justification for these recommendations was included in the before mentioned recommendations, the benefits of adopting these recommendations should at least alleviate some of the impact of the direct and indirect costs accrued from utility conflicts. The most significant of these recommendations is the incorporation of SUE into the roadway design. As previously suggested, the rate of return for every dollar invested in SUE work is 462% (Lew 2000). Kentucky's progressive SUE policy is warranted.

6.2 States Questionnaire

These research efforts utilized a survey sent to state utility directors in all 50 states, to identify issues related to the utility relocation process. A total of 45 states participated in the survey, and their responses have been combined and analyzed in the previous chapter. The analysis yielded important information pertaining to the utility process, and the most notable findings are provided below.

- The utility conflict identified as occurring most commonly on urban projects was related to underground telecommunication lines, while above ground electrical lines generate the most conflicts on rural projects.

- Underground telecommunication conflicts also have a more severe impact on urban projects than any other type of conflict. Similarly, rural projects are most severely impacted by underground telecommunication conflicts.

- A very significant difference exists between the frequency of conflicts occurring on urban and rural projects. All types of utilities experience a greater number of conflicts on urban projects in comparison to rural projects.

- A similar comparison of conflict impact on urban and rural projects indicated a very significant difference. The only utilities not indicating a significant difference were above ground telecommunication lines and above ground electrical lines.

- The level of coordination between utility companies and state transportation agencies is higher than the level of coordination between utility companies and designers outside the state transportation agency.

- Subsurface utility engineering is used more often on urban projects than rural projects, and is rarely used by utility companies for design.

- States prefer vacuum excavation over hydro excavation when obtaining SUE Quality Level A information, mainly because it is less destructive and has a reduced chance of damaging the utility.

- All utility companies locate a greater percentage of their facilities in comparison to one call centers.

- The analysis indicates that location accuracy provided by one call centers is not improved significantly by states that hold one call centers liable for the accuracy of their utility markings. All types of utilities indicated no significant difference between states that do hold their centers liable for marking accuracy and those that do not.

6.3 Suggestions

The research team compiled a list of suggestions on how to avoid utility conflicts through an extensive literature review, team meetings, site interviews, and state questionnaires. The suggested were prioritized by their anticipated level of impact and investment cost by the study advisory committee (SAC). A comparison of the suggestions that offered a combination of high impact and low cost are summarized below by different stakeholders that participated on the SAC.

Utility and Contractor Representatives:

<u>Highest Impact:</u>

1. Change the culture within the Cabinet to better address utility needs before a project is released for bid;
2. Require the contractor to submit as-built drawings for new and relocated utilities and for all utilities uncovered throughout the project; and
3. Use monetary incentives or penalties for (un)timely completion of utility relocations.

Smallest Investment:

1. Change the culture within the Cabinet to better address utility needs before a project is released for bid;
2. Development and dissemination of five-year work programs; and
3. Set time limits for plans that are kept on file.

Highest Score (Impact x Investment):

1. Change the culture within the Cabinet to better address utility needs before a project is released for bid;
2. Require the contractor to submit as-built drawings for new and relocated utilities and for all utilities uncovered throughout the project; and
3. Set time limits for plans that are kept on file.

Federal and State Workers

Highest Impact:

1. Change the culture within the Cabinet to better address utility needs before a project is released for bid;
2. Use monetary incentives or penalties for (un)timely completion of utility relocations; and
3. Common database of utility locations/GIS and GPS used for utility mapping.

Smallest Investment:

3. Excellence in highway utility award;
4. Pending contract in anticipation of utility relocation; and
5. Utilize unit price contracts when rock is expected in contracts where utilities are relocated.

Highest Score (Impact x Investment):

2. Change the culture within the Cabinet to better address utility needs before a project is released for bid;
3. Issue pending contracts in anticipation of utility relocation; and
4. Set time limits for plans that are kept on file.

6.3.1 Comparison of Results

The preceding results from the voting process show that both groups are in agreement on the following perceived characteristics for the proposed suggestions to alleviate utility relocation conflicts:

- Changing the culture and use of monetary incentives and penalties for (un)timely completion of utility relocations will have the greatest impact.
- Changing the culture and the "Excellence in Highways Utility Award" will have the lowest investment cost.
- Changing the culture and setting time limits for plans that are kept on file will have the highest overall impact with the lowest overall investment cost.

6.4 Implementation Plans

The following section divides the suggested methods into three different implementation plans based on level of impact, cost of investment, and magnitude of changes to current legislation and policies in order to execute the methods. The short-term implementation plan contains methods that can be enacted within the next 5 years and typically has an average to high impact with below average investment costs. A suggestion in this plan does not require any special legislation or major policy changes. The medium-term implementation plan contains methods that can be enacted within the next 5 to 10 years and typically has an average to high impact with an average investment cost. A suggestion within this plan may require special legislation and minor policy changes. The long-term implementation plan contains methods that cannot be enacted until 10 or more years to produce feasible benefits. A suggestion in this plan has an average to high impact with an average to high investment cost and will generally require special legislation and major policy changes to enact.

Short Term Implementation Plan (Next 5 Years):

1. Set time limits for plans kept on file to avoid using outdated design information during construction
2. Require the contractor to submit as-built drawings in order to improve the accuracy of utility information on future projects.
3. Maintain a pre-qualified list of utility contractors and/or allow contractors to perform relocation work whenever possible.
4. Pending contracts in anticipation of utility relocation (low bidder is identified, but a contract is not awarded until all utilities are successfully relocated by the utility

companies of other parties.)

Medium Term Implementation Plan (5 to 10 Years):

1. Formation of utility coordinating councils
2. Minimum utility coordination requirements
3. Use of monetary incentives or penalties for (un)timely completion of utility relocations
4. Cost sharing between the state and utility companies for utility relocation expenses.

Long-Term Implementation Plan (10 years or longer):

6. Change the culture within the Cabinet to better address utility needs before a project is released for bid;
7. Develop a utility web page to provide contact information at all utility companies and provide the state's five year work program.
3. Development and dissemination of five-year work programs
4. Develop a common database of utility locations
5. Develop utility corridors/utility preservation for common areas of utility locations on future projects.

According to the expert opinions of the committee's professional members, the following suggestions are not feasible to enact at this time:

1. Contract start date pending complete utility relocation;
2. Utilize unit price contracts when rock is expected; and
3. Excellence in Highways Utility Award.

7 Conclusion

Events in the past few years have made it clear that processes for highway improvement projects involving the relocation of utility facilities must change. Better communication, coordination and cooperation among the highway agency, design consultants, utility companies and contractors are essential to minimize disruption for motorists and nearby property owners and to reduce the time and cost of completing these projects.

Utility companies and government agencies both need to use the right-of-way to fulfill their respective legal duties to serve the public. Since the right-of-way is host to a complex network of utility facilities, highway improvement projects are likely to result in conflicts with those facilities. Such conflicts are likely to become more commonplace as a growing population demands greater highway vehicular capacity and enhanced utility services. This report details many of the factors that contribute to the problems experienced today.

This report also presents some initial ideas for addressing those issues. These ideas should be the starting point for a more comprehensive examination of those issues. The research team believes that implementation of these recommendations should minimize both delays and additional costs associated with these projects. The ultimate goal is to have procedures in place throughout the highway improvement process that provide for improved communication, coordination and cooperation among the project partners and stakeholders.

8 References

Anspach, Jim (2001). "Subsurface Utility Engineering in Washington State." *Washington State Technology Transfer,* Issue 71, Summer 2001.

AASHTO/FHWA. (2004). *Right of Way and Utilities Guidelines and Best Practices*, Strategic Plan Strategy 4-4, Washington, DC.

AASHTO/FHWA. (2005). Right-of-Way and Utilities Subcommittee Conference. Austin, Texas.

Barber, Andy. Personal Interview. June 2, 2005.

Barber, Andy. Personal Interview. June 4, 2005.

Barber, Andy. Personal Interview. June 15, 2005.

Bowman, Rick. Personal Interview. June 2, 2005.

Brown, Bill. Personal Interview. May 31, 2005.

Committee Meeting (9-21-2005). Utilities and Right-of-Way Committee Meeting. September 21, 2005.

Cox, Jim. Personal Interview. June 16, 2005.

Deaton, Raleigh. Personal Interview. June 20, 2005.

Denham, Charles. Personal Interview. June 3, 2005.

Dunn, Gene. Personal Interview. June 21, 2005.

Edwards, Alan. Personal Interview. April 7, 2005.

Ellis, Ralph. (2003) "Development of Improved Strategies for Avoiding Utility Related Delays During FDOT Highway Construction Projects." University of Florida Department of Civil and Coastal Engineering, < www.dot.state.fl.us/research-center/ Completed_Proj/Summary_CN/FDOT_BC354_52_rpt.pdf> (August 30, 2004).

FHWA Asset Management Position Paper (2004). Cambridge Systematics, Inc., Cambridge, Massachusetts.

FHWA (2002). *Acquiring Real Property for Federal and Federal-Aid Programs and Projects*. FHWA Publication No. FHWA-PD-95-005. U.S. Department of Transportation.

FHWA[1] (2003) "Table, Appraisal and Conflict of Interest Threshold," Federal Highway Administration, Office of Real Estate Services, U.S. Department of Transportation, Washington, D.C. <http://www.fhwa.dot.gov/realestate/waiver.htm> (February 3, 2005).

FHWA[2] (2003). "Program Guide: Utility Relocation and Accommodation on Federal-Aid Highway Projects" Office of Program Administration Federal Highway Association.

Griffin, Jeff. (2001). "Utility Locates: Many Factors Contribute to the Success & Failure of this Essential, Yet Complicated Process." *Underground Construction,* April 2001, 30-31.

Griffin, Jeff. (2002). "Massive Potholing Effort Saves Millions In Phoenix Area." *Underground Construction,* April 2002, 17-18.

Griffith, Ryan. Personal Interview. June 16, 2005.

Groves, Greg., Personal Interview, February 8, 2005.

Hakimi, Shadi, and Kockelman, Karla M. (2005). "Right-of-Way Acquisition and Property Condemnation: A Comparison of U.S. State Laws." *Transportation Research Record,* in press.

Hancher, Donn E., Thozal, Joseph J., and Goodrum, Paul M. (2003). *Constructability Issues on KyTC Projects*. Kentucky Transportation Center, Lexington, KY.

Hayes, Steve. Personal Interview. May 12, 2005.

Hinkle Contracting Corp. Personal Interview. May 11, 2005.

Hodskins, Joey. Personal Interview. May 24, 2005.

Jasper, Danny. Personal Interview. January 13, 2005.

Jeong, Hyung Seok, Dulcy M. Abraham, and Jeffrey J. Lew. (2004) "Evaluation of an Emerging Market in Subsurface Utility Engineering." *J. Constr. Eng. Manage.*, 130 (2), 225-234.

Keiser, Bob. Personal Interview. June 7, 2005.

Kuhn, Beverly. (2003) "Cramped Quarters: Researchers explore how to make the most of limited space in rights-of-way." *Texas Transportation Researcher,* 39(4), 19.

KyTC. (2005). "Kentucky – HIS Interactive Planning Map." *Highway Information Interactive Mapping*, <http://kytcgis.ky.gov/his/KYTC_PL-HIS_Pickit.htm> (June 22, 2005).

Lawson, Don. Personal Interview. May 25, 2005.

Lawson, Don. Personal Interview. June 15, 2005.

Lawson, Don. Personal Interview. June 16, 2005.

Lawson, Don. Personal Interview. June 22, 2005.

Lemaster, Ken. Personal Interview. May 23, 2005.

Lew, J.J. (2000). "Cost Savings on Highway Projects Utilizing Subsurface Subsurface Utility Engineering." *Federal Highway Administration, NTIS No. FHWA/IF00/014*, Washington, D.C.

Lew, J. J., and Anspach, J. H. (2000). ''Elimination of Utility Line Cuts on a Highway Project Using Subsurface Utility Engineering.'' *Proc. CIB W99 Int. Conf. on Designing for Safety and Health*, London, 235–242.

Lindas, L. I. Trial Aids in Condemnation Cases. In *Transportation Research Record: Journal of the Transportation Research Board, No. 76,* TRB, National Research Council, Washington, D.C., 1963, pp. 51-69.

Long, Kevin. Personal Interview. June 15, 2005.

Martin, Charlie. Personal Interview. June 15, 2005.

Meeting at Cabinet Central Offices (10-25-2005). Utility and Right-of-Way Meeting. October 25, 2005.

Meukus, Mark. Personal Interview. June 22, 2005.

Minnesota Department of Transportation. (2000). *Utility Relocation Study Report to the 2000 Minnesota Legislature: A Cooperative Effort to Improve the Utility Relocation Process During Highway Construction.* February 2000.

Moeller, Richard, et al. *European Right-of-Way and Utilities Best Practices.* American Trade Initiatives. August 2002. Accessed 24 August 2004. <http://international.fhwa.dot.gov/eurorightofway/index.htm>

Monohan, Jeff. Personal Interview. June 10, 2005.

NCHRP, 2000. *Innovative Practices to Reduce Delivery Time for Right-of-Way in Project Development*. National Cooperative Highway Research Program, Washington D.C.

Nichols Consulting Engineers (2002). *Avoiding Utility Relocations*. FHWA Publication No. DTFH61-01-C-00024. U.S. Department of Transportation.

Owner of The Goodie Shack. Personal Interview. May 11, 2005.

Owner of Lookout Marine. Personal Interview. May 31, 2005.

Proffitt, Tom. Personal Interview. April 1, 2005.

Ramey, Carol. Personal Interview. May 11, 2005.

Right of Way Quality Management System The Journey of Five States (1999). Federal Highway Administration, Washington D.C.

RS Means. (2003). *Building Construction Cost Data*, 62nd Ed., R.S. Means Company, Kingston, MA.

Sadler, RichaRoad Personal Interview. May 11, 2005.

Sharp, Tim. Personal Interview. June 16, 2005.

Shot, Bill. Personal Interview. May 10, 2005.

Slone, Brian. Personal Interview. June 9, 2005.

Slone, Brian. Personal Interview. June 22, 2005.

Stephenson, Steve. Personal Interview. June 15, 2005.

Stone, India. Personal Interview. May 31, 2005.

Stroop, Nasby. Personal Interview. May 23, 2005.

Swift, J.A., Ross, J.E., and Omachonu, V.K. (1998). *Principals of Total Quality Management,* Delray Beach, Fla., St. Lucie Press.

Swift, J.A. (1995). *Introduction to Statistical Quality Control and Management,* Delray Beach, Fla., St. Lucie Press.

Thomas, H. Randolph, and Ellis, Ralph D. (2001). *Avoiding Delays During the Construction Phase of Highway Projects*. National Cooperative Highway Research Program, Washington, D.C.

Thomson, Scott. Personal Interview. June 16, 2005.

Thomson, Scott. Personal Interview. June 20, 2005.

Tingle, Jo Anne. Personal Interview. April 21, 2005.

Tomko, Greg. Personal Interview. June 15, 2005.

Toy, Randy. Personal Interview. June 13, 2005.

Travis, Paul. Personal Interview. February 18, 2005.

Tubb, Rita. (2004). "BorTunCo Conducts Simultaneous Trenchless Construction." *Underground Construction*, March 2004, 18-19, 22.

U.S. General Accounting Office (USGAO). (1999). *Transportation Infrastructure: Impact of Utility Relocation on Highway and Bridge Projects*. Report No. GAO/RCED-99-131. Washington, D.C., June 1999.

U.S. Government Printing Office (GPO). (2004). "Davis Bacon Wage Determinations." *General Decision County Index*, < http://www.gpo.gov/davisbacon/ky.html> (May 11, 2005).

Vaughn, Morris. Personal Interview. May 31, 2005.

9 Appendix

KTC Utility Conflicts and Best Practices Questionnaire
Kentucky Transportation Center

Conflicts resulting from existing or proposed utilities occur on many highway construction projects. The conflicts may be a result of errors in construction, such as improper relocation of existing utilities, or the conflicts may be a result of errors in planning and design, such as lack of coordination between utility agencies, designer, contractor, and the state transportation agency. It is generally accepted that construction conflicts due to utilities can significantly increase a project's cost, in both time and money.

This survey is part of a research project at the University of Kentucky sponsored by the Kentucky Transportation Center. The purpose of this survey is to identify frequency and severity of utility conflicts and identify best practices used to avoid them. The survey includes general questions regarding your state's experience with utility conflicts and practices used to avoid these conflicts.

This survey is intended to be completed by your state utility director with possible assistance of utility coordinators within your state. Your state's participation in this survey is very important. It is your responses that will allow our research team to identify the most severe type of utility conflicts and best practices to avoid their reoccurrence. In time, this research will be used for process improvements in avoiding conflicts on future construction projects. **Individual state responses will be kept confidential.**

Please do not hesitate to contact Adam Smith at the University of Kentucky (Phone: 859-257-1036 or email: arsmit0@engr.uky.edu) if any part of this survey is unclear.

<u>Part 1 – General Information</u>

Name: ______________________________

State: ______________________________

Title/Position: ______________________________

Phone: ______________________________

Fax: ______________________________

Email: ______________________________

Address: ______________________________

____

<u>Part 2 – Frequency and Severity of Utility Conflicts</u>

This section identifies problems associated with utility relocation and identifies conflict frequency and severity for different types of utilities. For each question, please indicate the **frequency** you experience these problems on projects on a scale of 1 to 7, with **1 indicating as having never experienced them and 7 indicating a constant occurrence.** In addition for these problems, please indicate what you feel is the **severity** of their impact on project schedule by checking the appropriate number on the 1 to 7 scale, with **1 as having no impact on schedule and 7 indicating extreme impact on schedule**.

For example if utility relocation delays on your state transportation agency's projects are **often** a result of poor communication among different utility companies, you would circle number 5. If the poor communication resulted in **extreme** scheduling or cost impacts, you would circle number 7.

	← Less **Frequency** More →							← Less **Severity - Impact** More →						
	Never		Rarely		Often		Constant	None		Slight		Moderate		Extreme
How often is utility relocation delayed by poor communication among different utility companies?	1	2	3	4	5	6	7	1	2	3	4	5	6	7

		← Less **Frequency** More →							← Less **Severity - Impact** More →						
		Never		Rarely		Often		Constant	None		Slight		Moderate		Extreme
1.	How often is utility relocation delayed due to a lack of available financial resources on behalf of utility companies?	1	2	3	4	5	6	7	1	2	3	4	5	6	7
2.	How often is utility relocation delayed due to a lack of available financial resources on behalf of your state transportation agency?	1	2	3	4	5	6	7	1	2	3	4	5	6	7
3.	How often is utility relocation delayed due to a scheduling conflict on behalf of the utility companies?	1	2	3	4	5	6	7	1	2	3	4	5	6	7
4.	How often is utility relocation delayed due to a scheduling conflict on behalf of the contractor?	1	2	3	4	5	6	7	1	2	3	4	5	6	7

5. Are there any other sources of scheduling conflicts attributing to delays of utility relocation?

If yes, please list ____

6. Are there any other sources of financial conflicts attributing to delays of utility relocation?

If yes, please list ____

7. Do utility companies only perform utility relocation certain times of the year?

8. Is their any restriction on tree removal in relation to utility relocation?

If yes, please list

____

9. Are there any other environmental issues that pose problems in relation to utility relocation?

If yes, please list

____

	Less Accuracy More →						
	Fair		Good		Excellent		
d you rate the accuracy of the zontal location (i.e. x and y dinates) of existing utilities as shown onstruction plans?							
d you rate the accuracy of elevation z coordinate) of existing utilities as vn on construction plans?							

	Less Frequency More →							Less Severity - Impact More →						
	Rarely		Often		Constant			light		Moderate		Extreme		
hat is the frequency and severity of y conflicts within your state portation agency projects?														

Urban – Urban projects are those projects occurring in and immediately surrounding a city. The congestion of utilities present on urban projects generally differs from the congestion on rural projects. This section of the survey will identify the frequency and impact of different conflicts encountered on urban projects with existing utilities.

	rojects, what is the and severity of:	Less Frequency More →							Less Severity - Impact More →						
			Rarely		Often		Constant			Slight		Moderate		Extreme	
	flicts with existing gas pipelines?														
	flict with existing water pipelines?														
	flicts with existing storm sewer ines?														
	flicts with existing sanitary sewer ines?														
	flicts with existing underground ommunication lines?														
	flicts with existing above ground ommunication lines?														

		Less **Frequency** More →							Less **Severity - Impact** More →						
			Rarely		**Often**	**Constant**				**Slight**		**Moderate**	**Extreme**		
	flicts with existing underground rical lines?														
	flicts with existing above ground rical lines?														
	flicts with existing underground cable ?														
	flicts with existing above ground cable ?														

Rural – Rural projects are those projects occurring outside the urban areas in the country. This portion of the survey will identify the frequency and impact of different conflicts encountered on rural projects with existing utilities.

	·ojects, what is the and severity of:	Less **Frequency** More →							Less **Severity - Impact** More →						
		Rarely		**Often**		**Constant**			**light**		**Moderate**		**Extreme**		
	flicts with existing gas pipelines?														
	flict with existing water pipelines?														
	flicts with existing storm sewer ines?														
	flicts with existing sanitary sewer ines?														
	flicts with existing underground ommunication lines?														
	flicts with existing above ground ommunication lines?														
	flicts with existing underground rical lines?														
	flicts with existing above ground rical lines?														
	flicts with existing underground cable ?														
	flicts with existing above ground cable ?														

Part 3 - Practices to avoid utility conflicts

There are a number of practices that can be implemented to aid in avoidance of utility conflicts. The following practices have been identified from literature reviews and meetings with utility officials to prevent utility conflicts. For each practice, please identify your state's current participation and provide additional information when cued.

	Less Coordination More →						
	Fair		Good	Excellent			
e level of coordination between utility panies and your state transportation cy?							
e level of coordination between utility panies and designers outside your state portation agency?							

In order to discuss potential utility relocation needs, does your transportation agency forecast prospective transportation projects to utility agencies in advance through:

		s	o	if yes, how often
	e meetings			
	s			

Utility Involvement - Utility involvement in the project development process generally differs from project phase to project phase. Questions 39 – 41, involve identifying project stages in which various utility functions generally occur on projects. The four project development phases include: planning, preliminary line and grade, right-of-way plans development, and final design. The planning phase involves: determining project purpose and needs; establishing project timing requirements; conducting environmental overview; and identifying project special problems and limitations. Preliminary line and grade involves: determining if project objectives are being met; developing environmental documents; selecting a corridor for the project with alignment and grade; and identify critical right-of-way issues. Right-of-way plans development phase consists of: preliminary quantities; bridge requirements; construction erosion control plans; right-of-way, drainage, structure, and geotech plans are finalized. Final design phase includes: reviewing bridge design and requirements; finalizing maintenance of traffic plans, signalization, signs and striping plans; finalizing construction restrictions (timing, work requirements); and review of traffic and community impact studies.

39. At what project stage do utility companies typically get involved?

☐ Planning Phase

☐ Preliminary Line and Grade Phase

☐ Right of Way Plans Development Phase
☐ Final Design Phase
☐ Other (please describe) ______________________________

40. At what project stage is utility design typically performed for a project?
☐ Planning Phase
☐ Preliminary Line and Grade Phase
☐ Right of Way Plans Development Phase
☐ Final Design Phase
☐ Other (please describe) ______________________________

41. At what project stage are funds typically allocated for utility design?
☐ Planning Phase
☐ Preliminary Line and Grade Phase
☐ Right of Way Plans Development Phase
☐ Final Design Phase
☐ Other (please describe) ______________________________

42. Does your state pay for utility design of private utilities?

If yes,
When ______________________________

How _

43. Does your state pay for utility design of public utilities?

If yes,
When ______________________________

How _

44. Indirect costs are costs that are incurred, but are not directly assignable to a project. Examples of indirect costs include: costs to the facility users through diversions and delays along with increased vehicle operating costs; environmental costs through increased noise, air pollution, and soil runoff; safety costs due to decreased safety for motorists, decreased safety for pedestrians, and creating hazardous working conditions for construction workers; economical losses include damage to other utilities, damages to street pavement, and loss of trade to businesses.

Does your state reimburse contractors for indirect costs associated with utility conflicts?

If yes,
When ______________________________

How _

45. Does your state allow contractors to seek damages from utility companies when utility companies are the cause of construction delay?

46. Does your state offer a program that finances local municipality (e.g. water district, water association, sanitary sewer) utility relocation?

If yes, is it:

- ☐ Directly fund (i.e. your state pays for relocation without requiring repayment)
- ☐ Low interest loan
- ☐ No interest loan
- ☐ Other (please describe) ____________________

47. When does your state transportation agency reimburse relocations of private utilities? (check all that apply)

- ☐ Utility company had prior rights in right-of-way to the construction of roadway
- ☐ Utility is relocated prior to construction and then required to relocate a second time during the project
- ☐ If the state transportation agency deems it in the best interest of the state
- ☐ Other (please describe) ____________________

Subsurface Utility Engineering (SUE) – SUE is a discipline dedicated to determining the exact location of existing underground facilities. It is generally defined as "an engineering process for accurately identifying the quality of subsurface utility information needed for highway plans, and managing that level of effort during the highway project." The following is a description of the differing quality levels of utility location:

- **Quality Level D**: Information derived solely from existing records or verbal recollections.
- **Quality Level C**: Information obtained by surveying and plotting visible underground utility features and by using professional judgment in correlating this information to Quality Level D information.
- **Quality Level B**: Information obtained through the application of appropriate surface geophysical methods to identify the existence and approximate horizontal position of subsurface utilities. Quality Level B data should be reproducible by surfaced geophysics at any point of their depiction. This information is surveyed to applicable tolerances defined by the project and reduced onto plan documents.
- **Quality Level A**: Information obtained by the actual exposure (or verification of previously exposed and surveyed utilities) of subsurface utilities, using (typically) minimally intrusive excavation equipment to determine their precise horizontal and vertical positions, as well as their other utility attributes. This information is surveyed and reduced onto plan documents. Accuracy should be to applicable horizontal survey mapping accuracy and should be within ± 0.05 ft. vertical.

The following questions involve the use of SUE practices on construction projects.

	← Less			Frequency		More →	
	Never		Rarely		Often	Constant	
48. What is the frequency of SUE use on Urban Projects?	1	2	3	4	5	6	7

49.	What is the frequency of SUE use on Rural Projects?	1	2	3	4	5	6	7
50.	To the best of your knowledge, how often do utility companies in your state use SUE for design?	1	2	3	4	5	6	7

51. Has your state adopted some form of SUE policy?

☐ Yes	☐ No

If yes, answer questions 52 – 58; if no, skip to part four of the survey.

52. How does your state mainly perform the following SUE services?

a. Actual exposure/Excavation for quality level "A" work?

☐ Use in-house crews and excavation equipment
☐ Contract out the services

b. Surveying (measuring horizontal and/or vertical locations) for quality level "A" work?

☐ Use in-house survey crews and equipment
☐ Contract out the services

53. Some state transportation agencies allow contractors to know what projects SUE is being used on and provide the SUE information for the projects. Does your state provide a list of preconstruction projects utilizing SUE?

☐ Yes	☐ No

54. What SUE quality level of information on utilities does your state generally require before a project can be let for construction?

☐ A
☐ B
☐ C
☐ D
☐ No requirement

55. How do you identify locations where you need quality level "A" information? (check all that apply)

☐ Utility company input
☐ To confirm conflict between existing and proposed utilities (i.e. one identified by BUD)
☐ Other (please describe) ____________________

56. Based on your experience, do you prefer hydro excavation or vacuum excavation to perform quality level "A" work and why?

☐ Hydro excavation; ____________________

☐ Vacuum excavation; ____________________

☐ No preference

57. What type of quality assurance does your state have to assure accuracy of SUE information?

☐ SUE data must adhere to ASCE standards
☐ SUE data must meet state quality specifications

☐ Other (please describe) ____

58. Does your state archive SUE information in a central location for future use on other projects?

☐Yes	☐ No

If yes, how ____

<u>Part 4 – Before You Dig/One call Center</u>

This section identifies the accuracy of location provided by one call centers and utility company involvement in locating utility lines in your state. One call centers provide contractors and designers a single point of contact for participating utility companies, allowing utilities to be located for a specific project by one agency.

Accuracy Assessment

Overall, what is your assessment of the accuracy of location data provided by the one call agency in your state involving:

	← Less		Accuracy			More →	
	Poor		Fair		Good		Excellent
59. Gas	1	2	3	4	5	6	7
60. Water	1	2	3	4	5	6	7
61. Storm sewer	1	2	3	4	5	6	7
62. Sanitary Sewer	1	2	3	4	5	6	7
63. Underground telecommunications	1	2	3	4	5	6	7
64. Underground electrical	1	2	3	4	5	6	7
65. Underground cable	1	2	3	4	5	6	7

66. Is the one call center in your state held liable for the accuracy of utility markings?

☐Yes	☐ No

If yes, how ____

67. Does your state transportation agency accept utility markings by a one call center to be accurate enough for SUE quality level "B" marking?

☐ Yes
☐ No
☐ Not Applicable

Utility Involvement

68. After a request has been received by a one call center in your state, what percentage of the following utilities involves the actual utility company locating the utilities themselves?

Gas ______
Water ______
Storm sewer ______
Sanitary Sewer ______
Underground telecommunications ______

Underground electrical ______
Underground cable ______

69. After a request has been received by a one call center in your state, what percentage of the following utilities involves only the involvement of a one call center employee?
Gas ______
Water ______
Storm sewer ______
Sanitary Sewer ______
Underground telecommunications ______
Underground electrical ______
Underground cable ______

Part 5 – Right-of-Way

Right-of-way (ROW) can influence the ability of utility companies to complete relocations in a timely manner. The following questions concern the right-of-way practices in your state transportation agency that can impact utility relocation.

70. Does your state transportation agency prioritize parcels for ROW acquisition based on their need for utility relocation?

☐Yes	☐ No

71. How much right-of-way do you buy in urban areas from face of curb? (distance)

____

72. Often, ROW is acquired from property owners only to see utility companies require additional easements beyond the initial ROW to relocate utilities. Do you inform property owners of additional property that may be acquired beyond right-of-way for utility easements when acquiring right-of-way for road construction?

☐Yes	☐ No

73. Has your state acquired additional property beyond that required for road construction limits to provide additional room for utility relocation?

☐Yes	☐ No

If yes, when ____

74. How often as a percentage of your projects does right-of-way impact utility relocation due to:
Not enough right-of-way procured for utility relocation ______
Break down between negotiations of private land owners ______
ROW acquisitions take longer than expected ______
Other (list and provide percentages) ______________________________

75. Does your state transportation agency use utility corridors to support existing and future utilities?

☐Yes	☐ No

Part 6 – Contact Information

Who in your agency may we contact for additional information?

1. Name ____

   Phone Number ____

2. Name ____

   Phone Number ____

Part 7 – Summary Report Request

Thank you for your time and the responses you have provided. If you would like a copy of the summary report, please provide the following information:

Name: ____

Email: ____

Phone: ____

Fax: ____

When you have completed the survey, please return via scanned e-mail document at arsmit0@engr.uky.edu, fax at
859-257-4404, or Post to:

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