Final Report

Impact of Utility Delays on Project Delivery

Sponsoring Agencies:

South Carolina Department of Transportation

Federal Highway Administration

Principal Investigators:

Kalyan R. Piratla, Ph.D.

Tuyen Le, Ph.D.

Clemson University

Cesar Quiroga, Ph.D., P.E.

Texas A&M Transportation Institute

February 2024

Technical Report Documentation Page

1. Report No. FHWA-SC-24-01	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle *Impact of Utility Delays on Project Delivery*		5. Report Date *February 2024* 6. Performing Organization Code
7. Author(s) *Kalyan R. Piratla, Tuyen Le, Cesar Quiroga, Kris Harbin, Harshit Shukla, Mahmoudreza Seyed Yadollahi, Kehinde Elelu, Mark Attaway*		8. Performing Organization Report No.
9. Performing Organization Name and Address *Clemson University,* *109 Lowry Hall, Clemson SC 29634*		10. Work Unit No. (TRAIS) 11. Contract or Grant No. SPR No. 756
12. Sponsoring Agency Name and Address South Carolina Department of Transportation PO Box 191 Columbia, SC 29202-0191		13. Type of Report and Period Covered *Draft Final Report* 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

Utility issues often cause significant delays in transportation construction projects. These delays result from several factors spanning multiple project phases. This project studied the current utility process at the South Carolina Department of Transportation (SCDOT) and provided recommendations to minimize overall project delays. The project work entailed the following: (1) systematically reviewing the current literature to identify best utility coordination practices as reported by other researchers and state transportation agencies; (2) engaging numerous SCDOT personnel to understand the current state of dealing with utilities in South Carolina and identifying the most critical delay factors; (3) surveying other state DOTs to review their utility accommodation and coordination practices, especially with respect to in-contract utility relocation reimbursement schemes; (4) surveying utility owners in South Carolina to gain their perspectives on the critical bottlenecks in utility accommodation and potential incentives to improve coordination with SCDOT; and (5) mapping the critical delay factors across various project phases with best practices that could address those delays in order to develop project recommendations for SCDOT to consider implementing. Given the broad scope, this report does not provide detailed recommendations but presents an overview of best practices and useful references where appropriate.

17. Key Word	18. Distribution Statement
Utility coordination, in-contract relocations, incentives, transportation project delays	No restrictions.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified.	Unclassified.	*Total number of pages*	

Disclaimer

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented. The contents do not necessarily reflect the official views of the South Carolina Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

The State of South Carolina and the United States Government do not endorse products or manufacturers. Trade or manufacturer's names appear herein solely because they are considered essential to the object of this report.

Acknowledgments

The project team acknowledges the support and guidance of the SCDOT's project steering committee led by Mr. Robert Ryggs. Other committee members include Mr. Michael Barbee, Ms. Vanetta Jackson, Ms. Jennifer Necker, Mr. Lorenzo Worthy, Mr. Jason Byrd, Mr. Marvin Dawson, Ms. Barbara Wessinger, Ms. Stacey Johnson, and Mr. Tony Cooper. We also acknowledge the support and guidance of the former steering committee chair, Mr. Cedric Keitt. Mr. Mark Attaway has been highly valuable in supporting this research study, and we express our gratitude to him. Several SCDOT personnel and external consultants took part in this research study providing experiential inputs, and we thank all of them for their support. We also acknowledge the inputs of representatives from various state departments and in-state utility owners. We appreciate the help of Ms. Barbara Ramirez in proofreading and editing the final report. Finally, we also acknowledge the support of SCDOT's research staff, Mr. Terry Swygert and Ms. Jade Watford.

Executive Summary

Utility issues often lead to delays in transportation project delivery. Underground and aboveground infrastructure for such utilities as potable water, sewer, gas, telecom, and power may conflict with the design of a transportation project, resulting in the need for effective coordination between the state highway agency and the utility owners involved. This coordination process often becomes complicated because of uncertainty concerning the information specifying the utility location, the transportation project right of way (ROW) and design evolution, the responsiveness of the utility owners, the communication between the concerned parties, the financial and other resource constraints, the utility owner priorities, and varying market conditions, among others. This project developed recommendations for the South Carolina Department of Transportation (SCDOT) to minimize utilities-related delays on transportation projects and, thus, improve project delivery efficiency. These recommendations are primarily based on the reported and perceived effectiveness of various best practices synthesized from the literature or from other state departments of transportation (DOTs). Several SCDOT personnel were engaged to identify and assess various delay factors in different project life cycle phases. The scientific literature and current state of practice across the United States were also reviewed to identify best practices that may be suitable for SCDOT to implement for minimizing utilities-related delays in project delivery. The best practices suitable for addressing the most critical delay factors are prioritized, with project recommendations being developed accordingly.

Utility-related risk factors identified in this study are the following, listed in decreasing order of criticality:

- Unreliable utility relocation schedule or non-adherence to utility windows
- Non-responsiveness of utilities and the resulting lack of consequences
- Dealing with unknown/unresolved conflicts during construction
- Delays in ROW easement acquisition for utility relocations
- Location inaccuracies in utility relocations
- Late design changes leading to additional utility conflicts
- Interdependencies among utility relocations
- Lack of or delay in acquiring accurate utility location data, including subsurface utility engineering (SUE) investigations
- Change in SCDOT project ROW after utility certification is underway
- Dealing with utility relocations with prior rights
- Market conditions leading to delays
- SCDOT staff resource constraints
- Inability to accommodate utilities in SCDOT's ROW for relocations
- Delays in ROW acquisition by SCDOT
- Inability or lack of information to avoid utility conflicts by the design team
- Delay in relocations for clearing and grubbing

Below are the key recommendations for the SCDOT, some of which require legal, financial, and procedural issues to be addressed before they can be implemented:

1. Engage utility owners early in the project and maintain frequent communication; promote a strong and trustworthy working relationship between SCDOT and utility owners to avoid potential conflicts and explore less expensive project design changes rather than utility relocations. These meetings can generally be organized at three hierarchical levels:
    a. Regularly scheduled agency-level meetings (e.g., monthly, to discuss long-range projects, policies, incentives, etc.)
    b. Regularly scheduled project-level meetings
    c. Personnel-level meetings on a need basis
2. Modify the encroachment permit language suggesting potential liquidation of damages if relocations for utilities without prior rights were to delay the transportation project; such delays need to be assessed in a rational manner minimizing scope for litigation
3. Provide sufficient time for utilities to plan and relocate, and improve the requirements of the utility relocation schedule, making it robust with sufficient detail so that it can be better integrated with the construction project schedule
4. Promote the use of adequate utility investigations including below and above ground facilities in accordance with the ASCE 38-22 Standard
5. Train SCDOT personnel to manage utility conflicts more effectively
6. Coordinate ROW acquisition with utilities seeking private easements
7. Try to avoid late design changes; when unavoidable, effectively communicate these changes with relevant utility owners and compensate utility owners for the design and relocation rework
8. Extend utility coordination into the construction phase to reduce the burden on the SCDOT staff and maintain continuity in the utility coordination from design to the construction phases, preferably using the same coordinator
9. Have construction engineering and inspection (CEI) consultants handle inspection and as-built documentation of utility relocations in accordance with the ASCE 75-22 Standard
10. Explore the possibility of acquiring ROW for utility relocations outside of the SCDOT's ROW, at least for utilities with prior rights
11. Streamline communication between utility coordinators and the design team
12. Explore earlier utility relocation opportunities
13. Encourage utility coordinators to engage with the ROW office to track the progress of the ROW acquisition to identify both utility property interests and other situations earlier that are going to affect utility relocation schedules
14. Have an on-call service contract for pre-letting clearing and grubbing separately from the transportation project contract to facilitate utility relocations prior to letting
15. Consider the feasibility of continuing to reimburse wet utilities for schedule-compliant relocations beyond the current senate bill timeframe; in addition, explore opportunities for non-reimbursable relocations to be included in the transportation contract subjected to an advance funding agreement mechanism
16. Ensure SCDOT and the encroaching utilities, as specified by the permit, are aware of planned construction projects to avoid new installations that may come in conflict when these future relocations are undertaken

a. Include a step in the permitting process to verify if the proposed installation is in conflict with a planned project or relocatable utilities

17. Explore the possibility of requiring right-of-way certification completed prior (~2 months) to utility certification ***(P)***

Table of Contents

List of Figures

List of Tables

List of Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ALDOT	Alabama Department of Transportation
ASCE	American Society of Civil Engineers
CDOT	Colorado Department of Transportation
CFR	Code of Federal Regulations
CTUC	Combined Transportation Utility Construction
DDOT	District of Columbia Department of Transportation
DOT	Department of Transportation
DSS	Decision support system
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
GAO	United States General Accounting Office
GDOT	Georgia Department of Transportation
GPS	Global Positioning System
GUIDE	Geospatial Utility Infrastructure Data Exchange
KDOT	Kansas Department of Transportation
MDOT	Michigan Department of Transportation
MDT	Montana Department of Transportation
MnDOT	Minnesota Department of Transportation
MoDOT	Missouri Department of Transportation
NCDOT	North Carolina Department of Transportation
NCHRP	National Cooperative Highway Research Program
NDDOT	North Dakota Department of Transportation
NDOT	Nebraska Department of Transportation
NHDOT	New Hampshire Department of Transportation
NJDOT	New Jersey Department of Transportation
NMDOT	New Mexico Department of Transportation
NYSDOT	New York State Department of Transportation
ODOT	Ohio Department of Transportation
RFID	Radio frequency identification
RIDOT	Rhode Island Department of Transportation
SAULT	Selection Assistant for Utility Locating Technologies
SCDOT	South Carolina Department of Transportation
SDDOT	South Dakota Department of Transportation
SUE	Subsurface Utility Engineering
TDOT	Tennessee Department of Transportation
TxDOT	Texas Department of Transportation
UCM	Utility conflict management
UDOT	Utah Department of Transportation

UIA	Utility Impact Analysis
UIR	Utility installation request
UWHC	Utility work by highway contractor agreement
VDOT	Virginia Department of Transportation
WSDOT	Washington State Department of Transportation

1. Introduction

Utility issues can lead to significant delays in transportation project delivery. Many types of utilities including but not limited to potable water, sewer, gas, telecom, and power commonly use the right of way (ROW) of public roads as allowed by laws, regulations, and policies. However, the right of way, especially in urban and sub-urban regions, is becoming increasingly congested with buried and above ground utility infrastructure. In South Carolina, transportation construction projects often conflict with existing utilities, and these conflicts need to be resolved. Finding these conflicts is not a trivial process because location data for existing utility facilities with the required accuracy is not always readily available. In addition, the project ROW and many design details are also not known upfront, further making the conflict identification a complex and time-consuming process. As a result, many such conflicts are typically not recognized before it is too late to change the project design to avoid them. Most conflicts are resolved by relocating the utilities, which might result in additional issues, particularly during construction, if not managed properly. For utilities in the transportation agency's ROW through an encroachment permit, relocations become an added obstacle due to the unscheduled work and unplanned expenses (1). In general, several uncertainties are often associated with the entire utility coordination and conflict resolution process, from the identification of conflicting utilities to having any needed relocations completed within the scheduled timeframe.

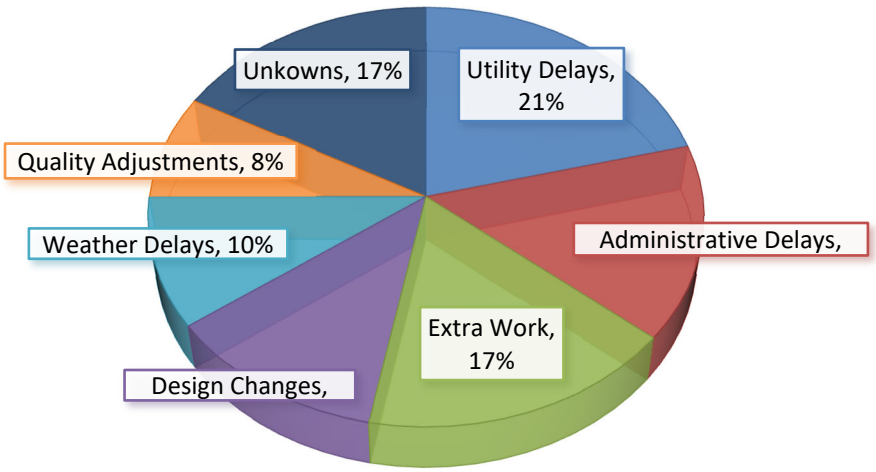


***Figure 1**. Construction Project Delay Factors (5)*

A survey of transportation agencies and highway construction contractors found that utility relocations ranked as the top cause of construction project delays (2). Further, a study specifically focused on delays caused by the relocation of utilities on federal-aid highway and bridge projects found that 20 states reported such delays accounted for 0-10 percent of their projects, 8 for 11-20 percent, 6 for 21-30 percent, and 8 for above 30 percent in the fiscal years 1997-98 (3,4). As can be seen in Figure 1, the most significant cause of delays for construction projects in South Carolina is utilities related, representing 21%, or almost one fourth of all delays (5), a situation that merits deeper investigation into the specific causes for these delays and the measures to potentially mitigate them.

This research first evaluates the impact of utility delays on the construction of transportation projects and subsequently recommends best practices for minimizing those impacts and improving project delivery. While utility delays are prevalent in both design-bid-build and design-build projects, they are understood to be more complicated in the former where the owner (i.e., SCDOT) handles the utility coordination either directly or through an external consultant. In design-build project delivery, which is typically avoided for projects with complex utility conflicts, utility coordination for the most part is handled by the design-build contractor, shifting the risk away from SCDOT. For these reasons this study primarily focused on utility conflict management in design-bid-build projects.

1.1 Project Objectives

The overarching objective of this project is to develop recommendations for minimizing utility relocation related delays to improve project delivery efficiency on SCDOT's construction projects. Specifically, the scope included the nine objectives shown in Table 1 and Figure 2, which were addressed in this project.

Table 1. *Project Objectives*

Objectives	Description
A	Explore possible incentives for utility providers to be added in-contract
B	Obtain specific contracts, statutes, regulations, and policy manuals from other states
C	Identify best practices/remedies/resolutions for addressing the principal reasons for delays in the relocation of utilities
D	Identify best practices for issuing and managing encroachment permits for utilities
E	Identify best practices for acquiring the necessary rights of way to accommodate utility relocations
F	Identify best practices for partnering between DOTs and utilities
G	Identify best practices for implementing at planning level with respect to utilities
H	Identify best practices for dealing with utilities with and without prior rights
I	Provide recommendations for increasing project delivery effectiveness by addressing utility related delays

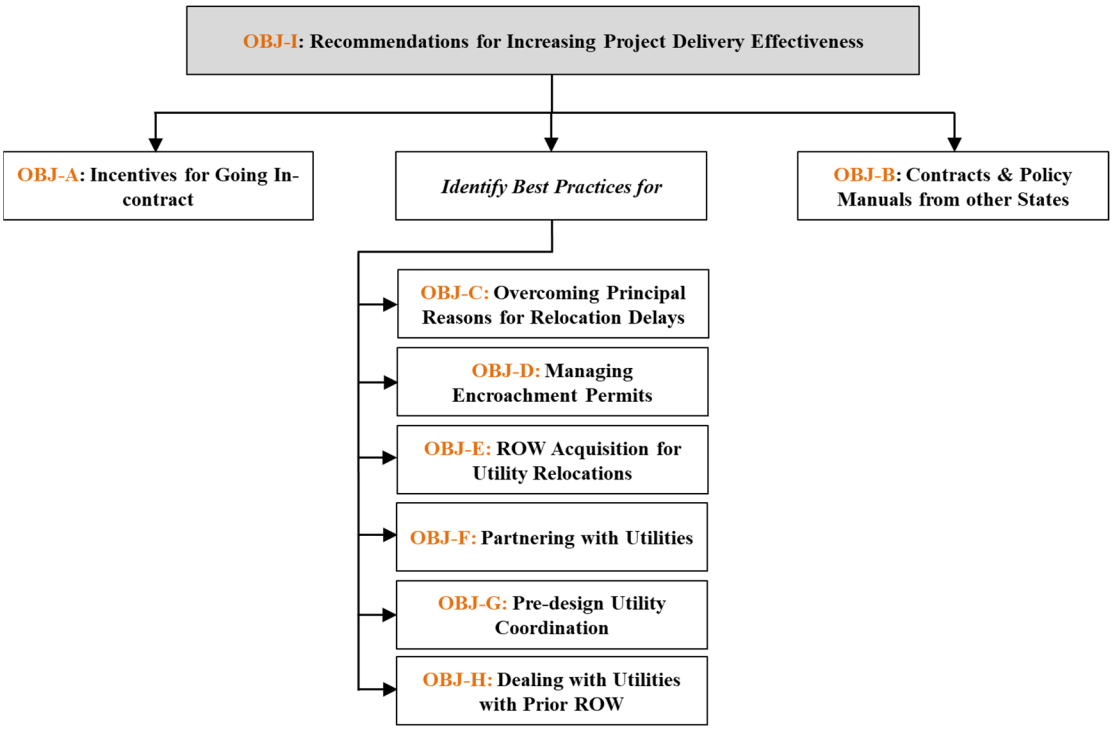


Figure 2. *Characterization of the Project Scope*

This topic has been studied by several researchers in the past, meaning there has been considerable related literature published. While there are gaps in the body of knowledge, the rich literature on this topic was an advantage for the project team as these earlier studies provide valuable lessons that can be leveraged without having to repeat the research work. However, each state DOT is different in terms of policies, processes, legislation, financial capabilities, priorities and working relationships with utility owners. It is, therefore, imperative to adapt previously developed recommendations from other states to make them suitable for and compliant with the SCDOT.

1.2 Project Tasks

The nine objectives (indexed as A through I) of this study were achieved through the six tasks illustrated in Figure 3. These tasks are further described below.

Research Tasks	Project Objectives								
	A	B	C	D	E	F	G	H	I
T1: Systematic Literature Review	●	●	●	●	●	●	●	●	●
T2: SCDOT's State of Practice Review			●	●	●	●	●	●	
T3: Survey/Interviews of State DOTs	●	●	●	●	●	●	●	●	
T4: Survey/Interviews with SC Utility Owners	●		●			●		●	
T5: Develop Specific Recommendations	●		●	●	●	●	●	●	●
T6: Final Report & Dissemination	●	●	●	●	●	●	●	●	●

Figure 3. *Proposed Research Tasks Mapped to Project Objectives*

In Task-1, an extensive literature review was conducted to identify current state-of-the-art knowledge on various utilities-related issues, while Task-2 focused on documenting the current SCDOT practices and identifying the critical delay factors that need to be addressed to minimize utilities-related project delays. Task-3 surveyed other state DOTs to obtain a variety of inputs, especially those focusing on in-contract utility relocations and reimbursement schemes. In Task-4, utility owners in South Carolina were surveyed to better understand their perspectives on the critical bottlenecks causing delays and to determine the potential solutions that they find effective. Task-5 synthesized, evaluated, and ranked the best practices based on their perceived effectiveness, subsequently mapping them to the critical delay factors identified in Task-2. This evaluation and mapping led to the development of the project recommendations. A workshop was conducted with relevant SCDOT personnel to disseminate the recommendations of this study, present best practices in utility conflict management and a comprehensive utility engineering framework.

The next chapter in this report provides a comprehensive review of the most relevant literature (Task-1) on utility conflict resolution for transportation projects, with Chapter 3 providing a concise summary of the takeaways from our review of the current state of utility accommodation and coordination practices employed by SCDOT (Task-2). Chapters 4 and 5 report on the outcomes of the surveys of other state DOTs (Task-3) and the in-state utility owners (Task-4), while Chapter 6 reports the evaluation of critical delay factors and perceived effectiveness of best practices synthesized from the previous four tasks in addition to providing our project recommendations for SCDOT to consider implementing.

2. Literature Review

The literature review is comprised of three main sections which focus on the impacts of utility delays on project delivery and potential strategies for resolving these issues. We reviewed a variety of sources including manuals, reports, peer-reviewed journals, and conference publications. It is important to note that each state DOT is unique and, thus, is affected by its state laws, regulations, policies, procedures, and financial capabilities, meaning what works in one state may not be allowed, appropriate, possible for another DOT.

2.1. Utility Coordination Practices

2.1.1. Causes for Utility Related Delays

Utility issues can cause delays in transportation construction projects. Many types of utilities including but not limited to potable water, sewer, gas, telecommunications, and power lines are commonly allowed to use the right-of-way of public roads as permitted by laws, regulations, and policies. The ROW, especially in urban and suburban regions, is becoming increasingly congested with a number of buried and above ground utility infrastructure.

Most utility conflicts are resolved by relocating the utilities, which might result in additional issues, particularly during construction. Utility owners do not necessarily relocate their facilities in a timely manner. A common perception is that the these delays often translate into change orders. In North Carolina, the DOT found that between 1994 and 2018, 13% of all construction delay claims were related to utilities (6). Utility companies are reluctant to begin relocation work until the letting of a highway construction project due to frequent changes in highway alignment (7,8).

Prior property rights also affect utility coordination and utility relocation (9). If the utility company has prior rights, reimbursable adjustments can take significantly longer than non-reimbursable ones since the former involves more legal requirements (10). Satisfying these requirements can take a considerable amount of time which may delay the utility coordination and relocation effort (11).

To address the issue of inadequacy in the preparation of utility agreements, the Federal Highway Administration (FHWA) identified a number of strategies and recommendations (12). In 2018 the FHWA completed a national review which references three prior efforts highlighting the importance of addressing utility issues early during project delivery:

- In 2002, the Transportation Research Board (TRB) report, *The Root Causes of Delays in Highway Construction*, found that utility relocation delays were the foremost reason for delays in highway construction. Utility conflicts were also cited by both contractors and DOTs as the top reasons for highway construction delays.
- In 2009, the Second Strategic Highway Research Program (SHRP2) report, *Encouraging Innovation in Locating, and Characterizing Underground Utilities,* concluded that the untimely discovery of an unknown underground utility needing relocation is one of the primary causes of

delays during highway renewal projects and, as such, one of the major contributors to traffic disruptions and budget overruns.

- In 2011, an Office of Inspector General (OIG) audit found that utility agreements and reimbursements were one of 12 key project activities where reoccurring noncompliance with federal regulations took place during the FHWA's oversight of the American Recovery and Reinvestment Act (ARRA). This audit found that 67% of the projects studied in the "utility agreement and reimbursement" category had errors and other noncompliance issues in the utility agreements.

Several uncertainties are often associated with the entire relocation process, beginning with the identification of conflicting utilities to having utility owners complete the relocation work within the scheduled timeframe.

In 1999, the United States General Accounting Office (GAO) published a report on the impacts of utility relocations on highway projects (7). This report included the results of a national survey focused on identifying the reasons for the delays on highway and bridge projects. The national survey, which was sent to all state DOTs, was followed by interviews with officials at the FHWA, both at the headquarters and the field offices; selected DOTs; and construction contractors in addition to utility companies in nine states. The survey asked all state DOTs to provide reasons for delays on highway and bridge construction projects. While Table 2 lists the reasons for delays provided by state DOTs, the top three are listed below:

- Lack of resources at utility companies to complete relocations
- Insufficient time allotted by the DOT for planning and design
- Utility companies not assigning a high priority for utility facility relocations.

Ten state DOTs indicated construction schedules and/or costs of highway and bridge projects as having a significant or most significant impact on utility facility relocation delays. Thirty state DOTs indicated that they incurred additional project costs due to claims related to utility facility relocation delays. Furthermore, contractors reported that these claims were either not fully reimbursed by the DOT or they were not worth their time and effort to complete the required paperwork for reimbursement. The GAO report also highlighted that contractors shift construction crew and equipment to different segments of the project or to another project to deal with utility facility relocation delays instead of submitting a change order or schedule extension requests. Therefore, state DOTs are usually not aware of the severity of the impacts of utility facility relocation delays on the schedule or cost of a highway and bridge construction project.

The national survey also asked about strategies to make utility coordination process more effective for state DOTs. A total of 41 DOTs used early planning and coordination, and 33 states used special contracting methods to address the impacts of utility relocation delays during construction. The Texas Department of Transportation (TxDOT), for example, highlighted its Utility Cooperative Management process for incorporating utility facilities into all phases of the project delivery process. Only seven DOTs indicated they used Subsurface Utility Engineering (SUE) on more than half of their projects. However, based on the information available at the time, the GAO noted that it was not clear if the use of SUE led

to a reduction in utility conflicts and delays during construction. A total of 44 DOTs allowed contractors to extend project deadlines for delays caused by relocating utilities.

Table 2. *State Transportation Authority Reasons for Delays in Utility Relocations (7)*

Reason for Project Delays	Number of DOTs
Utility company lacked resources	34
Short timeframe for state to plan and design project	33
Utility companies considered relocations as a low priority	28
Increased workload on utility relocation crews because highway/bridge construction had increased	28
Delays in starting utility relocation work: some utility companies would not start until a construction contract was advertised or let	28
Phasing of construction and utility facility relocation work out of sequence	26
Inaccurate locating and marking of existing utility facilities	23
Delays in obtaining right-of-way for utility facility relocations	23
Shortages of labor and equipment for utility contractor	19
Project design changes required changes to utility facility relocation designs	19
Utility companies were slow in responding to contractor' requests to locate and mark underground utility facilities	16
Inadequate coordination or sequencing among utility companies using common poles or ducts	13

A variety of factors contribute to utility inefficiencies in transportation project delivery, resulting in a number of problems including, but not limited to, those listed below (13):

- Disruptions when utility facilities are unexpectedly found during construction, either because there was no preceding information about those installations or because their stated location on the construction plans was incorrect.
- Damage to utility facilities, which can lead to disruptions in utility service, environmental damage, and increased risk to the health and safety of construction workers and the public.
- Unplanned environmental corrective actions.
- Unnecessary utility relocations and project delivery inefficiencies, both of which occur because adequate information about existing utility facilities was not available to allow stakeholders to apply alternative utility conflict resolution strategies.
- Delays that can extend the period of project development and/or delivery and increase the total project costs through higher bids, change orders and/or damage or delay claims, redesign, and litigation by utility owners or agencies. These delays also result in frustrations in the traveling public and negative public perceptions of the project.

A second study reported that delay in the relocation of utilities is primarily due to delay in (1) obtaining right-of-way, (2) starting relocation work, (3) administrative processes, (4) obtaining permissions, (5) redesign, and (6) relocation process (14). The types of delays are classified into organizational and technical factors as shown in Table 3 and Table 4.

Table 3. *Factors in Delays of Utility Relocation, Organizational (14)*

Organizational Factors
Lack of cooperation from utility companies
Transfer of engineers
Shortage of engineers
Slow response from utility companies
Lack of cooperation from the contractors
Protest by local public
Pending court cases
Damage of existing utility facilities
Conflict between agencies
Lack of land for relocation
Lack of materials in stores
Difficulty in identifying the office resoonsible for the utility due to jurisdiction control

Table 4. *Factors in Delays of Utility Relocation, Technical (14)*

Technical Factors
Lack of information on underground utility facilities
Inaccurate location and marking of underground utility facilities
Underground utilities uncharted
Geometry of utilities unique at every location
Difficulty in identifying underground utility facilities
Deviations in location of underground utility facilities on site
Complex network of utility facilities

In 2001, the NCHRP conducted a survey of DOT officials, design consultants, and highway contractors to determine the causes of project delays during the construction phase 15). The research team sent a list of 20 potential causes of project delays (Table 5), asking these participants to rank them in order of frequency. As Table 6 shows, they ranked utility relocation delays as the most frequent cause of highway construction project delays. DOT and design consultants identified differing site conditions (DSCs)—utility conflicts as the second most frequent cause for delays, while contractors identified errors in plans and specifications as the second most frequent cause of highway construction project delay.

Table 5. *Potential Causes of Project Delays from the 2002 Survey (15)*

Potential Causes of Project Delays
Conflict with other construction projects
Delays in environmental planning
Delays in receiving materials
Delays in right-of-way acquisition
Delays in design
Differing site conditions—utility conflicts
Differing site conditions—other causes
Equipment shortages
Errors in plans or specifications
Funding issues

Insufficient work effort by contractor
Labor shortages
Late start on work by contractor
Owner requested changes
Pay items not matching scope of work
Permitting issues
Poor coordination of work by contractor
Utility relocations delayed
Weather
Other

Table 6. *Top Ten Causes of Project Delays Based on Survey Results (15)*

Cause of Delay	DOTs	Designers	Contractors
Delays in utility relocations	1	1	1
Differing site conditions—utility conflicts	2	2	3
Errors in plans and specifications	3	13	2
Weather	4	6	4
Permitting issues	5	4	7
Delays in right-of-way acquisition	6	9	11
Delays in environmental process	7	3	8
Insufficient work effort by highway contractor	8	5	18
Owner-requested changes	11	10	5
Differing site conditions—other causes	9	7	6

The three groups differed in their ranking of the causes of highway construction project delays based on the frequency of occurrence (less frequent causes were considered less important and vice versa). For example, contractors ranked owner-requested changes as No. 5 whereas DOTs and design consultant indicated this cause as No. 11 and 10, respectively. Insufficient work by the contractor was ranked No. 18 for contractors but was ranked No. 8 for DOTs and No. 5 for design consultants. Errors in design and specifications was ranked No. 13 for design consultants but No. 3 for DOTs and No. 2 for contractors.

The research team also analyzed Florida DOT's (FDOT) database of contract supplement agreements, which included 2,616 contract changes, grouping these records by contract change reason code and finding that more than 5% ot the contract changes were related to utility conflicts. In addition, the researchers also analyzed 150 FDOT projects of varied sizes and types (16).

In 2006, the South Carolina DOT (SCDOT) completed a research project focused on factors that delay highway construction projects (17). More specifically, the researchers analyzed contract extension data, identifying six primary reasons for delays in highway construction projects. Utility-related delays accounted for 21% of all delays. The study also noted that SCDOT was beginning to use SUE more often to help with an earlier identification of utility conflicts. Along with other states, SCDOT began encouraging the inclusion of utility relocations in highway contracts, a practice which is slowly proving beneficial in minimizing utility-related delays although it is not a prevalent practice yet.

In 2018, the FHWA conducted a national review of practices to evaluate whether utility coordination practices posed a risk to the federal-aid highway program (12). This review was conducted in two phases: during Phase 1, it focused on utility coordination practices such as utility agreements; utility relocation plans, schedules, and cost estimates; information in contract bid documents; and impacts during construction, such as time delays and cost increases in all 50 states, the District of Columbia, and Puerto Rico; during Phase 2, the research team went to five DOT construction sites representing different geographic regions and sizes of federal-aid program. These site visits included a more in-depth review of the available information and discussions with DOT officials, construction contractors, and utility companies.

Issues found during the national review included the following:

- Lack of accurate utility facility location information on highway design plans
- Incomplete utility relocation plans
- Lack of justification for the cost estimate of utility relocation
- Absence of utility relocation schedules
- Lack of utility information in bid packages
- Difficulty in quantifying cost and time increases for utilities for highway projects
- Lack of inspection and oversight related to the utility relocation
- Difficulty sourcing documents to support utility relocation payments or final vouchers.

The FHWA report noted that a lack of adequate existing facility data leads to utility conflicts being misidentified or not identified at all prior to construction. Contractors then unexpectedly find these previously unidentified utility facilities during construction, potentially causing project delays and/or cost increases.

The FHWA report presented successful practices including examples and recommendations for how to address the issues related to utility facilities. The key practices focused on the preparation of utility relocation plans, utility relocation schedules, and cost estimates. The FHWA report further outlined a series of high-level recommendations for the FHWA division offices to discuss with DOTs, recommendations that subsequently formed the foundation for the National Highway Institute's web-based course "Preparing and Communicating Effective Utility Relocation Requirements" (18).

The information below was captured from interviews as part of the NCHRP 11-08 (19,20), Improving Rights-of-Way Acquisition and Compensation Practices for Utility Relocation, unless otherwise noted.

State DOTs experience delays because utility owners postpone participating in the coordination process. Frequently, utility companies elect to wait until the DOT has acquired the necessary right-of-way before engaging in meaningful utility coordination. One reason for this delay in coordinating with the DOT is that utility owners are not certain the highway project will move forward until the necessary right-of-way has been acquired. State DOTs have tried using variety of strategies to help alleviate this concern, including keeping utility owners informed throughout the project development process, engaging utility owners in a meaningful way earlier in the process, and enforcing rules that require participating and responding within a certain time period (19,20).

Delays in utility relocations may also be due to waiting for the utility company to acquire easements outside of the right-of-way. Specific examples of this can be seen Arkansas, Maryland, and South Dakota. In Arkansas and Maryland, the DOT received feedback from utility companies that property owners are hesitant to discuss easements with utility owners until an agreement for additional right-of-way has been reached between the property owner and the DOT. In South Dakota, utility owners often wait for the DOT to finish acquiring project rights-of-way before they begin discussion with property owners regarding utility easements. At least in some cases in South Dakota, the driving factor is a desire by property owners to wait until the process with the DOT is complete, similar to what is seen in Maryland and Arkansas (19,20).

As part of recently completed HCHRP 15-69, researchers at the Texas A&M Transportation Institute examined causes and impacts of utility issues during the project delivery process (primarily during construction), evaluated the use of utility impact analysis tools, documented case studies, developed functional requirements for a decision support tool, documented procedures for conducting utility inspections, and documented best practices and implementation recommendations (21). The research included a literature review, a practitioner survey, and a review of over 150,000 change order and claim records from six state departments of transportation. It also included three case studies to highlight exemplary practices on how to manage utility issues, particularly during construction. The utility inspection procedures included data collection equipment, software, and protocols. Because a substantial number of utility issues during construction trace their origin to events or decisions that take place during preliminary design or design, the recommendations included recommendations prior to letting and recommendations during construction.

2.1.2. Strategies for Reducing Utility-Related Delays

Strategies for getting utility relocations completed in a timely manner so that they do not adversely affect the highway project can vary depending on the state DOT. An interview and survey of state DOTs was conducted as part of NCHRP 11-08 (19,20). Much of the information presented in this section was collected as part of that research; information that was not part of this study is cited appropriately.

Much of the conversation on facilitating timely utility relocations centers around incentives and adverse inducements (penalties, motivational pressure, etc.). Table 7 lists incentives, or their lack, by state DOT. Although many states listed in the table do not use incentives when dealing with utility relocations, the few that do, use incentives to help ensure timely utility relocations.

Table 7. *Incentives by State DOT*

DOT	Incentives
Kansas	No incentives for timely utility relocations
Louisiana	No incentives for timely utility relocations
Maine	Does not provide incentives for utility relocations. Best incentive, according to MaineDOT, is good early planning and coordination and consistently achieving set project delivery dates

DOT	Incentives
Massachusetts	MassDOT has incentives for privately-owned utility facilities if the utility company relocates within the estimated time frame it provides. Reimbursement eligibility is 50 percent of the actual utility relocation cost, excluding betterment.
Michigan	No incentives for timely utility relocations
Minnesota	No incentives for timely utility relocations
Mississippi	No incentives to accelerate utility relocations
Missouri	No incentives for timely utility relocations
Montana	If it is in the best interest of the highway project, the Montana Department of Transportation (MDT) reimburses for utility relocations at a higher level than 75 or 85 percent. No incentives for right-of-way acquisitions.
Nebraska	No incentives for timely utility relocations. Nebraska DOT (NDOT) searches for a solution and works with utility owners to resolve any issues that may be causing delays to relocating utilities.
Nevada	No incentives for timely utility relocations
New Hampshire	No incentives for timely utility relocations
New Jersey	No incentives for timely utility relocations. But the New Jersey Department of Transportation (NJDOT) does reimburse 100 percent of the utility relocation cost if the utility facility is in the right-of-way by permit.
New Mexico	No incentives to accelerate utility relocations
New York	No incentives to accelerate utility relocations
North Carolina	No incentives to accelerate utility relocations. There has been some discussion on incentives for utility relocations, but there is a concern that they could be easily manipulated.
North Dakota	No incentives for timely utility relocations
Ohio	No incentives for timely utility relocations
Oregon	No incentives for utility relocations
Pennsylvania	Incentive policy is based on cost sharing with utility companies. The cost sharing is based on the utility company meeting milestones during the utility coordination process. If the milestones are not met, then there is no cost sharing by the DOT.
South Carolina	No incentives to accelerate utility relocations
South Dakota	No incentives for utility relocations. Depending on the project and utility conflict, South Dakota DOT (SDDOT) and utility owners have used cost sharing agreements. Cost sharing agreements are used in situations in which a utility conflict resolution strategy involves a highway design change that would eliminate the need for a costly utility relocation. So, the utility owner pays for the highway design change.
Texas	No monetary incentives to accelerate utility relocations. But TxDOT has implemented a process to reimburse utility companies for expenditures incurred as part of the utility relocation process, including design and materials if the DOT changes the highway design and the relocation work has to be redone. This process is not tied to the utility facilities reimbursability eligibility regarding prior rights.
Vermont	No incentives for utility relocations
Virginia	VDOT has an incentive program, but it is currently not being used. The incentive program paid for 100 percent of the preliminary engineering cost related to the

DOT	Incentives
	utility relocation if the utility company met the submission date. The DOT suspended the program due to late submissions and the increasing instances of preliminary engineering.
Washington State	No incentives to accelerate utility relocations. But for right-of-way acquisitions, Washington State DOT (WSDOT) had a pilot project that provided incentives for property owners for early property acquisition. The pilot project result was positive, and the DOT is considering applying incentives to other projects.
West Virginia	No incentives for timely utility relocations

2.1.2.1. Incentives

As can be seen in Table 7, MassDOT uses incentives for privately owned utility relocations that reimburse participating utility companies for at least 50 percent of the utility relocation costs, not including betterment (22). Most utility companies who participate in the incentive program relocate within the timeframe specified in the relocation schedule included in the utility agreement, meaning the incentives program has worked well for the DOT. Companies that do not follow the utility relocation schedule do not receive any incentive funds and are usually substantially delayed. These cases when the relocation schedule is not followed are often a result of causes unforeseen when signing the agreement.

When MassDOT began the incentive program, the DOT had little information on reasonable utility relocation timelines, a situation that allowed utility companies to include any schedule that may appear reasonable. Now DOT utility coordinators have both experience and an understanding of a reasonable relocation timeline based on past utility relocations. One issue related to providing incentives for timely utility relocations is that the benefit to the highway construction project is reduced if one relocation still causes a delay even if the majority of utility conflicts have been resolved.

In addition to the financial benefit, other factors that have contributed to the success of the incentive program at MassDOT is that utility coordination efforts have shifted to earlier in the project development process, with a goal to move the start of the utility coordination effort from 75 percent of the design being completed to 25 percent. The DOT has found that this incentive program has had a positive impact on the project delivery process as it encourages utility companies and the project manager to work effectively and efficiently to develop a realistic relocation plan. This incentive program also encourages the highway designer to provide a design that supports utility coordination.

In Texas, a concern by utility companies is whether a highway project may be canceled or have additional design changes after they relocate their facility. To address these concerns, TxDOT reimburses a utility company for expenditures incurred for the relocation, including the design and the materials, if the design is changed and the utility company has to relocate their utility facility a second time. The reimbursement is given regardless of whether the initial relocation was reimbursable.

The Virginia DOT has an incentive program to reimburse all preliminary engineering costs for the utility relocation provided the submission date is met. This program has been suspended for approximately a

decade because of the number of late submissions received and the rising costs for preliminary engineering.

The incentive policy for PennDOT uses a cost sharing model based on the utility company meeting milestones during the utility coordination process. Up to 75 percent of the cost is covered by the DOT for municipalities and up to 50 percent for private water and sewer utility companies that provide service to the public. If a utility owner does not meet the milestones, it loses this cost sharing incentive.

While the South Dakota DOT does not have an incentive policy for utility relocations, it has an interesting model for reducing the impact of utility conflicts. The utility company pays for highway design changes to help mitigate the need for a different conflict resolution strategy that may be more impactful to the utility facility.

2.1.2.2. Penalties

In contrast to incentives, penalties refer to adverse inducements, negative incentives, or motivational pressures. Penalties can come in a number of forms, including passing on delay claims from the contractor and withholding new utility installation permits. They can be an effective motivator; as Washington State, for example, has found, utility companies respond more effectively when penalties are involved. And the MassDOT thinks adding a penalty provision to its incentive program would make it stronger in situations when utility companies refuse to relocate their facilities in a timely manner. TxDOT has the ability to reduce the amount of reimbursement for a utility relocation if the utility company fails to relocate in a timely manner(23). Another potential method to prompt relocations is to have a mechanism for imposing liquidated damages to utility companies that fail to meet agreed upon utility relocation dates (6).

Additional motivational pressures for encouraging timely utility relocations include withholding or suspending utility permits. Usually, the threat of withholding permits is enough for a utility company to begin its relocation.

Delay claims and change orders are sometimes used to assign a penalty for delayed utility relocations. Some states have the ability to pass on or recoup costs associated with delays, but few actually use this capability. The Nevada Department of Transportation (NvDOT) and Minnesota Department of Transportation (MnDOT) have the authority to pass the costs for delay claims onto the utility company. For Minnesota, Administrative Rule 8810.3300 Subpart 3 gives the MnDOT this authority. However, it is rare for MnDOT to use it, and it is important to emphasize that documentation is very important when seeking compensation from utility companies. The West Virginia DOT (WVDOT) has the authority to recover costs related to the delay.

The Kansas Department of Transportation (KDOT), North Dakota DOT (NDDOT), New Hampshire DOT (NHDOT), and NMDOT all choose not to pass costs onto the utility company for utility related delays even though they have the authority to do so. New Mexico chooses not to exercise this ability due to the potential litigation associated with the process, while Kansas is unsure of the approprite mechanism for passing the costs onto a utility company. Instead of passing on the costs for delays, New Hampshire works with utility companies to acquire utility permits and develop relocation plans and schedules. Further the Nebraska DOT does not use penalities to encourge utility companies regarding timely utility relocations;

instead it looks for solutions and works with utility companies to resolve issues that may be causing a delay.

While penalties might motivate utility companies to relocate their utility facilities in a timely manner, they do little to change the oppositional outlook of working with these companies (7). There are other ways for enabling utility companies to accomplish this, including coordination meetings, providing access to the right-of-way early, and helping with the relocation design, to name a few. A discussion of other methods used by state DOTs is presented in the remaining subsections to provide further examples of ways that could be used to clear utility conflicts early to avoid delays during construction of a highway project.

2.1.2.3. Coordination Timing Between the DOT and the Utility Company

Early planning and coordination provides more advanced notice of upcoming projects More specifically, this approach involves inviting utility owners to meetings early in the design phase of a project; holding monthly, quarterly, or other periodic planning and coordination meetings; and improving utility coordination efforts and working relationships (7). It is also important to hold periodic district-wide meetings with utility companies as they may help improve communication between SCDOT and utility companies.

Early involvement by utility companies during the design phase—by the time the design is 30 percent complete--is recommended for proper utility coordination. In Utah, the DOT reaches out to utility companies early in the project delivery process as it believes this helps getting the utility companies to begin coordination instead of waiting for the right-of-way to be acquired. MassDOT, which has a goal of beginning utility coordination before design is at 25 percent, has also found that effective utility coordination during the design process results in better construction plans in addition to giving the highway contractor a better idea about scheduled utility delays.

In Utah, the Utah Code (Title 54, Chapter 3, Section 29) requires utility owners to participate in the utility coordination process in a timely manner under the threat of penalty. Rule R930-8-10, Utah Administrate Code, describes the kind of strategy that the UDOT can pursue, including (1) completing utility design and relocation work (with exceptions for natural gas, fiber optic, electrical and installations), (2) recovering additional costs, (3) obtaining reimbursement from the utility company, and (4) denying future permits. The UDOT does not have issues with utility companies wanting to wait to coordinate with the DOT.

2.1.2.4. Other Strategies for Reducing Utility Related Delays

Acquiring right-of-way early may help facilitate necessary utility relocations earlier in the project development process, thus being less likely to affect the construction phase. Nebraska DOT, for example, has acquired right-of-way early to help facilitate timely utility relocations when a utility crossing needs to be handled immediately. It is also possible for the California Department of Transportation (Caltrans) to acquire right-of-way early for hardships and corridor preservation although these acquisitions can be handled only through negotiations and by condemnation. Early right-of-way acquisition is possible for SCDOT, primarily for hardship cases or imminent property development; early utility relocations, however, are possible only if the utility facility is relocated to a private easement outside the state right-of-way.

Other interesting strategies to help facilitate timely utility relocations include the following:

- Performing a thorough and ongoing utility coordination process throughout project development, including the use of utility investigations and utility conflict analysis
- Assisting the utility company with their utility relocation design
- Including utility information in the design plans and other utility-related documents such as utility investigation (SUE) plans, utility conflict lists, test hole sheets, and utility specific phasing or management plans in the bid documents
- Authorizing utility reimbursement funds early to utility companies to help in funding the relocation. Missouri has used this strategy but notes that it only helps in situations where the utility company does not have enough financial resources to relocate the utility facility in a timely fashion.

In Ohio a statute gives the Ohio Department of Transportation (ODOT) the ability to relocate utility facilities if the utility company does not do so. The ODOT, however, does not see this as a viable option since it would need to contract the relocation work out, which would likely be bid by contractors who have a working relationship with the utility company in question, meaning it may not be able to find a contractor to do the work.

The use of bonds may also help facilitate timely utility coordination and relocation efforts. The New Jersey DOT (NJDOT) requires bonds when a utility facility is first installed. In the event that the company does not complete the installation, the NJDOT keeps the bond. A similar process could be used to help ensure timely utility relocation or to leverage the bond for the DOT to relocate the utility facility; however, bond would need to be required when the utility facility was installed and kept until it was either relocated or removed from the right-of-way.

2.1.2.5 Summary of Strategies for Reducing Utility-Related Delays

While a number of examples of incentives and penalties are used by state DOTs, a larger number of states do not use these motivational strategies, even if they are allowed, to help encourage utility companies to relocate their facilities in a timely manner. Some of the incentives covered in this report that could be implemented include the following:

- Reimbursement for utility relocations without a compensable property interest
    - The reimbursement should be tied to meeting relocation schedule milestones or some other factor that is quantifiable
    - The percentage of reimbursability seen in representative states ranges from 50 to 100 percent
    - The costs that are reimbursable may be limited to preliminary engineering and material, or may include the entire utility relocation cost
    - The costs may vary depending on the type of utility company (private vs. public ownership), utility type, or utility customer type (public vs. private use)
- To address utility company concerns related to changes to the overall highway project and how these may impact the required utility accommodation, the offer to reimburse should include the costs for rework related to changes in the highway design that affect the utility relocation plan.

Some DOTs have found that incentives have a positive impact on the project delivery process as they encourage utility companies and project managers to work effectively and develop a realistic relocation plan. However, one issue related to providing these incentives for timely utility relocations is that the benefit to the highway construction project is reduced if one utility relocation causes a project delay even if the majority of utility conflicts have been resolved.

There is slightly more variety in the penalties that the DOT can use to motivate utility companies to relocate their facilities. Some of these penalties include the followng:

- Pass delay claims and change order costs related to delays caused by late utility relocations to utility owners
    - Have a process in place to use for passing these delay costs on to utility companies
    - Ensure proper documentation supporting this process is kept when seeking compensation from utility companies
- Reduce the reimbursement amount if the utility company does not meet its utility relocations schedule
- Withhold or suspend utility permits.

Penalties can be an effective motivator, but they do little to change the adversarial relationship between the DOT and utility companies. Other strategies to help facilitate timely utility relocations include the following:

- Assist with or complete the utility design work for the utility relocation.
- Relocate the utility facility without approval from the utility company. This may only apply to certain utility types and facilities, depending on the comfort level of the DOT and its contractors.
- Coordinate early and often with utility companies to improve utility coordination efforts and working relationships.
    - Doing so will allow the DOT to be aware of and possibly help resolve issues when they are identified.
        - Look for a solution and work with the utility company to resolve the issue causing a delay in the utility relocation process.
    - Begin coordination early in the project development process, for example in the preliminary design phase, but coordination with utility companies can begin as early as in the planning phase of a project.
    - Ensure the utility coordination process includes a proper utility investigation, for example one using the American Society of Civil Engineers (ASCE) 38-22 standard, and utility conflict analysis.
    - Coordination can be on the project, district, or state level and can be held at various intervals.
        - Higher level utility coordination meetings at the state or district level, may be held quarterly or yearly.

    - Project level meetings may be held weekly, bi-weekly, or monthly depending on the amount of coordination needed, where in the process the highway project is, and the status of the utility relocation effort.
- Acquire right-of-way early to help facilitate necessary utility relocations in the project development process.
- Include utility information in the design plans and other utility related documents such as utility investigation plans, utility conflict lists, test hole sheets, and utility specific phasing or management plans in the bid documents.
- Authorize utility reimbursement funds to utility companies early to help fund the relocation. This strategy is especially useful for smaller utility companies that may not have enough resources to relocate the utility facility in a timely manner.
- Use bonds to help motivate timely utility relocations. If the utility company is not responsive, the bond could help cover the cost of relocating the utility facility. Bonds should be in place before the request to relocate the utility facility.

2.1.3. DOT and Utility Partnering

Unfortunately, while there is no magic wand that will instantly improve the relationship between DOTs and utility companies, there are strategies for collaboration, coordination, and partnering that can help foster relationships between them.

A research project completed for TxDOT identified strategies for improving the participation of utility owners during project delivery process (24). Coordination with utility owners during this y process involves multiple activities: (1) requesting and collecting data about the location and the characteristics of existing utility facilities, (2) identifying and analyzing utility conflicts, (3) coordinating with utility stakeholders to resolve utility conflicts, (4) preparing and executing utility agreements, (5) coordinating and inspecting utility adjustments, and (6) coordinating utility reimbursements and audits. The research developed strategies to improve the participation and response of utility owners in the project delivery process. From the set of more than 70 strategies that were identified, the research short-listed four sets of strategies:

- Modernization of the utility process
- Implementation of conflict management
- Streamlining and standardization of utility cost data submissions
- Core skill training on utility topics.

TxDOT also has a process, the Utility Cooperative Management Process, for identifying and including utility company concerns in the project development process; early utility coordination helps with this (25).

2.1.4. In-Contract Utility Relocations

In-contract is also known as joint bidding, combined contracts, Combined Transportation Utility Construction (CTUC), joint project agreement (JPA), and utility work by highway contractor agreement (UWHC). In-contract refers to the inclusion of utility relocation in the highway contract to expedite highway construction projects and reduce utility-related delays.

Vilventhan and Kalidindi studied 11 projects, ranging from short to long in duration. One finding from their research was that for projects where utility relocations were in-contract with the highway project resulted in fewer delays due to relocation issues (14). Table 8 shows the project delays recorded. In the table "conventional" refers to a project where the utility company completed the relocation and "combined" designates a project where the relocation was in-contract with the highway construction contract. As can be seen from this table, delays due to utility relocations were substantially lower for the projects that used the highway contractor for the utility relocations. However, the effectiveness of in-contract utility relocations is affected if other relocations not in-contract impact the highway project construction (26-28).

When deciding if a utility relocation should be completed in-contract, the following questions need to be considered (8,11):

- Does the utility relocation need to be completed before the highway project is let?
- Are there any efficiencies by having the utility relocation work completed as part of the highway contract?
- Will the utility relocation work substantially alter the scope of the highway project?
- Do the policies of the utility company and/or labor union allow others to complete the relocation? If so, under what conditions, such as agreeing to use proprietary materials or pre-approved subcontractors, may others do the relocation work?
- Can the utility relocation work be completed by the highway contractor or an available subcontractor? A pre-approved list of subcontractors acceptable to the utility company may help address this.
- Is funding available for the utility relocation to go in-contract?

Table 8. Utility Related Delays on Projects Studied (After (14))

Project	Strategy/Method	Planned duration (months)	Actual duration (months)	Delay due to utility relocation (months)	Percentage delay
1	Conventional	24	42	10	42%
2	Conventional	36	60	16	44%
3	Combined	36	40	6	17%
4	Conventional	14	58*	54*	386%
5	Combined	36	48	8	22%
6	Combined	24	38*	7*	29%
7	Combined	24	36*	5*	21%
8	Conventional	8	22	12	150%
9	Conventional	8	18	10	125%
10	Conventional	8	19	8	100%
11	Conventional	8	20	11	138%

Note: *Ongoing at time of publication (14).

A challenge to the in-contract method is the perception, real or perceived, that the utility relocation cost is higher for in-contract versus being completed separately by the utility company. Past research has reported a 10 to 30 percent increase in the cost of utility relocation when using the in-contract method (11). According to utility companies in the metro areas of Texas, the following contributes to the higher cost of utility relocation (11):

- Contractor front-end loading cost
- Inclusion of subcontractor management contingency
- Increased number of change-orders
- Added contractual tier.

In addition, in the event that bid prices for the utility relocation work in-contract is excessively high, it may be appropriate to have an exit or contingency plan for removing this work from the highway contract and completing it separately (8,11).

When reimbursement eligibility is at or near 100 percent, utility companies are less concerned with the perceived cost increase related to going in-contract (11). Some of the other cost items that utility companies consider when thinking of going in-contract include opportunities for cost savings and reimbursability of the utility relocation. The eligibility ratio for a utility relocation reimbursement is very important in the utility company's decision whether to go in-contract (11). The reimbursability of a utility relocation is tied to the cost savings. Past research has found that utility companies want to see direct cost savings before going in-contract for utility relocations (11). In addition, in-contract utility relocations provide the company with protection from claims due to delays in relocating the facility since the highway contractor is responsible for the relocation (29). If SCDOT can show a cost savings to the utility owner for going in-contract, it may play an important role in persuading the utility owner to do so.

Advanced funding for utility relocations can be an important consideration for utility companies, especially smaller ones who may not have the budget for a major relocation. It has been identified as especially important in deciding whether to use the in-contract method when the utility relocation is not reimbursable, especially for private utility companies (11). It has been reported that utility companies find the in-contract method for utility relocations more appealing if there is another process that did not expect the utility company to pay the entire cost of the utility relocation up front (11).

Since utility relocations and highway construction are being completed by the highway contractor or the approved subcontractors, activities requiring the same resources can be scheduled with the utility relocation to save project resources (11). This coordination can result in a more efficient use of the highway contractor's resources and minimize duplication of effort on overlapping items such as traffic control and excavation due to the consolidation of the work (8,11). The contractor can also control the schedule for both the highway work and utility relocation so that delay and possible disruptions to the construction schedule are minimized (8).

A common risk associated with utility relocations is related to inspections (11). It is critical for the long-term success of in-contract utility relocations to require utility owners to inspect (or provide inspections) and accept the relocation work done for their facilities (8,11).

When a utility company does not have the workforce and resources to manage the utility relocation work without impacting the highway project schedule, the in-contract method can be beneficial to the company. This approach can reduce the demand on the utility company by allowing others, besides utility company crews or contractors, to perform the work (11).

Another possible benefit of an in-contract approach to the utility company is the possibility that the design of the utility relocation will be handled by the DOT (11). While the DOT may use internal resources to design the utility relocation facilities, it is more likely that the design work will be outsourced to a firm with experience in utility design. However since this is not always feasible, it may be better for the utility company to provide the design work for the relocation (27).

A disadvantage of handling utility relocations in-contract is that utility companies may not have confidence in the highway contractor's ability to accomplish them (26). If the contractor typically in charge of the highway construction does not have utility construction experience, it can be difficult to convince utility companies to agree to an in-contract approach (7). One potential way to help alleviate the utility company's concern is to have the contractor install general civil infrastructure such as utility poles and conduits (27), after which the utility company installs cables, wires, and other specialized equipment. This option is more feasible for complex utility facility installations.

2.1.4.1. In-Contract Method at DOTs

A survey conducted by AASHTO in 2001 reported that two thirds of state DOTs ave used in-contract utility relocations in at least one highway construction project (30). Below are representive examples from a several DOTs on their in-contract process, with information on the in-contract incentives being presented on a state-by-state basis.

The Alabama Department of Transportation (ALDOT) allows utility companies to use the in-contract approach on a case-by-case basis (19,20). Municipally owned water or sewer utilities are typically included in the highway project for relocation work while, in general, electric, gas, and communication utilities are not (19,20). ALDOT uses two separate agreements depending on the reimbursability of the utility relocation: Utility standard agreement form SAHD No. 3 is used for reimbursable utility relocations in-contract and form SAHD No. 4 is used when the in-contract utility relocation is non-reimbursable (19,20).

Caltrans has widely used highway contactors for utility relocations and to control utility-related delays during construction (11). Its right-of-way manual outlines utility agreements for various contracting methods.

The Georgia Department of Transportation (GDOT) includes the utility relocation work in highway construction projects for all utility companies that have been granted utility aid through GDOT policy 6863-11- Utility Aid Guidelines.

Michigan Department of Transportation's (MDOTs) roadway design manual provides information on the the state's DOT utility relocation procedures. The interim update dated February 27, 2012, outlines the process for including utility relocation in the highway construction contracts of the DOT contractor. MDOT

often includes utility relocation work in the highway construction contract for municipally owned utility facilities (19,20).

In New Jersey, many utility companies go in-contract with the DOT for their relocations in the highway project, thus reducing the risk of utility-related delays (19,20). The New York State Department of Transportation (NYSDOT) supports the in-contract utility relocation approach and is developing a process for relocating utility facilities using it (11). Further, it allows reimbursable utility companies to either go-in contract with the highway project or complete the utility relocation through their contractors (29).

The Tennessee Department of Transportation (TDOT) allows for in-contract utility relocations. More information is provided in a later section regarding its incentives for using this approach.

A TxDOT research study produced an in-contract decision support tool as part of TxDOT 0-4997-1 to help determine if utility relocations should be to be included in a highway project. The use of such a decision support tool, or other means of determining if it is appropriate for a utility to be included in-contract, may help in selecting utility relocations that will be successful usng this approach (11). This study also developed a decision support model to help select the contracting method, traditional versus in-contract, appropriate for utility relocation (11). While this model is based on TxDOT project data, it can be used to help support SCDOT in the selection process.

Washington State (WSDOT) uses DOT Form 224-077 or Form 224-062 for in-contract agreements (19,20). The former is used by the DOT when the utility company has a prior right, in which case the DOT pays for the utility relocation. Form 224-062 is used in all other cases.

2.1.4.2. In-Contract Incentives

Providing incentives may encourage utility companies to go in-contract for utility relocation work. Thus, they can be an important factor in expediting SCDOT construction projects. As noted in the proposal, few studies explore the the best incentives for companies to include their utility relocation in-contract.

As part of NCHRP 11-08 project Improving Rights-of-Way Acquisition and Compensation Practices for Utility Relocation, researchers asked state DOTs if they provide incentives to utility companies for in-contract utility relocation. Most the the rest of this subsection is from NCHRP 11-08, which is under review; information that is not part of it is cited appropriately.

GDOT policy 6863-11- Utility Aid Guidelines allows the GDOT to provide financial assistance to utility owners in following two cases:

- Extreme hardship case: when the relocation cost is unforeseen and is significantly higher than the utility company's operating budget.
- Major project schedule or design changes in the highway project development process, substantially increasing the utility company's budget with little time remaining to budget the increased funds.

If the utility company has more than 25,000 customers,the GDOT is limited to 60 percent of the cost of utility relocation directly in conflict with highway construction; if the utility company has fewer than

25,000 customer, it can provide up to 100 percent of the cost of utility relocation directly in conflict with highway construction. This reimbursement excludes the betterment, preliminary and construction engineering, inspection, and administrative costs. However, the GDOT may provide final preliminary engineering costs through its consultant services contract to utility companies with 5,000 to 25,000 customers and may reimburse preliminary engineering costs to utility companies with fewer than 5,000 customers. These latter companies may choose to complete the preliminary engineering using their own staff and at their own expense; however, any delay in the preliminary engineering resulting in failure to meet the project schedule may result in their forfeiting any utility aid granted on the project for other costs. The GDOT includes the utility relocation work in the highway construction projects for all utility companies who have been granted utility aid through GDOT Policy 6863-11- Utility Aid Guidelines (32).

For the Michigan DOT, the cost of the relocation of municipal utilities (water mains, sanitary sewers, storm sewers, power lines, poles, and street lights) serving customers within their municipal corporate boundaries is included in the project cost, and relocation work is included in the highway construction project (33).

According to NYSDOT's design manual, an effective method for encouraging utility companies go in-contract with the highway construction contract for utility relocation work (i. e. work to be performed at the utility company's expense) is to use "fixed price lump sum items" (31).

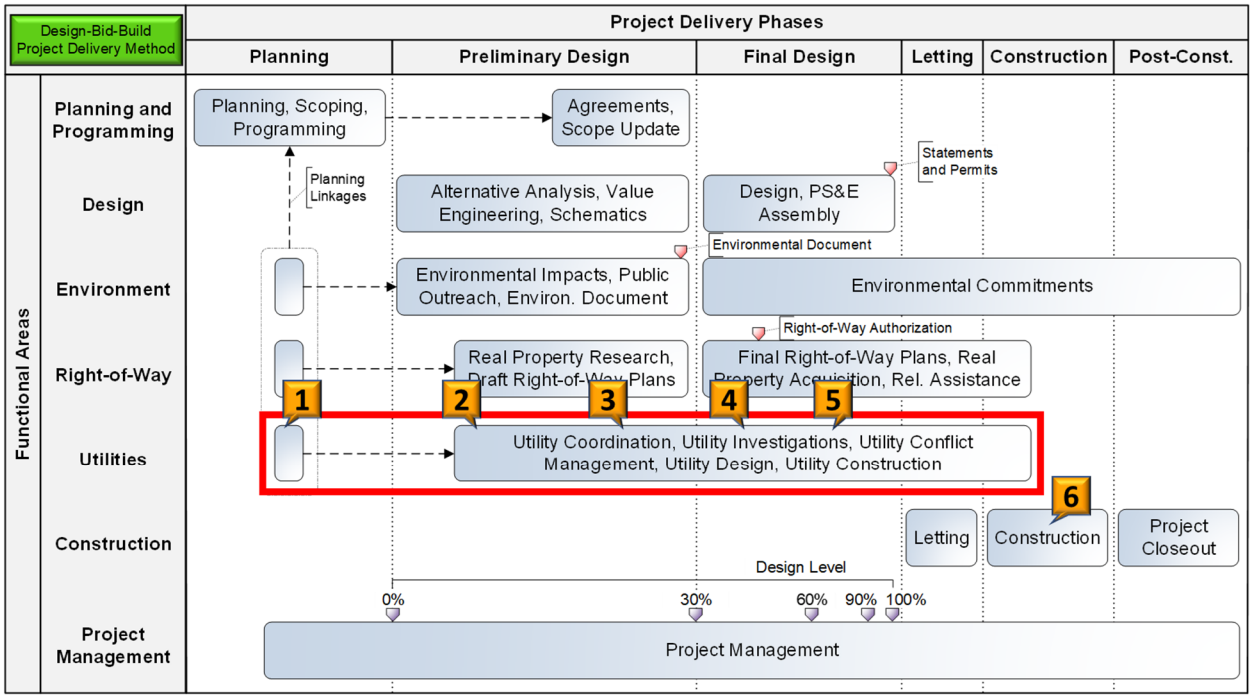
In 1998, the Rhode Island Department of Transportation (RIDOT) considered legislation requiring utility companies to relocate their facilities with 30 days of written notice. Failure to do so within the stipulated timeframe meant that the RIDOT could include the utility facility relocation work in their highway construction contract and the utility company would be responsible for the cost of its facility relocation. This legislation was not enacted because utility companies argued these relocation costs due to delays would be passed on to customers, thus raising their utility costs (7).

In Tennessee acording to TDOT Rule TCA 54-5-804 and TDOT Policy 340-07 Chapter 86, if the utility relocation work is included in the highway construction contract, then the utility is eligible for 100% of the relocation cost for municipally owned utilities, utility districts, and utility cooperatives and 75% of the relocation cost for all other utilities (19,20). If the utility relocation work is not included in the highway contraction contract, then the utility is eligible for 50% of the relocation cost for municipally owned utilities, utility districts, and utility cooperatives and 25% of the relocation cost for all other utilities (34).

2.1.5. Utility Process within the Project Delivery Process

Identifying utility conflicts late during the design phase, e.g., at 60 percent design, makes it difficult to revise the design to avoid these conflicts. A more effective strategy is to identify utility conflicts earlier. The project design process is shown in the diagram in Figure 4. The project delivery phases typically used at SCDOT include planning, preliminary design, final design, and construction. The utility process, as shown in Figure 4, should begin during the planning phase, where the project has not even started yet. At this point, coordination with utility owners would help to identify issues that might impact the project scope. When the project starts, at the beginning of preliminary design, utility owners are notified that the project might affect them. At this point, a best practice is to start conducting a preliminary utility investigation

based on existing records. This investigation would enable an early identification of utility conflicts. Figure 4 shows shows six concurrence points that correspond to important UCM stages and a summary of UCM activities by stage. In practice, the number and placement of the UCM activities can vary from project to project. However, the stage structure and UCM activities provide a framework for implementation.

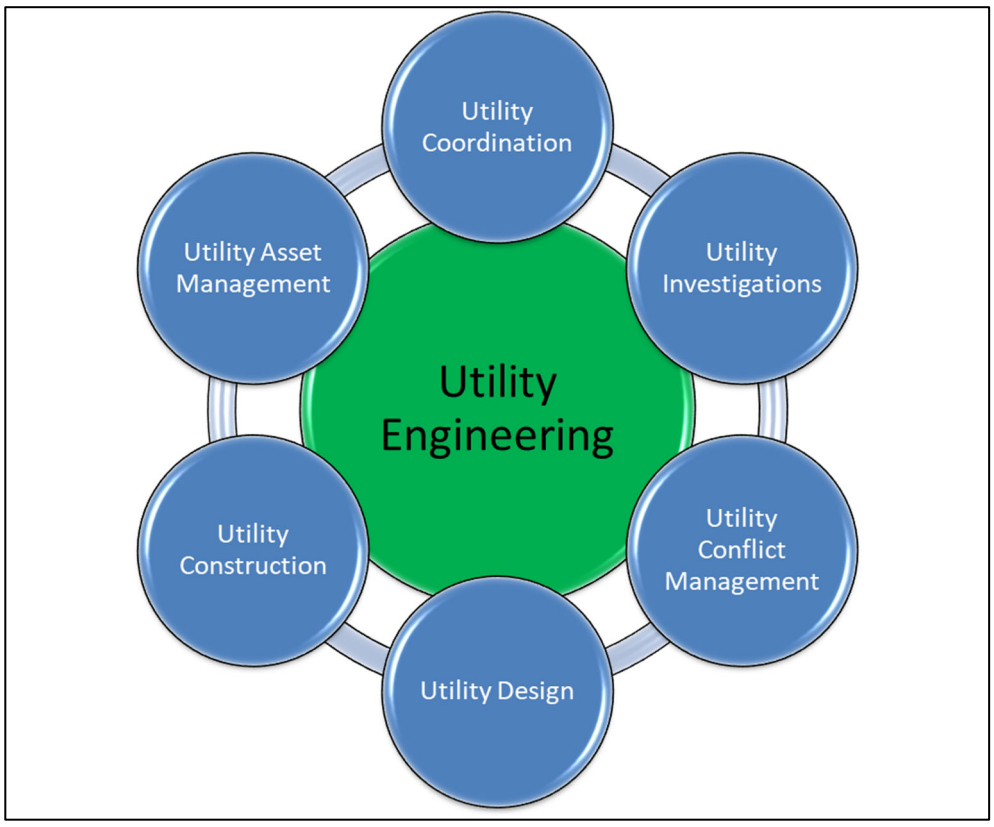


Stage	UCM Activities	
1	Utility field investigations are not conducted at this stage. Prepare realistic project scope (fiscally constrained).	Identify major UR issues that might affect the project route, scope, or schedule. Meet with utility owners about planned project.
2	Send notifications of the highway project to utility owners. Conduct preliminary utility investigation based on existing records (QLD). Identify utility conflicts and conduct initial assessment using a utility layout and a preliminary utility conflict list.	Focus on major physical constraints associated with utility facilities. Determine where additional utility investigation is needed.
3	Survey aboveground utility facilities (QLC). Conduct utility investigation using geophysical techniques (QLB). Identify or update utility conflicts using utility layout and preliminary utility conflict list.	Request utility owners to confirm conflict locations, assess constructability challenges, and discuss potential resolution strategies. Determine where more detailed investigations are needed. Develop preliminary critical path schedule for utility relocations.
4	Conduct geophysical investigation (QLB) as soon as possible if not done before. Conduct utility test holes at specific locations (QLA). Identify or update utility conflicts. Analyze and review resolution strategies. Notify utility owners of required relocation or adjustment.	Design and coordinate utility relocation and protect-in-place measures. Prepare utility relocation plans and schedules for inclusion in utility agreements. Prepare or revise critical path schedule for utility relocations. Monitor and inspect utility relocations. Prepare utility as-built plans.
5	Need for a utility investigation at this point should be minimal. Finalize design of utility relocation and protect-in-place measures. Finalize utility agreements. Refine utility relocation schedules. Monitor and inspect utility relocations and prepare utility as-built plans.	Prepare utility construction plan. Include utility plans and utility relocation schedules in PS&E package. Prepare utility statement to include in the construction bid package.
6	Need for a utility investigation at this point should be minimal. Conduct preconstruction utility coordination meeting. Conduct construction utility coordination meetings. Monitor and inspect utility relocations and prepare as-built plans.	Assess and resolve new utility conflicts and corresponding impacts that are uncovered during construction. Update utility relocation schedules.

Courtesy of Texas A&M Transportation Institute.

Figure 4. *Project delivery process chart showing the utility process.*

Related to the recognition that utility issues during project delivery are complex is the increasing acceptance of utility engineering as a valid engineering specialty (much like other specialties needed in project development, e.g., planning, traffic engineering, pavements and materials, structures, and hydraulic engineering). A critical feature is the recognition that utility engineering involves a holistic approach to the utility process at DOTs, involving areas such as utility utility coordination, utility investigations, UCM, utility design, utility construction, and asset management (35,36). Figure 5 provides a graphical depiction of the connection among these six areas, which, in effect, are pillars of the utility engineering specialty and practice.



Courtesy of Texas A&M Transportation Institute

Figure 5. *Six Pillars of Utility Engineering (37)*

Past research includes other state DOT-funded studies that developed best practices for mitigating utility related delays. For example Ellis et al. (38) identified the following categories of best practices for minimizing utility relocation delays:

- Specify appropriate SUE quality levels for highway projects
- Strive to have utility conflicts addressed before beginning construction. Utility conflict management, which should take place continuously throughout the project, can begin as soon as the project right-of-way outline is determined.
- Include utility relocations in-contract
- Include utility coordination responsibility as part of the scope of the construction contract

- Improve partnering with utility companies and
- Provide incentives for timely utility relocations.

In a study funded by the Illinois Department of Transportation, El-Rayes et al. (39) identified 45 best management practices for expediting utility relocations to minimize project delays, grouping them into the following four categories: (a) coordination practices, (b) financial incentives, (c) practices requiring cost, and (d) no-cost practices.

2.1.6. Resolution of Utility Conflicts

When a transportation construction project involves the relocation of utility facilities, a DOT or other responsible agency must engage in complex negotiations with utility owners and other stakeholders, discussions which may include the acquisition of right-of-way or easements to facilitate the relocation and reimbursement to the parties affected. The process for addressing and resolving utility issues during project delivery depends on a variety of laws, regulations, and business practices in at least three categories:

- project delivery process
- acquisition of real property interests
- accommodation and relocation of utility facilities.

Detection of utility conflicts as early as possible facilitates the identification and implementation of optimum strategies for resolving these conflicts. The goal of these strategies is first to avoid conflicts, second to minimize impacts, and if neither of these two strategies is feasible, then consider relocating the utility facility. In practice, strategies to resolve a utility conflict could include one or more of the following:

- Modifying the proposed transportation facility, e.g., by changing the horizontal and/or vertical alignment of the project, altering the drainage design to avoid existing utility lines, altering noise walls or traffic signal components, or optimizing construction phases.
- Implementing an engineering measure to protect-in-place a utility facility, which does not involve utility relocation or changes to the transportation project alignment.
- Removing, abandoning, or relocating the utilities in conflict.
- Accepting an exception to policy.

It is increasingly recognized that DOTs frequently begin utility coordination too late during project delivery (60%) and that there are tangible benefits for starting the process considerably earlier. It is common to wait until the horizontal and vertical alignments are in place, and certain design features such as the drainage design are substantially finished to start identifying potential utility conflicts. As part of the implementation of utility-related products that emerged from the Second Strategic Highway Research Program (SHRP2), in particular Project SHRP2 R15B, several DOTs documented time and money savings by identifying and resolving utility conflicts earlier (40).

It is also increasingly recognized that the systematic adoption of UCM principles leads to a more complete identification of the elements required in utility agreements, in particular the preparation of more

thorough utility relocation plans, utility relocation schedules, and utility cost estimates. UCM is based on the principle that identifying and resolving utility conflicts is a team effort that should involve both DOTs and utility companies. To address the issue of inadequacy in the preparation of utility agreements, the FHWA identified a number of strategies and recommendations (12), with one of the action items resulting from this effort being the need for a systematic review of practices throughout the country.

One factor that is frequently ignored is the connection between the utility process and the environmental review process. A 2009 TxDOT research project examined the feasibility of establishing synergy and concurrence points between both processes (41). The purpose of this research was to evaluate the feasibility of (a) obtaining better existing utility data during preliminary design and coordinating this activity with the environmental process and (b) increasing the level of definition of design components during preliminary design without affecting environmental requirements. This analysis resulted in ten optimization strategies that address a variety of environmental and utility issues identified through a literature review and meetings with stakeholders throughout the state. The researchers also developed a detailed business process diagram that integrates environmental and utility functions, with a specific emphasis on the preliminary design phase.

In September 2008, the FHWA and AASHTO conducted an international scan in Australia and Canada to learn about innovative practices used in right-of-way and utility processes that might be applicable for implementation in the United States (42). The study team visited four state transportation agencies in Australia: The Road and Traffic Authority (RTA), New South Wales (NSW); the Department of Main Roads, Queensland; the Department for Transport, Energy, and Infrastructure (DTEI), South Australia; and the Roads Corporation (VicRoads), Victoria. In Canada, the study team visited Alberta Transportation, Alberta, and the Ministry of Transportation, Ontario. This scanning tour complemented an earlier scanning tour of European countries in 2000 covering Norway, Germany, the Netherlands, and the United Kingdom.

Detection of utility conflicts as early as possible helps facilitate the identification and implementation of optimum strategies for resolving them, i. e., ways to avoid conflicts or minimize impacts before considering relocating the utility facility if no other conflict resolution strategy is viable.

It is increasingly recognized that DOTs frequently begin utility coordination too late during project delivery process, at around 60 percent. It is common to wait until the horizontal and vertical alignments are in place and certain design features such as drainage design are substantially finished to begin identifying potential utility conflicts. Utility coordination needs to begin early in the project development. In fact, there are tangible benefits for doing so: a number of DOTs have documented time and money savings by identifying and resolving utility conflicts earlier. It is also increasingly recognized that the systematic adoption of UCM principles leads to a more complete identification of required elements.

2.1.7. Use of Utility Impact Assessment Tools During Project Delivery

2.1.7.1 Utility Investigations and Impact Analysis

As-built data provided by utility companies is frequently unreliable (43). Typically, project owners or consultants send project drawings to utility companies, either as PDFs or in computer-aided (CAD) format, to annotate and label with existing utility facility information. Usually, utility companies prefer to use the

PDF files to provide this information, which is limited to the approximate location of utility facilities. Ocassionally, utility companies provide digital as-built files; however, they are often not georeferenced, and different utility companies follow a variety of formats for such files. As a result, it is necessary to convert the files to a format consistent with the rest of the project's drawings, including adjusting their scale and projections to match the project files. The reliability of these converted digital as-built files usually remains unclear even when the utility facility information is imported into the design files.

Questions related to the reliability and completeness of existing underground utility facility as-built data and the potential liability of project designers using these data triggered the development of the national ASCE 38-02 Sandard Guideline (44). This standard, which provides guidelines for conducting utility investigations, specifies four quality level attributes for individual utility features: Quality Level D (QLD), Level C (QLC), Level B (QLB), and Level A (QLA). Utility data attribution and feature symbology description are limited in ASCE 38.02. The 2022 revision of this standard, ASCE 38-22*, Standard Guideline for Investigating and Documenting Existing Utilities,* provides more information and guidance as well as examples on how to indicate utility facilities on the utility investigation deliverables.

ASCE also published a companion standard guideline, ASCE 75-22, *Standard Guideline for Recording and Exchanging Utility Infrastructure Data*, which outlines minimum, optional, and conditional elements of the spatial and non-spatial attribute data associated with utility facilities. This standard guideline also provides recommendations on how to effectively facilitate data exchange among project stakeholders in addition to establishing the definition of the positional accuracy levels required for utility facilities. In addition, it provides a utility data exchange framework that includes feature types, geometry types, and feature attributes. Importantly, the list of feature types includes minimum requirements and optional and conditional feature types. Example of minimum requirements include utility company name, utility type, feature type, operational status, horizontal spatial reference and positional accuracy, and vertical spatial reference and positional accuracy. The optional and conditional feature types may be found in the ASCE 75-22 guideline.

Techniques and methods for conductng utility investigation are well documented in the technical literature. The available literature, however, primarly focuses on underground utility facilities. For example, in 2009, a Second Strategic Highway Research Program (SHRP2) report highlighted underground utility facility investigation techniques available at the time (45), discussing their capabilities as well as their limitations. It also reported that professional interpretation is required for most geophysical investigation methods. In 2017, a research project conducted in the Netherlands completed an assessment of detection technologies for underground features (46), comparing electromagnetic, magnetic, ground penetrating radar (GPR), and acoustic technologies (Table 9).

Table 9. *Comparison of Underground Detection Technologies (46).*

Feature	Conditions	Electromagnetic		Magnetic	GPR	Acoustic
		Inductive	*Passive*			
Detectable material	*Cables*	×	×		×	
	Metal	×	×	×	×	×
	Non-metal				×	×
Functional at excavation speed		Yes	Yes	Yes	Yes	No
Accuracy		~ 0.1 m		~5% depth	5~10% of depth	0.1~0.2m
Depth range		<2m	<2m	3m~6m	<4m	<3m
Frequency		50 ~ 480 Hz	50 ~ 60 Hz		50 Hz ~ 4 GHz	132 ~ 210 Hz
Impact of soil condition on functionality	*Wet soil*	High	High	Low	High	High
	Salty soil	High	High	High	High	Low
	Clayey soil	Low	Low	Low	Low	Low
Sensitivity to terrain conditions		Low	Low	Low	High	Low
Scanning Pattern		Swinging along estimated pipeline location	Swinging along estimated pipeline location	Swinging along estimated pipeline location	In grid	N/A
Data Processing	*Real-time*	×	×	×		
	Post-processing				×	×
Estimated maturity level (scale 1-10)		7	7	6	8	4

According to the ASCE 38-22 standard (primarily QLB and QLA investigations), utility investigations are typically conducted during the design phase. However, increasingly, DOTs are beginning to request utility investigation information during the preliminary design phase. While SUE is usually not done during construction, contractors conduct test holes during construction to verify the location of underground utility facilities. In some cases, due to missing or erroneous utility facility information on the project plans, contractors dig slit trenches or dry holes.

As part of a joint transportation research program, in 2002 the Indiana DOT and Purdue University conducted a survey, reporting that 22 state DOTs used SUE on highway projects; however, it was not clear from the survey, how systematically or to what degree SUE was used (47). Most of the state DOTs that used SUE on highway projects, left the decision of whether to use it up to the project manager or district utility coordinators.

As part of Phase 1 of the national utility review conducted in 2018, the FHWA asked state DOTs to describe the process for depicting existing utility facilities on the design plans and whether they used a utility company's input as-built plans, or SUE for this purpose (12). Twenty-seven state DOTs indicated that their initial utility investigation method was based on as-built plans provided by utility companies and the One-Call process. Contractors, utility companies, and DOT staff indicated as-built utility facility location data were unreliable, providing only a general indication of X-Y utility facility location data.

A few state DOTs use In-house developed tools to determine when to conduct SUE. The Pennsylvania Department of Transportation (PennDOT) developed a spreadsheet tool, referred to as the Utility Impact Analysis (UIA), for selecting the suitable utility investigation quality level for a project, more specifically whether QLB or QLB and QLA would be required (48,49). In general, UIA assumes that preliminary utility

data (QLC and/or QLD) are available prior to beginning the analysis. UIA is a two-step process for determining when to use SUE and what quality level is required. Step 1 is usually at the overall project level, while Step 2 generally applies at the project segment or location level because projects are not always consistent regarding factors such as the age or density of utility facilities.

As part of Step 1, the user answers the following four questions as yes or no:

- Whether there is evidence of underground utility facilities.
- Whether any excavation of more than two feet is necessary, including excavation on temporary construction easements or other easements.
- Likelihood the project will impact subsurface utility facilities.
- Lack of accurate utility facility data.

A yes answer to any of these four questions could indicate that a QLB or QLA investigation is required, and the user proceeds with Step 2, in which they evaluate the potential impact level associated with the following 13 complexity factors:

- Density (i.e., number) of utility facilities
- Type of utility facilities
- Pattern of utility facilities
- Material of utility facilities
- Access to utility facilities
- Age of utility facilities
- Project area description
- Type of project
- Quality of utility record
- Estimated business impact
- Estimated environmental impact
- Estimated safety impact
- Other impact

All 13 complexity factors include three impact levels, each rated with a numerical value of 1, 2, or 3, representing Low, Medium, and High, respectively. The user selects one of the following options for the density of utilities:

- Lo— for one pipeline crossing
- Mediu— for two to three pipeline crossings
- Hig— for more than three pipeline crossings or if there are unknown pipelines in the area.

For utility types, the user selects one of the following:

- Less-Critical: for water, stormwater, or forced sewer main
- Sub-Critical: for gravity-fed sewer, electrical, telephone, or cable

- Critical: for fiber optic cable, high-voltage electrical, oil and gas pipelines, or unknown utility types.

After totalling the complexity factor values and dividing by the number of complexity factors used, the average impact score is compared to the reference table seen in Table 10 to determine the quality level of the utility investigation required.

Table 10. *PennDOT's Utility Impact Scores (*49*).*

Descriptor	Utility Impact Score		
	1.01–1.67	**1.68–2.33**	**2.34–3.00**
Recommended Minimum SUE Quality Level	QLB	QLB or QLA	QLA
Relative Cost Factor	16.67	33.33	66.67

The GDOT developed a utility impact rating form to determine the required quality level for a utility investigation (50,51). This form includes ten factors, the impact level for each rated as low, medium, or high. An overall utility impact factor is calculated by totalling the impact levels for the ten factors, resulting in a low utility impact factor (minimum project impact), medium (moderate project impact), or high (high project impact). The GDOT recommended gathering QLD data during the planning phase of project development, QLC if the utility impact rating was low, and QLB if the utility impact rating was medium or high. These recommendations were at the project level.

In 2018, GDOT modified the process for determining quality levels (52), currently recommending conducting utility investigations as follows:

- QLD: During the highway project's concept development phase.
- QLC: At the beginning of preliminary design when project mapping and survey control are established. QLC is typically used on rural projects.
- QLB: At the beginning of preliminary design when project mapping and survey control are established. QLB is typically used on urban projects and the information is used to make preliminary decisions about storm drainage, foundations, and footings with a focus on the highway design avoiding existing utility facilities.
- QLA: After preliminary field plan review and preferably after completing a UIA. QLA is needed at specific locations for final design and utility facility placement decisions focusing on cost savings.

GDOT's UIA tool is different from PennDOT's tool as it includes a utility conflict list along with avoidance alternatives, required relocation and cost estimates (53). The GDOT's analysis is typically conducted after QLB data are collected and is used to determine where QLA test holes are required (approximately 30% design). The GDOT also recommends using the UIA tool again after the second submission of the project files to the utility companies to resolve any new or remaining utility conflicts (approximately 70–90% if applicable). The GDOT also has various checklists for SUE deliverables, depending on the SUE quality level that it requests (54).

Depending on the project activity, the WSDOT determines the type of utility investigation needed (55). Table 11 shows the minimum quality levels usually required for each type of project activity along with the quality levels recommended depending on the information found during the analysis. The WSDOT

emphasizes that project teams should identify and apply appropriate techniques for the utility investigation based on budgets and expectations. Project teams should evaluate the potential costs associated with the risk of accepting a lower quality level versus the costs of a higher quality level to resolve the conflict.

Table 11. *WSDOT's SUE Quality Level Requirements (*55*).*

Type of Work	Quality Level Required			
	QLD	QLC	QLB	QLA
Curbing	●			
Concrete barrier	●			
Striping	●			
Hot mix asphalt (HMA) overlay only	●	○		
HMA or Portland cement concrete pavement	●	○		
Clearing and grubbing operations	●	○		
Removal of structures and obstructions	●	○		
Surfacing	●	○		
Sidewalks	●	○		
Guideposts	●	○		
Monuments	●	○		
Pit site production	●	○		
Signing		●		
Mailboxes		●		
Guardrail installation		●	○	
Roadside planting		●	○	
Fencing		●	○	
Irrigation systems		●	○	
Temporary erosion control		●	○	
Pipe/drainage structures			●	○
Ditch/pond excavation			●	○
Roadway excavation/widening			●	○
Advanced geotechnical work			●	○
Bridge structures			●	○
Retaining walls			●	○
Piling			●	○
Signal systems			●	○
Illumination systems			●	○
Intelligent transportation systems			●	○
Railroad crossings			●	○
Sanitary sewers			●	○
Water mains			●	○
● – Minimum level required	○ – Optional, depending on what is found			

Until recently, Caltrans was not using geophysical techniques for utility investigations; rather positive verification of utility locations (using test holes) is required if the utility facility is considered a high priority (56). High priority utility facilities include the following:

- Pipelines transporting hazardous materials
- Petroleum pipelines
- Natural gas pipelines that are either
    - 6 inches in diameter or larger
    - 60 psi operating pressure or greater
- Pressurized sanitary sewer lines
- High-voltage electric supply, conductors, or cables 60 kV or greater.

2.1.7.2. Utility Data Available During Construction

The current highway project designs primarily use CAD software that relies predominantly on vector graphics (such as points, lines, polylines, or polygons) as opposed to raster images (i.e., based on pixels). In general, highway projects are designed in 2D by using plan views, cross sections, and profiles. Increasingly, DOTs are using 3D modeling techniques to visualize, design, and construct projects, which involves depth information (the z value) for all features (57). 3D modeling has evolved into building information modeling (BIM), in which each feature is modeled as an individual object with geometry, attributes, and connections. BIM is primarily used for vertical construction applications such as project scheduling, cost and quantity estimation, and supply chain management. More recently, it has been used for horizontal construction projects such as highways.

Michigan's Geospatial Utility Infrastructure Data Exchange (GUIDE) is a joint effort of the Michigan Utility Coordination Committee, which includes the Michigan Department of Transportation (MDOT), the One-Call notification center, three major utility owners, and the contractor's trade association (58). In 2014, MDOT received funding from the FHWA through the State Transportation Innovation Council Incentive Program (59). In the same year, the FHWA also funded 12 3D-related projects at 10 state DOTs, most focusing on the development of standards, specifications, and procedures to support 3D modeling applications for the design and construction of highway projects. One of these 12 funded projects was GUIDE, which focused on utility related topics. Later, the MDOT received additional funding through the SHRP2 implementation assistance program.

The aim of the GUIDE program is the development of a sustainable approach to data collection, management, and dissemination of 3D underground utility facility data. The program requires capturing X-Y-Z data at the time of installation, subsequently organizing these data in a spatial database (58). Basic requirements include positional accuracy (0.16 ft horizontally and vertically) and attribute data such as utility type, installation method, feature type, traceability method, and material. Utility companies participate in GUIDE through the MDOT utility permitting process. High-level activities include the following (58):

- Utility company
    - Request and obtain utility permit from MDOT
    - Procure surveying services for data collection
    - Proceed with utility installation concurrently with the data collection
- Surveyor
    - Follow GUIDE manual for proper data collection, formatting, and submittal
    - Collect data concurrently with the utility installation

    - Format and submit data to the GUIDE web portal
- MDOT
    - Review data for compliance. As needed, return data for correction and resubmittal
    - Accept data and close permit

The GUIDE manual provides instructions for direct and indirect survey observations for open-trench and trenchless installations, respectively. The data collection protocol includes collecting data at the following locations (58):

- Start and end points
- At least every 100 ft with the following additional points:
    - Deviations in installation alignment, including, but not limited to, intentional changes in geometry (e.g., to avoid obstacles) and fittings such as elbows
    - Changes in facility characteristics (e.g., change in size, material, or encasement size).
    - Start and end points for vaults
- Appurtenances installed concurrently with new main installations (e.g., service leads or stubs)
- New appurtenances from existing mains
- Transverse utility crossings installed via trenchless methods

A pre-determined feature class template must be used by surveyors. The MDOT provides a sample geodatabase template that includes all the required feature classes and attributes. The MDOT GUIDE web portal rejects files that do not comply with the pre-defined standard data architecture.

In 2019, the Colorado Department of Transportation (CDOT) initiated a program for collecting the required attribute and location data about utility facilities using a web-based platform that includes three components (57):

- Data collection platform
- Data integration tools
- A web-based dashboard application

The CDOT uses PointMan, a GPS-based mobile application that enables users to capture utility facility location and attribute data in the field, as a data collection platform. It also allows user to upload the field data to an online geospatial database in real time. Users can also georeference photos, annotate design files, prepare electronic forms, take field notes, and create sketches. PointMan collects field data in a 2D platform, but users can capture depth data using an attribute. In addition, PointMap uses a web-based dashboard application, Transparent Earth, which enables users to visualize and analyze utility facilities or other features based on information received from portable data collection devices running the PointMan application via a real-time interface. It covers information such as aboveground or underground utility facilities, as-built information, photos, and documents. This web-based dashboard application allows users to annotate and edit map and tabular data and share that information with field users via the cloud.

2.1.7.3. Decision Support Systems

The literature on the application of decision support systems (DSSs) for addressing utility-related risks during the project delivery process is limited. However, the PennDOT's UIA tool discussed earlier could be

considered a DSS because it calculates a utility impact score, which relies on a combination of unstructured and semi-structured data to determine whether QLB or QLA is required for a project.

In 2006, the TxDOT completed a research project evaluating the effectiveness of including utility relocations in the highway contracts (11). The research team developed a prototype using Visual Basic in an Excel spreadsheet framework. Referred to as the Combined Transportation and Utility Construction (CTUC) decision support tool, it was designed to help officials decide whether to include a utility relocation in the highway contract. However, this tool was never implemented.

This decision support tool could isolate significant utility facility related issues and display feedback from project owners and utility companies in favor of or against including utility relocations in the highway contract. Their response was based on a list of 53 factors referred to as decision drivers, each with an impact level ranging from 4 (No Impact) to 1 (High). The impact level ranges associated with each decision driver was based on the feedback provided by selected TxDOT and utility company stakeholders. Table 12 lists the top five pro-CTUC decision drivers and the corresponding impact levels as well as the top five anti-CTUC decision drivers and the corresponding impact levels. A total of 17 questions were included in this tool to provide context for the decision drivers considered in the analysis.

Table 12. *Top Five Decision Drivers (11).*

Rank	TxDOT Decision Driver	Impact Level	Utility Owner Decision Driver	Impact Level
Pro-CTUC Decision Drivers				
1	Severe schedule pressures	2.81	Reduced delay costs due to CTUC	2.61
2	Relocation can happen only during construction	2.73	Relocation can happen only during construction	2.56
3	Reduced delay costs due to CTUC	2.62	Substantial clearing and grubbing	2.47
4	Reduced delay costs due to CTUC	2.44	Reduced delay costs due to CTUC	2.45
5	Shared underground facility (all CTUC)	2.37	Severe schedule pressures	2.44
Anti-CTUC Decision Drivers				
1	Only utility crew can do	–3.75	Front-end loading: Increased costs with CTUC	–3.5
2	Utility cannot pay in advance	–3.38	Change order: Increased costs with CTUC	–3.47
3	Utility work beyond right-of-way	–3.29	Utility cannot pay in advance	–3.44
4	Utility plans are unacceptable	–3.00	Added contract tier: Increased costs with CTUC	–3.37
5	Utility owner does not qualify for State Infrastructure Bank financial assistance	–3.00	Only utility crew can do	–3.33

Note: CTUC = Combined Transportation and Utility Construction

In 2011, the SHRP2 research produced a reference database of methods for utility facility locating and characterization that led to the development of a prototype decision support tool, referred to as Selection Assistant for Utility Locating Technologies (SAULT) (45, 60). The researchers evaluated several design approaches when developing SAULT, including deterministic, case-based selection, fuzzy logic, choices and preferences, and artificial neural networks. This research team highlighted that a robust database of

real-world examples was not available; therefore, it settled for a system that provided guidance based on a variety of conditions. This system, however, was not a substitute for first-hand experience with specific equipment under given site conditions.

SAULT was written in Jess, a rule-based engine for the Java platform based on a series of flowcharts describing locating technology options and site conditions. Figure 6 depicts a section of the first flowchart illustrating the basic decisions for a cable utility facility. The flowcharts shown in Figure 3 provide an example of the various screens available to users in the SAULT system.

2.1.7.4. Construction and Utility Inspection Practices

Traditionally, conducting accurate, complete, and reliable construction and utility inspections at DOTs has been challenging. A limited number of inspectors and several simultaneous, ongoing construction projects make it extremely difficult for inspectors to be at all the job sites where inspections are needed. Job sites that involve excavation (e.g., for the installation of an underground facility such as a pipeline and the subsequent backfill) typically have the trenches backfilled soon after the utility installation. Currently, by the time the inspector arrives at the job site, the only way to verify the underground utility facility installation is to re-excavate and remove the backfill to uncover the recently installed utility facility. In practice, re-excavation of a recently installed facility for inspection purpose rarely happens. Furthermore, it is unusual for contractors to have the access or training to use surveying equipment to verify the position of the installed facility in the field during construction.

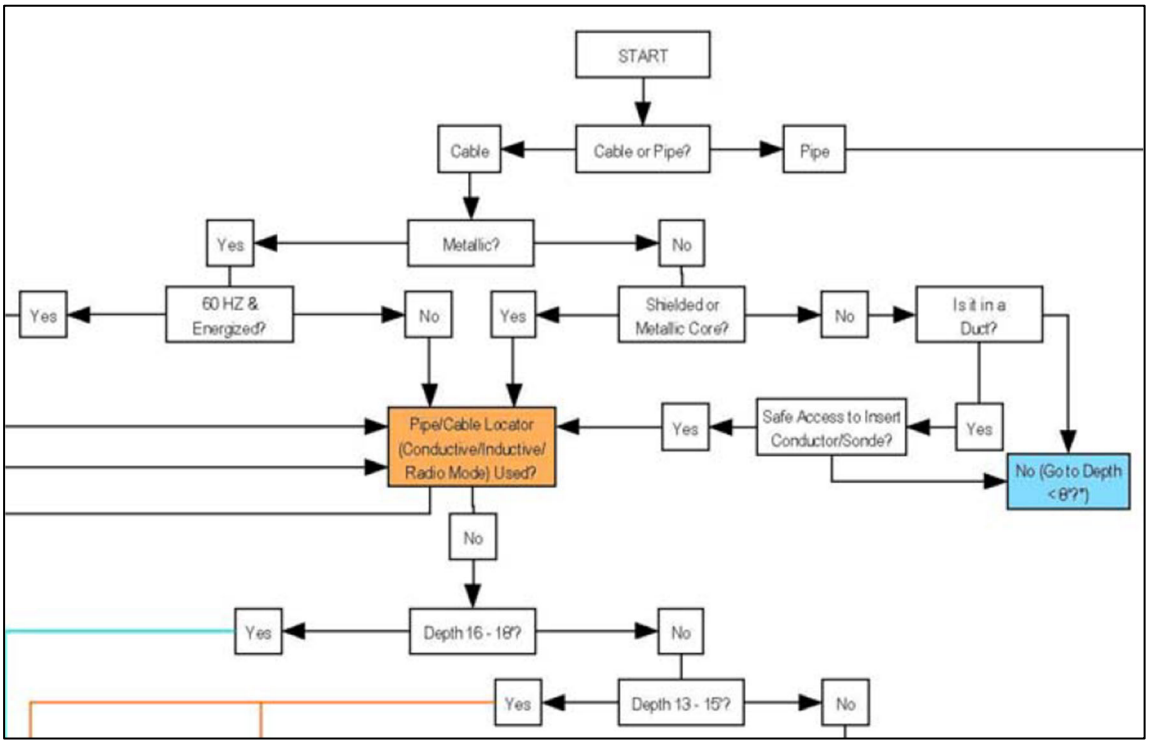


Figure 6. *Sample Flowchart Used for Designing in SAULT (60).*

For decades, a common practice has been to use markers of various types to facilitate the identification and location of underground utility facilities. Table 13 shows a summary of commonly used markers (53).

In 2015, the FHWA completed a research project focused on the feasibility of managing utility facilities within the state right-of-way using 3D technology (57). This research project included a literature review on the use of 3D technology; documentation of the current business practices and lessons learned from a review of selected case studies; a review of the use of radio frequency identification (RFID) technology to mark and manage underground utility installations; and an analysis of the strategies, barriers for implementation, and return on investment (57).

The use of RFID technology at the VDOT is unique among DOTs. This DOT initiated the installation of RFID markers on new utility facility construction to reduce the level of uncertainty and, more specifically, as a damage prevention strategy.

Table 13. *Commonly Used Utility Facility Markers (*45*).*

Marker Type	Description
Surface-to-structure marker	A marker (usually a 2-inch PVC pipe) is embedded in the soil from the ground surface down to the utility facility.
Utility sign or pipeline marker	An aboveground sign or maker is placed near a utility facility (e.g., a high-pressure gas line, major water pipeline, or fiber optic line).
Continuous buried marker	Tracer tapes and wires are placed in the backfill, typically above newly constructed nonmetallic water and gas lines.
Parker-Kalon (PK) nail or survey marker	PK nails, surveying hubs, and surveying lathes are placed directly over a utility facility after excavating a test hole.
Single point buried marker	Small magnets are placed in the roadway material directly over a utility facility after it is exposed.

Benefits that VDOT officials noted from the implementation of the RFID marker program include the following (57):

- Availability of as-built information that highway contractors can use for test hole planning purposes. This level of information can lead to a reduction in the safety hazards, delays, and costs commonly associated with conflicts with underground utilities in highway construction projects.
- Georeferenced utility facility segment information can be used to establish a zone of protection for that specific utility facility installation if the construction equipment is equipped with GPS-enabled digging trigger mechanisms.
- Better horizontal and vertical accuracy of utility facility information.
- Attribute data associated with each RFID marker can be infused with georeferenced coordinates for mapping and locating purposes.
- Reliable utility facility inventory database that provides comprehensive information for future use by contractors, locators, and designers.
- Production and conveyance of reliable, as-built utility information to utility companies, locators, excavators, and design engineers. Reliability in the information can lead to increased coordination among stakeholders.
- Improved effectiveness of utility inspections by enabling inspectors to verify the actual utility locations on the ground with design documentation. As a quality control measure, the VDOT

inspectors can also verify that the data programmed into the marker are accurate and consistent with the utility installation on the ground.

- Use of RFID marker has led to more productivity in the inspection process. Inspectors can now collect data from approximately 180 markers (or approximately 4,500 ft) per day, which is a significant improvement compared with prior practice.
- Improved coordination with other VDOT officials, including construction inspectors during construction.
- No conflict with One-Call laws or regulations.
- Installation of RFID markers in proximity to existing gas markers without interference.
- Reduced risk of confusion between active line and out-of-service lines.

2.1.7.5. Summary of Utility Impact Assessment Tools

It is recommended that utility companies be reqested to submit scaled and georeferenced digital information about their existing utility facilities. At times utility companies provide digital as-built files, but they are often not georeferenced nor scaled and the digital files from different utility companies are created using a variety of formats. The reliability of converted digital as-built files usually remains unclear even when utility facility information is imported into the design files.

DOTs are beginning to request utility investigation information during the preliminary design phase. Contractors, utility companies, and DOT staff indicated as-built utility facility location data were unreliable, only providing a general indication of X-Y utility facility location data. It is recommended that ASCE 38-22 and ASCE 75-22 be used, the former to define how to show utility facilities in the utility investigation deliverables and the latter to outline the minimum, optional, and conditional elements of the spatial and non-spatial attribute data associated with utility facilities.

It is recommended to adopt or develop a UIA tool to determine when to conduct a utility investigation and SUE, and what quality level is required for a given project. The GDOT, PennDOT, and WSDOT have UIA tools which determine the need for the different SUE levels. The GDOT UIA tool includes a utility conflict list along with avoidance alternatives, required relocation and cost estimates. It is recommended to use the GDOT UIA tool again after the second submission of project files to utility companies to resolve any new or remaining utility conflicts. The WSDOT emphasizes that project teams should identify and apply appropriate techniques for utility investigation based on budgets and expectations. PennDOT's UIA tool could be considered a decision support system since it calculates a utility impact score to determine whether QLA or QLB may be required. Risk management is an area where DSS has a good application Because a database of real-world examples was not available when SAULT was developed, the research team used a system that provided guidance based on a variety of conditions.

Increasingly, DOTs are using 3D modeling techniques to visualize, design, and construct projects, which involves z data. MDOT's GUIDE program captures X-Y-Z data at the time of installation and organizes these data in a spatial database using such basic requirements as positional accuracy and attribute data. The GUIDE manual provides instructions for direct and indirect survey observations.

The Colorado DOT (CDOT) developed a program for collecting the required attribute and location data for utility facilities using a web-based platform comprised of three components: a data collection platform,

a web-based dashboard application, and data integration tools. It uses a GPS-based mobile application that enables users to capture utility facility location and attribute data in the field. This application uses a web-based dashboard application that enables users to visualize and analyze utility facilities or other features based on information collected in the field. In addition, this dashboard application also allows users to annotate and edit map and tabular data and share this information to field users via the cloud.

Inspections are an important part of construction. However, the limited number of DOT inspectors combined with several ongoing highway construction projects make it extremely difficult for inspectors to check the aspects of construction needing inspection. Typically, underground utility relocations are already backfilled by the time an inspector gets on site, making it difficult to inspect for proper placement and other issues. However, the use of RFID technology, like that being used by the VDOT, can address this issue. The installation of RFID markers on new utility facility construction can reduce the level of uncertainty and, more specifically, act as a damage prevention strategy. This technology makes verifying the location of newly relocated underground utilities easier after they are backfilled.

2.2. Right-of-Way Acquisition

One reason for utility relocation related delays is the uncertainty associated with the acquisition of rights-of-way either because the facility can be accommodated within the project's right-of-way or because of the need for additional right-of-way to accommodate the utility relocation. Prior rights of utility owners also affect the utility accommodation process.

2.2.1. General Right-of-Way Acquisition

Generally, right-of-way acquisition practices are influenced by the Code of Federal Regulations (CFR) 49 CFR 24 and 23 CFR 710, but state laws, regulations, and policies include differences that have created a variety of functions and procedures across the United States (61). State DOTs begin collecting information for the development of right-of-way plans during preliminary design and generally complete them once they receive environmental clearance (19,20). Typically, however, these plans are not fully developed until the highway design is complete enough to reduce the chance of having to update them. Usually, DOTs develop their preliminary right-of-way plans before the environmental review, meaning they have limited information, including nothing about property easements. SCDOT's right-of-way plans are completed at approximately 60 percent design after environmental clearance is received for the highway project, a decision that is within the general scope of DOTs (19,20).

As seen in NCHRP Report 771, the right-of-way acquisition for DOTs is a separate process, with limited opportunities for its coordination and integration into the rest of the delivery process (61). This separation can lead to limited interaction between the right-of-way and other state DOT project personnel even though it is important to ensure right-of-way personnel are included in the project scoping and cost estimates as well as in the district and division level meetings with utility owners (61).

2.2.2. Right-of-Way Acquisition for Utility Relocations

Much of the information in this subsection was collected from interviews conducted as part of NCHRP 11-08 (19,20), Improving Rights-of-Way Acquisition and Compensation Practices for Utility Relocation. Additional citations have been included where appropriate.

Recognizing the need for replacement right-of-way for a utility facility begins with the identification of a utility conflict, which requires information about both the utility facility and the proposed highway project. The process for identifying utility conflicts, which is part of the utility coordination process, is considered in other sections in this report.

Utility relocation can only begin after the right-of-way needed for the utility facility has been acquired (62), either purchased by the utility company or the DOT (63). Because it may take longer than anticpated if the utility company acquires the right-of-way, it makes sense for the DOT to do so. Replacement right-of-way is referred to in a variety of ways in various statues, including replacement right-of-way, substitute right-of-way, replacement easement, and replacement property interest. A literature review conducted as part of the NCHRP 11-08 research found statutes from 34 states include a reference to the authority for acquiring replacement right-of-way. State DOTs with no authority to acquire replacement right-of-way include South Carolina, Alabama, Arkansas, Connecticut, District of Columbia, Maine, Mississippi, Nebraska, North Dakota, Tennessee, Texas, and Wisconsin.

For the states with the authority to acquire replacement right-of-way, there is a wide variability in the authority granted in the statutes. Legislation determines whether a state can condemn property for replacement purposes and who can hold ownership of the land after condemnation. Statutes provide who has the authority to transfer the property of interest, or they can state that the ownership of the property remains with the DOT or state. In general, to acquire a replacement right-of-way, the DOT either purchases it, transfers it to the utility company, or purchases it directly in the name of the utility company.

The review, conducted as part of NCHRP 11-08, found three general practices for DOTs acquiring right-of-way for utility relocations:

- 30% of state DOTs have the authority to acquire replacement right-of-way and use it regularly
- 42% of state DOTs have the authority to acquire replacement right-of-way but do not use it regularly
- 28% of state DOTs do not have the authority to acquire replacement right-of-way

The benefits for DOTs that can acquire replacement right-of-way include reduced risks of delays and more control over the project schedule, while some of the reasons why DOTs do not or rarely use their authority to acquire replacement right-of-way include the bureaucratic hurdles involved and the preference for utility companies to acquire replacement right-of-way on their own because of

- Increased flexibility in compensation amounts
- No requirement to the Uniform Act
- Eligibility retention for future relocation reimbursements

For DOTs that do not currently have the authority, the general consensus was there was no need to change the laws to enable them to acquire replacement rights-of-way.

Currently, South Carolina state law allows only the DOT to acquire the right-of-way necessary for highway construction; however this law may need to be changed to allow other public agencies to do so.

2.2.3. Prior Rights

Utility companies with prior property rights do not have to pay for the relocation of their facilities; this financial obligation falls on the DOT. Past studies have identified that reimbursable utility relocations take longer than non-reimbursable ones due to the legal requirements associated with the former (10). Having to fulfill these requirements can take a considerable amount of time, perhaps delaying the utility relocation which, in turn, may delay the highway project (11).

A suggested best practice for mitigating delays associated with utilities with prior rights is to identify and address the needs of the utility facility early in the project development process. For example, Caltrans uses a process referred to as liability determination which determines the utility company's property rights for facilities in the project area by 30% design, so by the end of preliminary plan phase, Caltrans knows which utility facilities are in conflict with the project design features and of those, which have prior rights (19,20). This early identification of prior rights allows Caltrans to begin the acquisition of replacement right-of-way early.

In South Carolina, as in other states, utility relocations are reimbursable if there is a prior right. In addition, the SCDOT does not acquire replacement right-of-way for utilities; the utility owner is responsible for acquiring the replacement easement for the relocation (19,20). Together these two contraints can cause utility related delays. It may be beneficial to consider petitioning for a change in the state law to allow the SCDOT and other public agencies to acquire right-of-way for utility relocations.

2.3. Issuing and Managing Encroachment Permits

All state DOTs use permits to accommodate utility facilities within the right-of-way without establishing a property interest. In addition, they specify that the utility facility must be relocated at the company's expense when requested by the state DOT. Utility companies may apply for a permit throughout the life of a highway whenever they are installing or modifying a utility facility within the right-of-way. In most cases, there is no cost to apply for a permit; however, when therer is one, it usually is minimal and covers only a small amount of administrative costs to review and approve the application. Permits, in general, may also be referred to as occupancy or encroachment permits.

Table 14 shows the utility accommodation approach within the the right-of-way by state, and similarly, Table 15 shows the permit fee approach for accommodating the utility facilities within the state right-of-way. The information in these two tables as well as that in this subsection is part of the NCHRP 11-08 project, Improving Rights-of-Way Acquisition and Compensation Practices for Utility Relocation. Information that was not part of the NCHRP 11-08 study is cited in the table individually.

A few states have additional rules for accommodating utility facilities within their rights-of-way. In Washington state, permits and franchises are only applicable to utilities companies as defined in Section 468-34 of the Washington Administrative Code. This state does not consider lessees on another utility facility for permitting and franchising purposes; only the utility company, the lessor, who constructs and maintains the facility is considered as the utility facility and, thus, responsible for coordinating the relocation of the facilities directly, meaning only the utility company that maintains the facility can apply for permit. If the utility company leases space to another utility company, the WSDOT requires the original company to be responsible for the lessor's facility and to coordinate the relocation with lessees.

The Tennessee DOT (TDOT) allows utility facilities to occupy the right-of-way by permit. In addition, the TDOT also receives compensation for the utility permit, the amount set by an advisory board based on the location (i.e., urban, suburban, rural, or clear zone) and the duration (number of years) of the request.

Table 14. *Utility Accommodation Approach Within Right-Of-Way by State*

States	The Way Utility Facilities Are Accommodated Within the Highway Right-Of-Way
Alabama	via permit (64)
California	via permit (65)
Delaware	Delaware uses a master franchise agreement process. Once it is in place, utility owners can obtain utility construction permits for locations where they are installing or maintaining facilities
District of Columbia	via permit DDOT does not use separate lease agreements for the annual rental fees
Florida	via permit (66)
Georgia	via permit (32)
Kansas	via permit
Louisiana	via permit
Maine	via permit
Maryland	via permit
Massachusetts	via permit, easement, or other suitable instruments
Michigan	via permit
Minnesota	via permit Does not grant a permit to utility companies that do not comply with the provisions of the permit
Mississippi	via permit
Missouri	via permit Utility facilities that serve Missouri DOT (MoDOT) are accommodated via utility easement
Montana	via permit Occupancy permit for public utility An encroachment permit is required for a private utility or if the utility facility's location is not agreeable to the MDOT
Nebraska	via permit
Nevada	via permit
New Hampshire	via permit or license If the utility facility relocates before letting, the utility company needs a permit If the utility facility is relocated during construction, no permit is needed, but a

	license is required for poles, structures, conduit, and cables upon completion of the project
New Jersey	via permit
New Mexico	via permit
New York	Public utility facilities via permit Private utility facilities via a different type of permit with an agreement to pay the compensation owed to the NYSDOT
North Carolina	via permit
North Dakota	via permit
Ohio	via permit
Oklahoma	via permit
Oregon	via permit
Pennsylvania	via permit
Rhode Island	via permit
South Carolina	via permit
South Dakota	via permit If the utility facility is upgraded, the permit is renewed
Tennessee	via permit
Texas	via permit
Utah	via permit The UDOT also uses license agreements to accelerate the review and approval of the permit
Vermont	via permit Utility facilities inside the right-of-way on a limited access highway are accommodated via lease
Virginia	Utility facilities are accommodated within the highway right-of-way via permit The Virginia Department of Transportation (VDOT) has a master agreement with all major utility companies, which require relocation because of a project
Washington	Permits for crossings Franchises for longitudinal installations greater than 300 feet in length along the centerline of the highway Franchises expire in 25-years
West Virginia	Utility companies via permit Small cell installations are treated as utility facilities for permitting purposes
Wisconsin	via permit
Wyoming	via permit

Table 15. *Utility Accommodation Permit Fee by State*

States	Fee for Permit
Alabama	No fee (56)
Delaware	No fee
California	Charges a fee to cover the time taken to review, process and issue the permit as well as conduct the inspection (65)
District of Columbia	One-time fee for each permit Annual rental fees
Florida	No fee Utility company is responsible for restoring the damage due to the installation, relocation, or repairs as part of the permit (66)
Georgia	For non-communications utility companies an annual lump sum amount to cover a reasonable approximation of the average cost of administrative processing of the permit and the continued occupancy For communications utility companies the permit fee covers the actual incurred costs of administrative processing of the permit and inspection (32, 67)
Louisiana	Annual rental fees
Minnesota	No fee
New Mexico	No fee except for the lines that transmit electricity through New Mexico and the electricity is not used by the NMDOT or other state entities.
New York	No fee for public utility companies Private utility companies are required to pay a fee to the NYSDOT
North Carolina	The NCDOT may require performance and indemnity bonds to reimburse any damages within the state right-of-way due to the installation
North Dakota	$100 for a crossing $200 per mile for longitudinal installations
Oregon	No fee
Pennsylvania	The PennDOT charges an inspection fee for permits
South Dakota	No fee
Tennessee	Charges a fee for fiber optic installations on controlled access facilities
Texas	No fee
Utah	Administrative fee Inspection fee
Vermont	No fee for relocation due to highway construction project $100 for a new installation permit $500 for an annual maintenance permit
Washington	The WSDOT has a one-time fee and can recover additional costs associated with the review, approval, and inspection of utility permits
West Virginia	Utility companies have free access to the right-of-way via permit Waives the inspection fee if the utility work is due to a highway project Charges a fee for inspection services
Wisconsin	The WisDOT charges a longitudinal occupation fee along interstate highways

The NMDOT uses a master utility agreement as a vehicle for receiving georeferenced location information, updated on a monthly basis, from a gas utility company. This information provided by the utility company helps the DOT minimize potential conflicts with the utility facilities.

Past research completed for the TxDOT developed recommendations for the future of the utility installation request (UIR) system (68). Before this system was implemented, utility companies previously mailed or hand delivered several copies of an application form, supporting engineering drawings, and other documents. The review process required subsequent submissions and possibly in-person meetings, and the TxDOT had to mail responses and approvals back to the utility company along with sending the documents from the DOT to various departments. After the implementation of UIR system, all the documentation exchange became electronic and online, and one of its critical goals was to develop and maintain a centralized database of all the utility facility installations within the right-of-way. The UIR system required all utility companies to submit georeferenced utility location data along with their requests. As a result, DOT officials and project stakeholders, such as consultants and contractors, have the ability to locate the new utility facilities within state rights-of-way. This georeferenced data on utility facilities within state rights-of-way, which is critical during the early phases of the project development process, enables planning and design teams to locate facilities within the proposed boundaries of highway construction project.

The TxDOT also requires utility companies to submit as-built or certified as-installed construction plans that include the installed location, vertical elevations, and horizontal alignments of the utility facility based on the department's survey data, the relationship to existing highway facilities and the right-of-way line, and access procedures for maintenance of the utility facility for each relocation or new installation (69).

Georgia and Florida DOTs also require as-built plans to be submitted. The GDOT requires utility companies to submit a new permit request for any change in the approved plans in addition to sending revised as-built plans to the District Utilities Office for the DOT's permit record files (32). The FDOT requires utility companies to submit the bore logs, test results, approved plans changes, and as-built plans upon completion of work as a condition of the permit approval (66).

2.4. Concluding Remarks

Even though most states do not use incentives and/or penalties to help motivate utility companies to relocate their facilities in a timely manner, some states have found them effective. Examples of typical incentives include the following:

- Reimbursement for utility relocations without a compensable property interest
    - The reimbursability should be tied to meeting relocation schedule milestones or some other quantifiable factor.
    - The reimbursability ranges from 50 to 100 percent.
    - The costs that are reimbursable may be limited to preliminary engineering and material or may include the entire cost of the utility relocation.
    - The costs may vary depending on the type of utility company (private vs. public ownership), utility type, or utility customer type (public vs. private use).
- Reimbursement for costs for utility relocation rework related to changes in the highway design.

The benefit of these incentives to the highway project is reduced if a utility relocation causes a delay for the project even if the majority of utility conflicts have been resolved.

There is a bit more variety in the penalties the DOT can use to motivate utility companies to relocate their facilities. Penalties include the following:

- Passing the delay claims and change order costs related to delays caused by late utility relocations to utility owners
    - Ensure proper documentation is kept when seeking compensation from utility companies
    - Have a process in place to pass delay costs onto utility companies
- Reducng the reimbursement amount if the utility company does not meet its relocation schedule
- Withholding or suspending utility permits.

Penalties can be an effective motivator; however, they do little to change the adversarial relationship between the DOT and utility companies. Other strategies to help facilitate timely utility relocations are listed below:

- Assist with or complete the utility relocation design work
- Coordinate early and often with utility companies to improve working relationships and utility coordination efforts
    - Begin coordination early in the project development process
    - Ensure the utility coordination process includes a proper utility investigation, use of ASCE 38-22 standard and utility conflict analysis
    - Coordinate on the project, district, and state levels
- Acquire right-of-way early to help facilitate necessary utility relocations early
- Include utility information and other utility-related documents in the design plans
- Use bonds to help motivate timely utility relocations
- Authorize utility reimbursement funds early to help expedite the utility relocation. This is especially useful for smaller utility companies who may not have the financial resources to relocate in a timely manner.

Two thirds of state DOTs have used in-contract utility relocations for at least one highway construction project. However, some state may restrict utility relocations from going in-contract based on utility facility type or ownership, i. e. either public vs. private. Other state DOTs place utility relocations in-contract if a financial incentive is provided for the relocation.

When deciding if a utility relocation should be included in-contract consider the following:

- Does the utility relocation need to be completed before the highway project is let?
- Will it be more efficient if the utility relocation work is completed as part of the highway contract?
- Will the utility relocation work substantially alter the scope of the highway project?

- Do the policies of the utility company or labor union allow others to complete the relocation?
- Can the utility relocation work be completed by the highway contractor or subcontractor?
- Is funding available for the utility relocation to go in-contract?

One challenge to the in-contract method is the perception that the utility relocation cost is higher when using it. However, when reimbursement eligibility is at or near 100 percent, utility companies are less concerned with the perceived cost increase related to going in-contract.

Advanced funding of the utility relocation can be a serious issue for utility companies, especially smaller ones who may not have the budget for a major utility relocation. Utility companies may find the in-contract method more appealing if another process in place prevents the utility company from paying for the entire cost of the relocation up front.

The in-contact approach can reduce the demand on the utility company by permitting others to complete the utility relocation work. It is important for the long-term success of in-contracting to make satisfactory conditions for the owners to provide inspections and accept the relocation work of their facilities.

A disadvantage of including utility relocations in-contract is that these companies may not have confidence in the contractor's ability to complete them and that they have no say or control over the contractors doing the utility relocations. One potential way to help alleviate these concerns is to have the contractor only handle the installation of the general utility infrastructure, such as utility poles and conduits.

In-contract incentives can be an important factor in expediting SCDOT construction projects by encouraging utility companies to go in-contract. Some state DOTs, for example, provide financial incentives for doing so. The utility relocation may be reimbursable at a rate of 60 to 100 percent based on various qualifying factors, including, for example, the size, type, and expressed need or hardship for the utility company. Providing fixed price lump sum items for the utility relocation may also help encourage utility companies to go in-contract.

Best practices for mitigating utility related delays include the following recommendations: specify appropriate SUE quality levels for highway projects, include utility relocations in-contract, include utility coordination responsibility as part of the construction contract scope, improve partnering with utility companies, provide incentives for timely utility relocations, and attempt to have utility conflicts cleared before beginning construction. Utility conflict management can begin as soon as the project right-of-way outline is determined and should continue throughout the project.

Detection of utility conflicts as early as possible helps facilitate the identification and implementation of optimum strategies for resolving them. The goal of utility conflict resolution strategies is to first avoid conflicts, then minimize impacts, and finally consider relocating the utility facility if no conflict resolution strategy is workable.

Utility coordination should begin early in the project development as there are tangible benefits for doing so. A number of DOTs have documented time and money savings by identifying and resolving utility conflicts early. It is also increasingly recognized that the systematic adoption of UCM principles leads to a more complete identification of the required elements.

It is recommended to request utility companies submit scaled and georeferenced digital information about their existing utility facilities. While utility companies may provide digital as-built files to some DOTs, often they are not georeferenced nor scaled and these digital files from different utility companies come in a variety of formats. Contractors, utility companies, and DOT staff have indicated as-built utility facility location data were unreliable and provided only a general indication of X-Y utility facility location data.

DOTs are beginning to request utility investigation information during preliminary design phase. It is recommended to use ASCE 38-22, which defines how to show utility facilities in the utility investigation deliverables and ASCE 75-22, which outlines minimum, optional, and conditional elements of spatial and non-spatial attribute data associated with utility facilities.

It is also recommended to adapt or develop a UIA tool to determine when to conduct a utility investigation and a SUE, including the quality level required for a given project. GDOT, PennDOT, and WSDOT have UIA tools to determine when the different SUE levels are needed, with the GDOT UIA tool including a utility conflict list along with avoidance alternatives, required relocation and cost estimates.

Increasingly, DOTs are using 3D modeling techniques involving Z data to visualize, design, and construct projects. For example, MDOT's GUIDE program requires capturing X-Y-Z data at the time of installation and organizing the data in a spatial database, while the CDOT uses a GPS-based mobile application that enables users to capture utility facility location and attribute data in the field.

While inspections are an important part of construction, the limited number of state DOT inspectors combined with several ongoing highway construction projects make it difficult for them to check the aspects of construction that need inspection. Usually underground utility relocations are already backfilled by the time an inspector gets on site, making it difficult to inspect for proper placement and other issues. The installation of RFID markers on new utility facility construction helps to reduce the level of uncertainty and, more specifically, is a damage prevention strategy. This RFID technology makes verifying the location of newly relocated underground utilities easier after they have been backfilled.

One reason for utility relocation related delays is the uncertainty associated with the acquisition of right-of-way. The reasons for this uncertainity may be related to the need for additional right-of-way to facilitate the relocation of the utilities and the utility companies with prior rights. As the right-of-way acquisition process for DOTs is separate from the project delivery process, it is important to ensure right-of-way personnel are included on the team conducting project scoping and cost estimates and participating in district and division level meetings with utility companies.

Thirty-four states include a reference to the authority to acquire replacement right-of-way. South Carolina does not have authority to acquire replacement right-of-way and would need to have the law changed to do so.

Utility relocation can begin only after the right-of-way needed for the facility has been acquired. And since it could take longer for the utility company to acquire the needed replacement right-of-way, it is logical for the DOT to consider acquiring the right-of-way for a utility relocation. Some of the benefits for having DOTS acquire these replacements include reduced risks of delays and more control over project schedules. Reasons that DOTs with the authority to acquire replacement rights-of-way do not or rarely use it include the bureaucratic hurdles and the preference for utility companies to acquire replacement rights-of-way on their own because of no requirement to the Uniform Act, increased flexibility in compensation amounts paid to property owners, and retention of eligibility for future utility relocation reimbursements.

In South Carolina, like other states, utility relocations are reimbursable if there is a prior right. In addition, SCDOT does not acquire replacement rights-of-way for utilities, the utility owner is responsible for acquiring the replacement easement for the relocation of the facility. These two items together can cause utility related delays. It may be beneficial to consider petitioning for a change to allow SCDOT to acquire right-of-way for utility relocations.

Previous studies have identified that reimbursable utility relocations take longer than non-reimbursable ones due to the associated requirements. A best practice for mitigating delays associated with utilities with prior rights is to identify and address the needs of the utility facility early in the project development process.

The majority of state DOTs allow utility facilities to occupy the right-of-way by permit, with some states chargng for this permit ranging from a nominal fee ($100) to a one that covers the actual time spent reviewing, processing, and issuing the permit, and inspecting the installation. Fees may be calculated per installation, mile, or crossing and charged annually, one-time, or both.

A few state DOTs have procedures for collecting georeferenced information utility facility location data. For example, the New Mexico DOT uses a master utility agreement as a means for receiving monthly georeferenced location information from a gas company that installs its facilities in the right-of-way. Per this agreement, it provides location data on their new facilities for the DOT to use, information the DOT finds helpful in minimizing potential conflicts between highway projects and existing utility facilities.

In Texas, the utility installation request system requires all utility companies to submit georeferenced utility location data along with the request to the DOT. As a result, DOT officials and project stakeholders have the ability to locate the new utility facilities within the state right-of-way. TxDOT also requires utility companies to submit as-built plans or certified as-installed plans that must include the installed location, vertical elevations, and horizontal alignments of the utility facility based upon the department's survey data; the relationship to existing highway facilities and the right-of-way line; and access procedures for maintenance of the utility facility for each relocation or installation. Other state DOTs also require as-builts to be submitted as part of the file requesting the utility permit.

3. Review of Current SCDOT Practices

[1]One of the main concerns leading to utility delays is constraints of utility owners, financial and otherwise. Financial constraints may be addressed through reimbursement from the state highway agency as legally allowed by the state, whereas human resource constraints to some extent may be addressed by including the utility relocation work in the transportation project. Through Senate Bill 401, the SCDOT is currently able to reimburse public water and sewer utilities, either partially or fully, for relocations resulting from SCDOT's transportation project needs. This section presents the outcomes from eight focus groups conducted with of SCDOT's employees to synthesize experiential knowledge on the critical factors leading to delays in utility conflict resolution and potential solutions to minimize them. The range of SCDOT personnel engaged in these focus groups included assistant project managers, design engineers, district construction engineers, district utility coordinators, permit agents, project managers, resident construction engineers, and ROW agents. These discussions were focused on their experiences dealing with utility companies and problems regarding utility conflict resolution during various phases of a construction project.

3.1 SCDOT Utility Conflict Management Process

Figures 7 and 8 illustrate the utility conflict management process currently used by the SCDOT. Figure 7 is adapted from the SCDOT training material while Figure 8 was developed based on conversations with SCDOT personnel in the focus groups. When a utility company wants to install its facilities in SCDOT's ROW, it usually does so through an encroachment permit. By applying for this permit, utility companies agree to move their facilities at the request of SCDOT. However, due to resource constraints, the SCDOT is not able to accurately verify that the utility owner has installed the utility lines at the location as stipulated in the approved permit. The as-builts submitted by the utility owner in many cases are believed to be same as the original design plans, meaning they are less reliable for future locating purposes. These utility lines may come in conflict with the transportation project and in many cases need to be relocated to resolve the issue.

[1] This section is published as a stand-alone conference paper in the *2023 ASCE Pipelines Conference Proceedings*

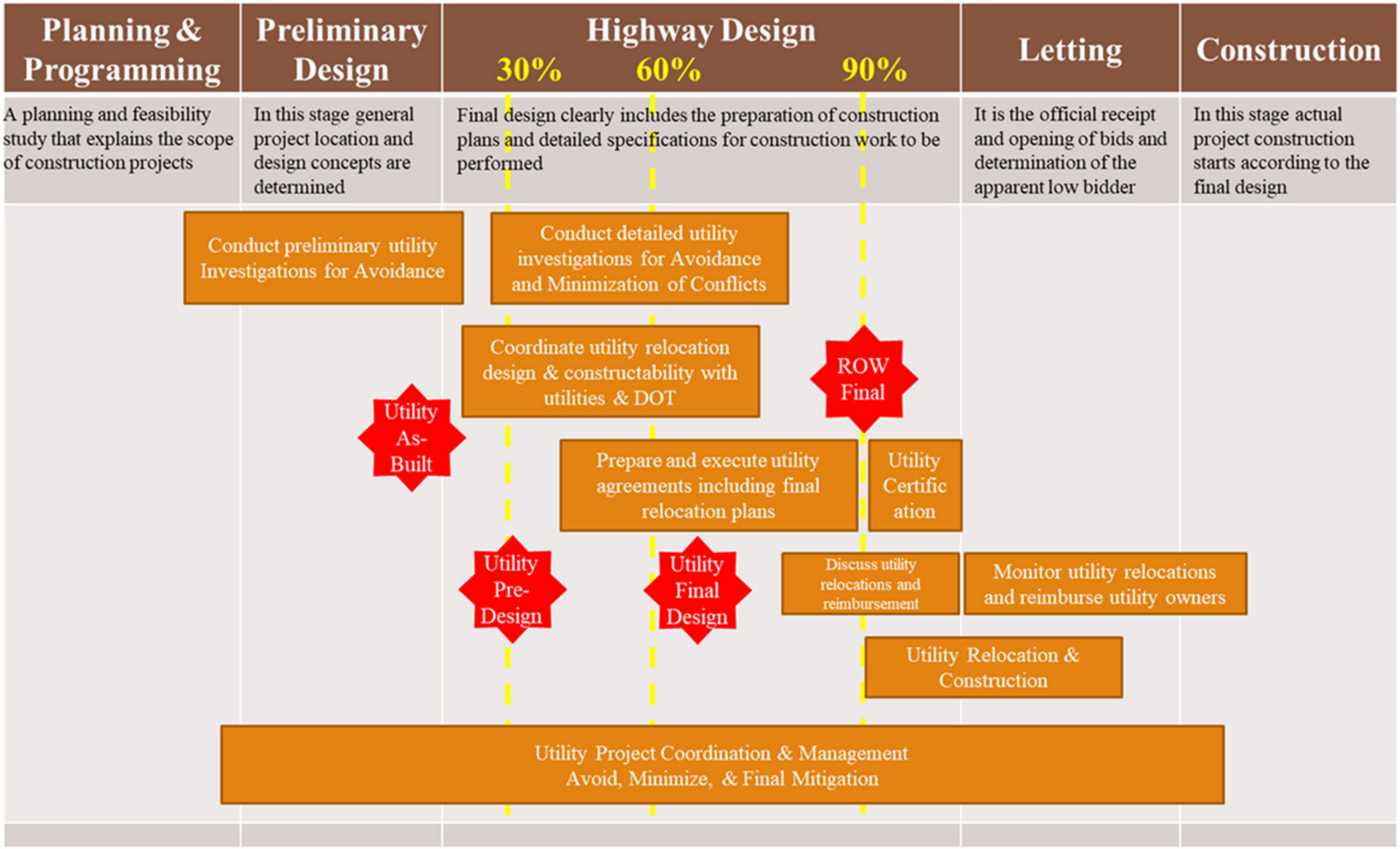


Figure 7. *Utility Coordination Management Process Used by the SCDOT*

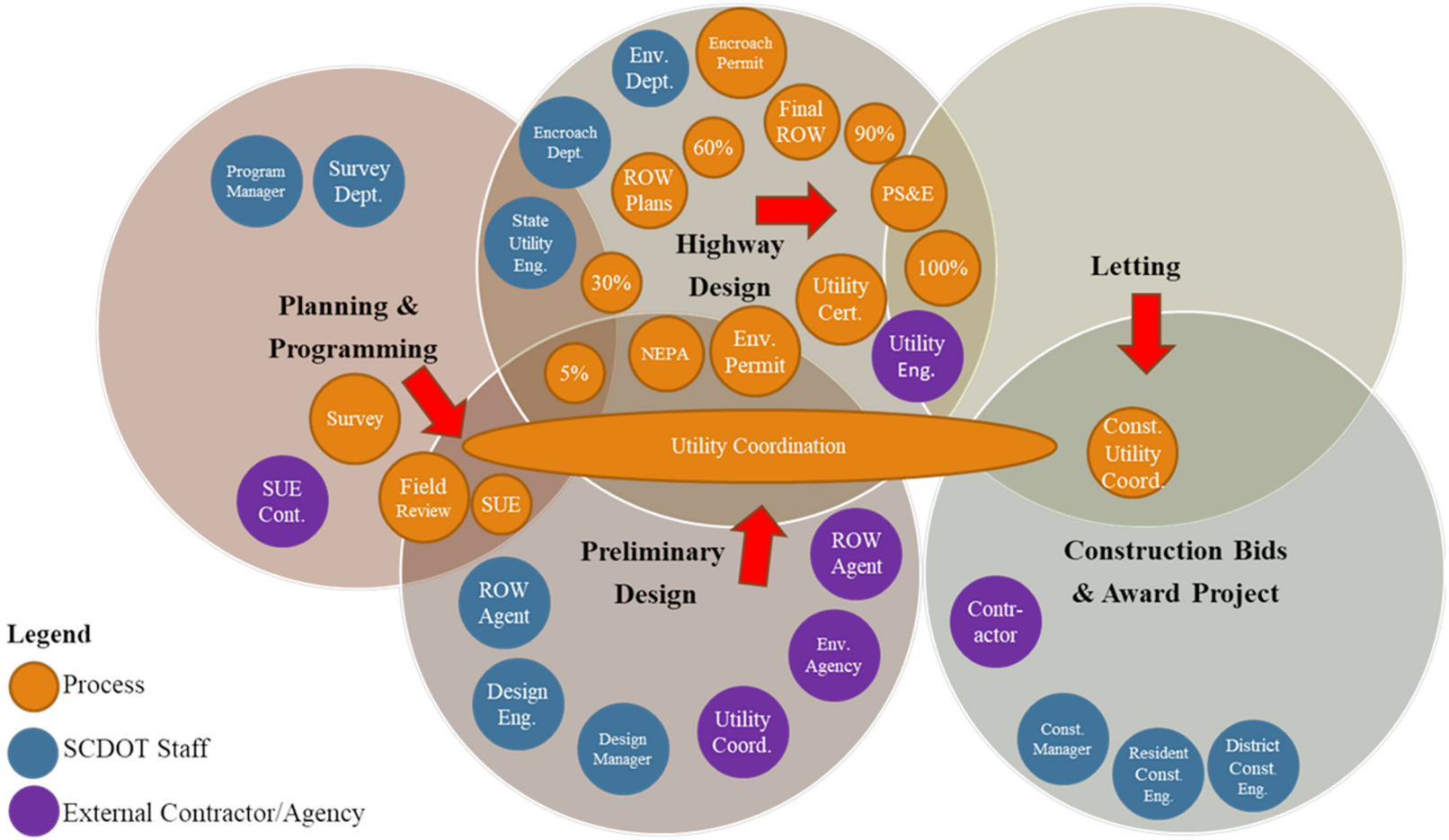


Figure 8. *Project Development Process*

In South Carolina, utility coordination typically begins at approximately 5% design completion when the design team has identified the project footprint. All the utility owners in the project corridor are identified through SC811 and subsequently meet with the design team about the conceptual plans for the upcoming project. At this stage, available as-builts of the utility lines in the project corridor are requested to minimize conflicts as the design progresses. The SCDOT may also choose to conduct a SUE investigation using their on-call service contractors to obtain accurate utility location information. Another typical utility communication milestone is at approximately 30% design completion when the more finalized ROW plans are shared with the utility owners in the hopes that they will prepare to relocate their lines. At approximately 60% design completion when the ROW plans are completed, utility owners are asked to share their utility relocation design plans so that any conflicts with other existing or relocatable utilities and transportation project plans may be identified and resolved through the utility coordination process. Once all utility conflicts are resolved and relocation plans completed, utility agreements are drafted. This entire utility coordination process may be handled by in-house personnel or external consultants depending on the district, project type and size. A utility conflict matrix is typically used to keep track of the conflict resolution progress as the project continues through its different phases.

Approximately 45 days after letting, the SCDOT, the utility owners, and the transportation project contractor meet to discuss and finalize the relocation schedule and the preliminary work the contractor may need to complete before the utilities can be relocated as planned. Ideally, utilities relocate prior to beginning of the construction of the transportation project. Despite best efforts in implementing this utility coordination process, several unanticipated delays have occurred in past transportation projects The factors in several project life cycle phases were identified by our focus groups as being responsible for project delays.

3.2 Critical Delay Factors

These various factors identified as causing delays are categorized by project life cycle phase in the following discussion.

3.2.1 Preliminary Design and Design Phases

Unresponsiveness from utility owners: In the project preliminary design phase, utility owners cooperating with the SCDOT can help track the exact location of their utility facilities to mitigate or minimize conflicts. However, some utility owners are not responsive during this phase, leading to utility conflicts later in the design phase that could have been avoided. The design team may not get the utility facility information until well into the ROW stage, and it is difficult to avoid conflicts at that point. From a utility owner standpoint, transportation project plans have changed on numerous occasions, resulting in repetitive and often unproductive work in their utility relocation designs. As a result, utility owners are cautious about beginning their relocation designs too soon, often waiting at least until SCDOT's ROW plans are finalized. Some utility owners are also resource-constrained and cannot meet SCDOT's needs in a timely manner while trying to meet their own customer needs. On the other hand, early involvement of utility owners in the transportation project design may help the SCDOT mitigate or at least minimize design conflicts.

Inaccurate utility owner records: Even in cases when utility owners are responsive, the as-built plans of the utility lines shared may not be accurate as they may be the design drawings or simple sketches. In some cases, the SCDOT may choose to conduct a SUE in accordance with ASCE 38-22 (70) during the preliminary design and design phases to help the design team validate the utility companies' plans, correct any false information, and locate unspecified utility facilities in the field.

Determining prior rights: The process of determining prior rights can significantly contribute to project delays. During the early stage, the SCDOT typically asks the utility owners with facilities in conflict with the project to provide documentation substantiating that they have prior rights. Utility companies can be slow in reviewing and submitting these documents to the SCDOT. Until the issue of prior rights is resolved, the SCDOT cannot move forward with resolving any conflicts, thus causing delays.

ROW acquisition: To relocate the facilities in conflict, utility companies can use the existing ROW of the SCDOT. However, because of the limited ROW available and depending on the transportation project design, it is possible that utility owners may need to move out of SCDOT's ROW to relocate the conflicting utility lines. According to the current statutes, the SCDOT is not able to purchase ROWs for utilities but can only purchase them for transportation project needs. As a result, the utility owner may need to purchase a private easement, which could involve a time-consuming process. In addition, the SCDOT and the utility owners involved may be approaching the same set of private property owners for ROW acquisition, but their efforts may not be coordinated, frustrating the property owners and leading to additional delays.

Transportation project design changes: It is common for the transportation project design to be revised during the various design stages. Even as late as the 90-95% stage, there may be a change in the ROW plans. Inevitably, there will also be utility conflict resolution delays in these situations as the utilities may have planned their relocation designs based on the footprint of the prior transportation project design, meaning they may have to revise their design and spend additional resources, causing delays.

Inexperienced personnel and ineffective inter-team communication: Depending on the flexibility of the project, an experienced designer may be able to avoid a conflict and eliminate the need for relocation; however, young designers at times lack experience in how to avoid conflicts, leading to unnecessary resolution-related delays. Some focus group participants recommended better communications among the departments responsible for design, project management, and utility coordination so that utility conflicts can be identified and avoided or resolved efficiently even when inexperienced personnel are involved in these processes.

3.2.2 Project Construction and Utility Relocation Phase

Unreliable relocation schedule: Typically, utilities do not relocate early enough because of resource constraints resulting from their business priorities, but there could be delays from the SCDOT's side as well due to site preparation issues (e.g., clearing and grubbing not completed on time) or dependencies on other utilities needing to be relocated. For a project requiring multiple utility relocations, a long utility window is scheduled based on the most significant conflict attributed to the major utilities. These long

utility windows can sometimes demotivate other utilities with less complicated conflicts from beginning relocation early. They may choose to save their resources and prioritize other business needs as much as possible and only begin to relocate in time to meet the last deadline. The project may be delayed unnecessarily if the major utilities with significant relocation needs are able to complete their relocations earlier than anticipated while other utilities do not.

Inaccurate relocations: It is possible that utilities do not relocate to where they are supposed to as per the utility agreements. The SCDOT is not equipped with enough resources to inspect and validate relocation as-builts submitted by utility owners. This could cause unnecessary delays due to potential conflicts with other relocatable utilities or pose a risk to future transportation project needs as the relocation as-builts would be inaccurate.

Material shortages affecting relocation schedules: In some cases, there might be valid reasons for relocation delays. For example, there was a severe shortage of materials (e.g., electric poles) during the pandemic that has caused utility relocation delays. While these are unforeseen, they can affect transportation project schedules.

Inaccurate utility records: Inaccurate utility records can cause significant delays during the utility relocation and the construction phases of a transportation project as incorrectly located utilities might be damaged accidentally. Inaccurate utility records are a frequent issue in cases where a large utility acquires smaller utilities without having all of the location data.

3.2.3 Overall Project Life Cycle

Lack of financial incentives for utility relocations: In addition to not being able to purchase additional ROW beyond the transportation project needs to accommodate utility relocations, the SCDOT is also not able to compensate all the utility owners for relocations and, thus, minimize project delays. Bill 401 up for approval in the South Carolina senate allows the SCDOT to partially or fully reimburse wet utility (i.e., public water and sewer) relocations irrespective of prior rights as long as there are no delays to the transportation project resulting from those relocations. This financial incentive program has been well received by most wet utilities in South Carolina and has already resulted in a reduction in project delays because of utility relocations. The wet utilities are also able to have their relocations completed as part of the transportation project contract (a practice referred as in-contract relocations), a process affording them additional advantages in terms of reduced human resources constraints. However, based on Senate Bill 401 except for water and sewer utilities, the SCDOT is not legally allowed to pay for relocations of other utilities such as gas, telecommunications, and power lines. This constraint could be burdensome for smaller, not-wet utilities even if they want to relocate early to avoid causing delays.

Inability to enforce the terms of an encroachment permit: Another primary issue for the SCDOT is its inability to force utility companies to relocate on schedule. According to the terms of an encroachment permit, utilities must relocate their facilities in a timely manner when requested by SCDOT; however, there is no legal recourse in place for the SCDOT to hold utility owners responsible for meeting this

deadline. Except for the reimbursement of wet utilities, there appear to be no repercussions for utility companies if they do not meet an agreed upon relocation schedule, thereby leading to project delays.

SCDOT's staffing issues: It is common for relevant SCDOT staff to feel stressed because of utility coordination work even when external consultants are involved. There seem to be resource constraints making it time-consuming to coordinate utility conflict resolution, thereby causing delays. These constraints were not uniform across SCDOT districts. Furthermore, successful utility coordination relies heavily on established professional relationships between the local staff at the SCDOT and the utility involved where they efficiently coordinate utility conflict resolution over a phone call. In this environment, utility companies have less concern and feel more motivated to cooperate with the SCDOT. Unfortunately, when people move out of their positions or retire, these established professional relationships may be lost, thus affecting utility coordination and potentially causing delays.

3.3 Potential Solutions for Effectively Resolving Utility Conflicts

As part of the focus groups, the SCDOT employees were asked to comment on best practices or strategies to minimize delays resulting from utility conflict resolution. The following are strategies offered by SCDOT employees.

Early involvement of utility companies: Early involvement of utility companies in a project is an effective strategy supporting utility conflict resolution and coordination. By working with a utility substantially before the ROW process, the SCDOT can determine the exact location of facilities that may conflict with the project. Doing so can significantly help the design team mitigate the conflict as much as possible. One strategy for including utilities early in the project is to develop a conceptual plan to give them the general idea and goal of the project. This heads-up gives them time to organize their resources and schedule accordingly for potential relocation. Early involvement of utilities also provides a sense of cooperation in the project, resulting in their being more responsive during utility conflict management. Early involvement may be more likely when personnel at the utilities and the SCDOT know one another and have had a good working experience in the past.

Consistent and continuous engagement of utility companies: Keeping the utility companies involved throughout the project is another influential factor. Consistent meetings with their representatives for updates on resolution, coordination, and relocation processes incentivize the utility companies during the project. These meetings also keep various parts of the project such as the design team, project managers, utility coordinators, and utility companies coordinated. For example, the design team can be informed of the exact location of utility facilities, which was not possible in the early planning phase. These meetings could also help in identifying utility problems during the conflict resolution processes and subsequently addressing them in constructive ways. For instance, utilities may ask for a change in the design for some level of protection or conflict prevention with another segment of their facilities. Agreeing to these minor design changes makes the utility companies more cooperative in relocating other areas of their facilities and contributes to building a solid professional relationship for future projects.

Utility window in transportation project schedule: Securing a utility window in the project schedule establishes a time limit for utility companies to manage their relocation and act as early as possible to meet the deadlines, especially when there is more than one conflict. In these cases, utility companies with fewer conflicts might procrastinate their relocation. Incentives such as giving priority ROWs for relocation to utilities that act faster can help prevent procrastination in such scenarios.

Financial incentives: Financial incentives are key in motivating utility companies and keeping them motivated throughout the project. If all utilities can be reimbursed by completing the relocation process according to the DOT's schedule and deadline, they may be more motivated to begin the relocation process sooner. This, however, is not currently feasible legally except for wet utilities. It would be beneficial to find ways to reimburse, even partially, small non-wet utilities so that they would be more cooperative in addressing the SCDOT's needs, thus potentially minimizing project delays.

Effective partnering and working relationships with utility owners: Overall, building a professional relationship with utility companies might be the most important and influential factor in addressing delays in utility conflict resolution. To maintain this relationship even after the project is completed, the SCDOT can hold annual meetings where all utility owners get together and discuss upcoming projects and related utility conflicts. This practice was successful in several districts in SC prior to the pandemic.

3.4 Concluding Remarks

Like many state transportation agencies, the SCDOT faces multiple challenges with its utility conflict management processes leading to project delays. This section summarized the critical factors that have led to considerable project delays based on eight focus groups with various SCDOT personnel. Four hour-long meetings with an experienced consultant project team member to learn about the utility accommodation and coordination processes at the SCDOT helped the team prepare for the focus groups. The issues identified at the SCDOT seemed consistent with aspects of utility conflict management frequently studied across the U.S. However, some aspects specific to the SCDOT include its inability to purchase the right of way to accommodate utility relocations and the new senate Bill 401, which allows reimbursement of wet utility relocations if they don't delay the transportation project. Multiple best practices and strategies identified by the participants in the SCDOT focus groups were also discussed in this section. Early and continuous engagement and communication with utility owners along with effective partnering and professional relationships seem to have proved beneficial in minimizing delays resulting from utility conflict resolution. Utility conflict resolution is a complex process, and state transportation agencies need to continue finding better ways to motivate utility owners and support their needs while consistently and effectively communicating the transportation project plans to minimize delays.

4. Survey of State DOTs for Utility-related Incentives

To survey the current practices involving the use of utility-related incentives across various state DOTs, this study used a questionnaire, which can be found in Appendix B. Its findings and their significance are discussed in this chapter.

4.1 Participant Demographic Information

The states shown in red in Figure 9 participated in our survey. As shown, we received completed responses from 16 states (approximately one-third of the states). One state provided responses from two professionals, with the rest providing one; 82 percent of the respondents (14/17 responses) indicated they were in the headquarters level of the organization as seen in Figure 10, while one of the 17 respondents worked for a local office.

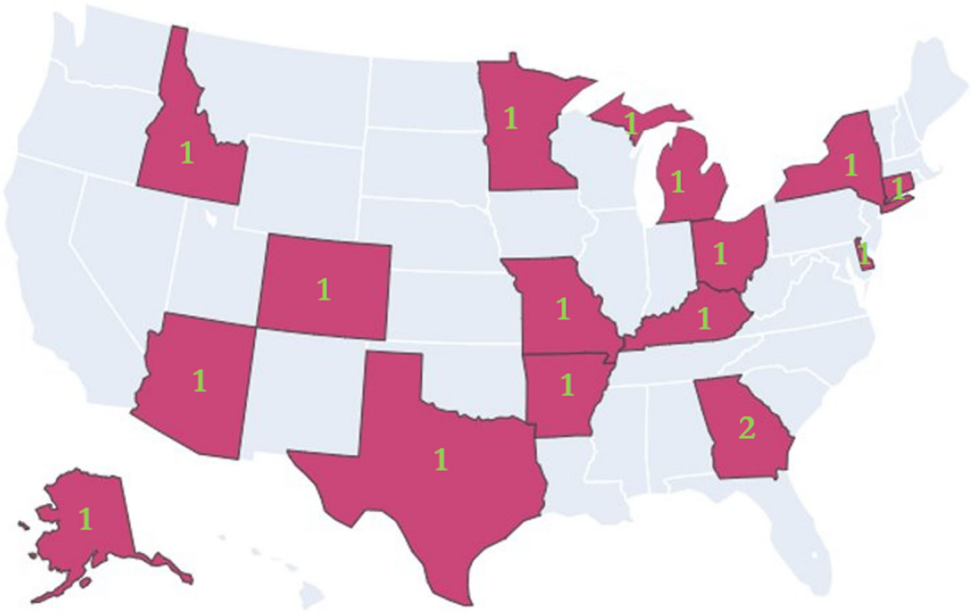


Figure 9. *States that Participated in the Survey.*

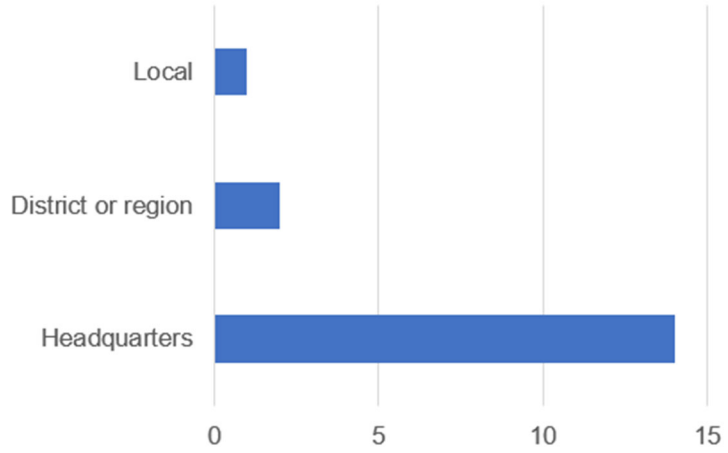


Figure 10. *Distribution of Participant's Working Division*

Figure 11 illustrates that the participants possess a wide range of expertise in across various project phases, with a notable concentration during the design and construction stages. Only 6 experts indicated their experience in project planning. This suggests that most participants are involved in later phases of the project life cycle.

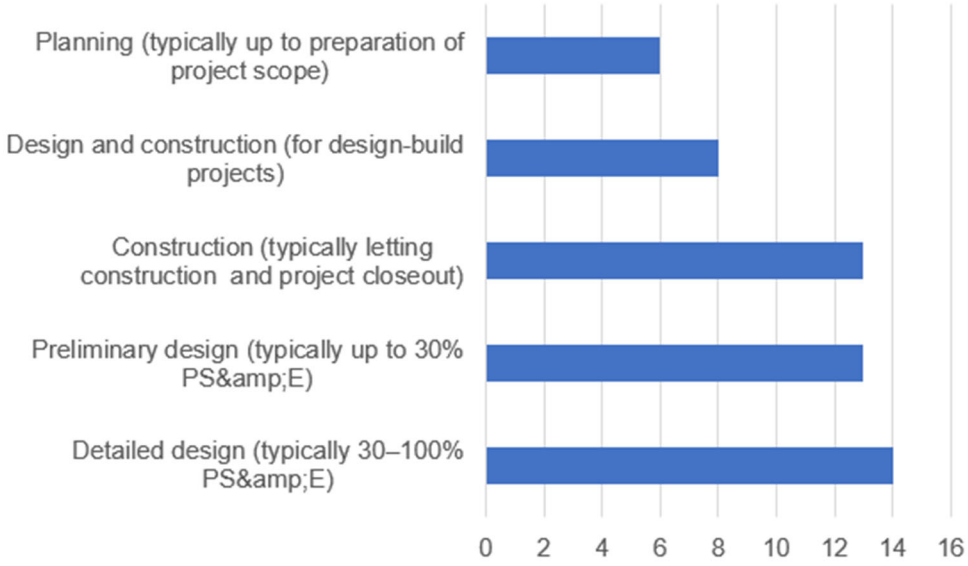


Figure 11. *Distribution of Utility Relocation Work Involvement*

4.2 Types of Utilities Typically Involved in Highway Construction Contracts

Figure 12 summarizes the survey results regarding the types of utilities typically included in highway

construction contracts. As indicated in the figure, there is no significant difference among the utility services, although water supply and wastewater were allowed to use the in-contract method in more states than the others. Stormwater appears to be the least popular utility found in highway construction contracts among the responded states.

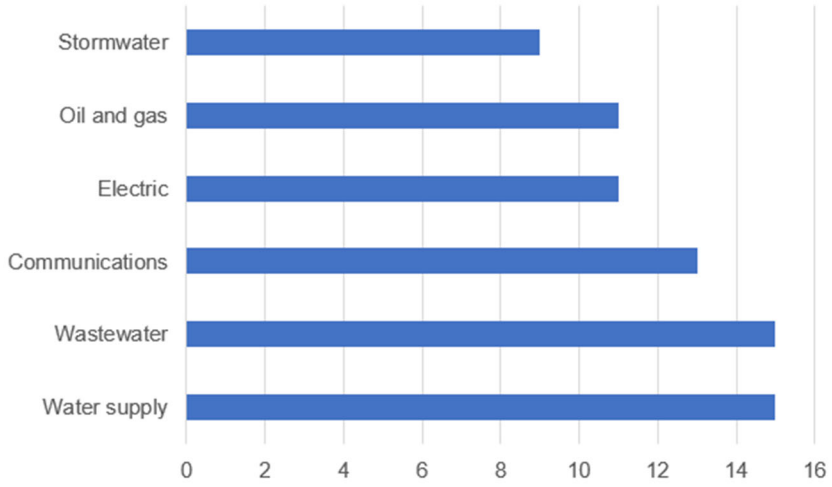


Figure 12. *The Number of States Using the In-Contract Method*

4.3 Perceived Benefit of In-contract Method Compared to Utilities Relocating Their Lines

This segment of the survey aimed to evaluate the perceived advantages of employing the in-contract approach in comparison to the traditional method. We evaluated these advantages across eight specific aspects, each assigned an index ranging from 0 to 7.

- Criterion 0: Enhanced coordination of utilities with the State Department of Transportation,
- Criterion 1: Reduction in delays associated with utility relocation,
- Criterion 2: Simplification in acquiring relevant permits,
- Criterion 3: Decrease in incidents of utility strikes during construction,
- Criterion 4: Lowering of costs related to utility relocation,
- Criterion 5: Streamlining of paperwork required to execute utility relocation agreements,
- Criterion 6: Reduction in the time and effort needed for the development and approval of utility relocation designs,
  Criterion 7: Relaxation of stringent requirements for incorporating utility design plans, schedules, and cost estimates in highway bid packages.

The survey results pertaining to various types of utilities are depicted in Figures 13 (for wet utilities) and 14 (for non-wet utilities). These figures reveal that respondents provided similar feedback across different utility types, with the majority perceiving the new method as superior to the traditional one in most

aspects, except for Criterion 7 - the relaxation of stringent requirements for incorporating utility design plans, schedules, and cost estimates in highway bid packages. Over 40% of respondents expressed the belief that the new method does not eliminate the burden of contract requirements for most utility types.

Furthermore, it appears that utilizing the in-contract method for non-wet utilities such as communications, oil, and gas, and electric tends to yield less benefit in Criteria 5-7, as indicated in Figure 14. However, this disparity was not observed for wet utilities, as illustrated in Figure 13. This discrepancy suggests that while the in-contract method may offer notable advantages for wet utilities, its efficacy in reducing paperwork, contract requirements and design effort for non-wet utilities is less pronounced.

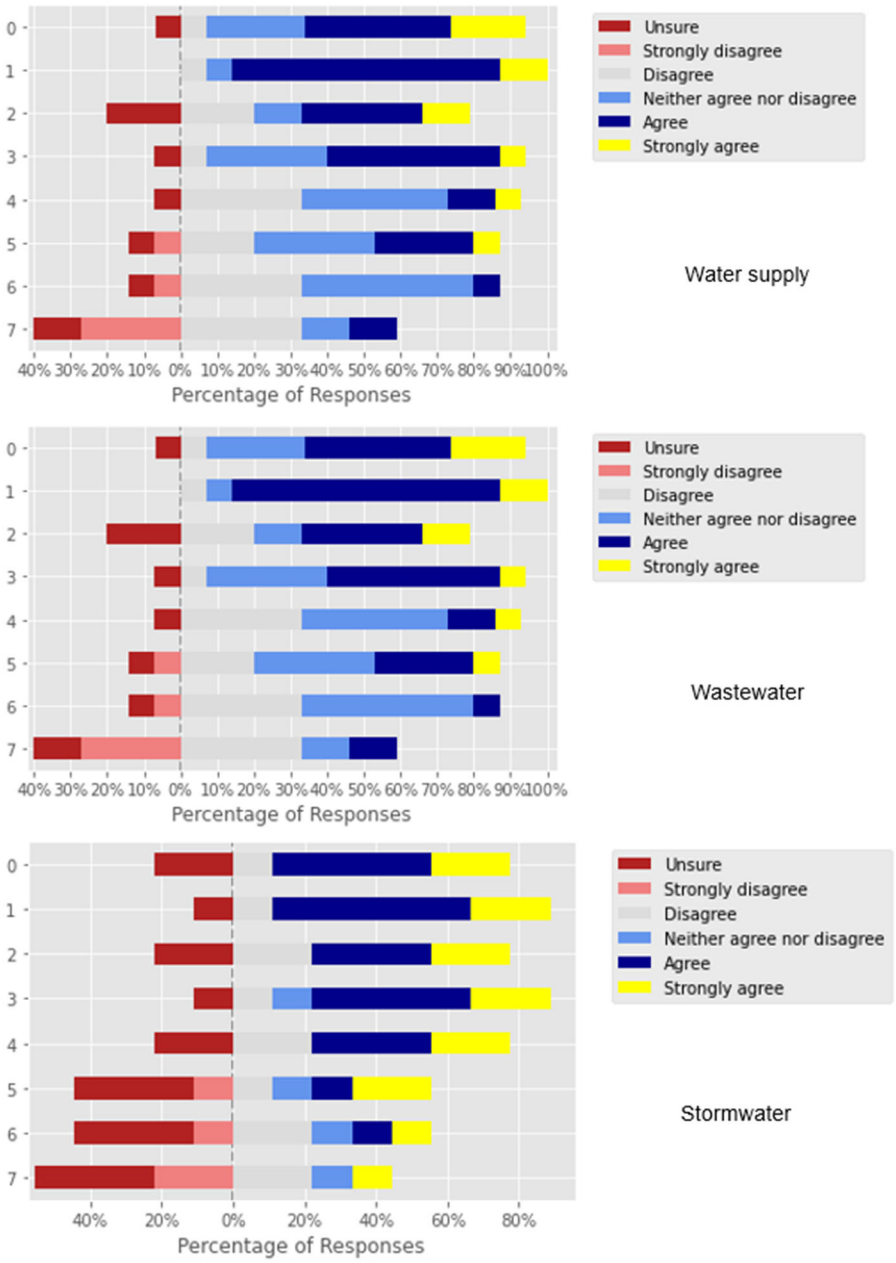


Figure 13. *Perceived agreement on the relative benefits of the in-contract method for wet utilities (The numbers from 0 to 7 indicate the benefits)*

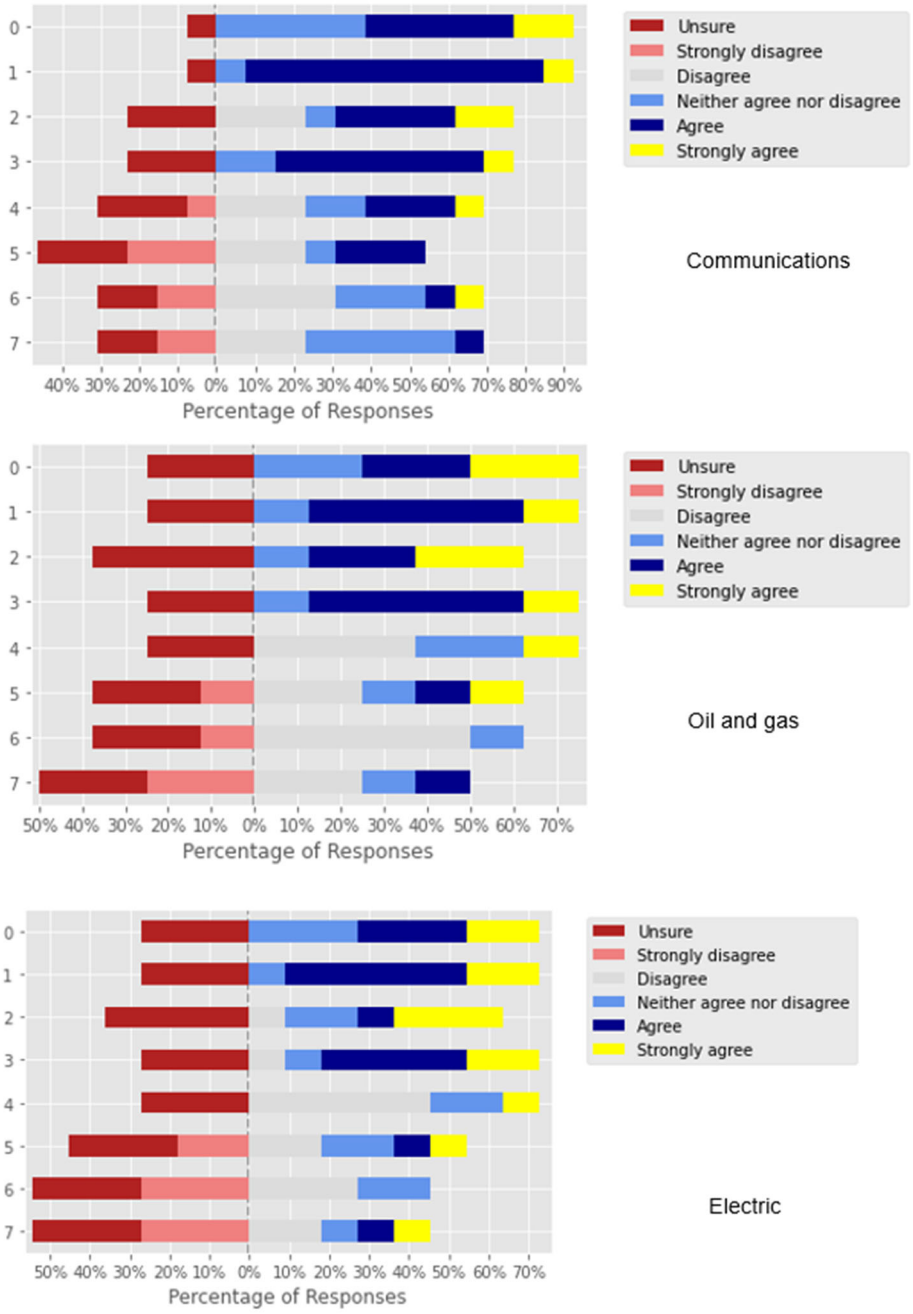


Figure 14. *Perceived agreement on the relative benefits of the in-contract method for non-wet utilities (The numbers from 0 to 7 indicate the benefits)*

4.4 State DOTs' Perspective on Benefits of In-contract Utility Relocations

Participants were requested to share their perspectives on the advantages of incorporating utility relocation within construction contracts. According to the survey findings, some personnel from state

DOTs highlighted several benefits associated with including utility relocation in highway contracts. These benefits encompass granting greater control to the construction contractor, eliminating the involvement of utility owners' contractors, thereby enhancing scheduling and traffic management. Furthermore, logistical challenges related to utility owner crews can be mitigated, enabling state contractors to work without such impediments. State DOTs and highway contractors may exert more influence over project schedules, resulting in fewer instances of utility-related delays.

Additionally, involving utility owners early in the process allows for their integration into the design and construction phases, facilitating better control over scheduling. This early engagement fosters improved project coordination, reduces risks for all stakeholders, and ensures comprehensive documentation of utility relocation activities. The inclusion of utility work in the contract assigns responsibility to the highway contractor for planning, coordinating, and scheduling utility work efficiently, leading to enhanced coordination with designers and utility companies.

Further benefits reported encompass improved construction coordination, reduced uncertainty, fewer delays, enhanced phasing, decreased traffic control expenses, and streamlined contract management and onsite construction responsibilities. The capacity for contractors to manage the schedule offers a significant advantage, enabling them to deploy multiple crews and prioritize relocation efforts accordingly.

4.5 State DOTs' Perspective on Benefits of Utility Relocation Done by the Utility Owner

Similar to the preceding section, this part of the survey invited participants to articulate their perspectives on the potential advantages of traditional utility relocation contracts. Respondents highlighted several benefits associated with having utility owners oversee utility relocation tasks.

Primarily, entrusting owners with the responsibility for utility relocation offers several advantages. Firstly, utility owners assume accountability for their materials and possess intimate knowledge of their facilities and systems, thereby facilitating a smoother relocation process. The opportunity to facilitate relocations prior to highway construction by pre-clearing areas proves particularly advantageous for large-scale projects. Moreover, the design workload is significantly reduced when utilities undertake this task themselves, as they only need to furnish plan sheets for the relocation work without detailed designs and other specifications in the format required by the state DOT.

Given their expertise in their respective facilities, utility owners are well-equipped to manage relocations, particularly when engaged early in project planning and design stages. They can provide valuable insights to circumvent relocations if given the opportunity during project planning. Additionally, utility owners exercise greater control over relocation costs and can offer technical expertise tailored to their utility type. They may also maintain readily available materials, minimizing procurement delays, thus facilitating better cost control, and ensuring accountability.

Furthermore, internal handling of relocations diminishes the potential for utility owners' discontent with construction, as clear responsibility is established. Costs related to traffic control, land clearing, and grading may be assumed by the utility rather than the DOT when integrated into the utility owner's self-performed or bid relocation.

4.6 State DOTs' Perspective on Risk of In-contract Utility Relocations

The participants were also asked to share their perspective on potential risks associated with including utility-type relocations in the highway construction. They reported that this method can lead to increased costs to the utility company due to the involvement of the highway contractor. These costs can result from additional expenses or unforeseen circumstances that may occur during the relocation process. Another risk is that stormwater, which is not considered a utility by some agencies, for example the Delaware and Connecticut DOTs, may not receive adequate attention or be properly addressed during the relocation. Additionally, utility companies may have strict requirements and standards that are challenging to meet, leading to dissatisfaction with the implementation and completion of the relocation. This dissatisfaction could be exacerbated by potential shortcomings in communication, coordination problems, or a failure to grasp the utility company's specific requirements and specifications.

4.7 State DOTs' Satisfaction Level of Utility Relocations going In-contract

The survey data reveals an overarching trend of satisfaction among respondents regarding the inclusion of utility relocations in highway contracts, with satisfaction levels predominantly ranging between neutral and satisfied. Across various utility types, respondents generally expressed a favorable outlook towards this contracting method for utility relocations. Notably, stormwater utilities garner the highest satisfaction rating, with a mean satisfaction score of 4, closely followed by wastewater utilities at 3.75. Water supply utilities also show a notable satisfaction level, with a mean score of 3.73. Electric and communication utilities, while experiencing a slightly lower satisfaction, still exhibit respectable mean satisfaction scores of 3.33 and 3.29, respectively. These findings suggest a consistent and positive sentiment towards the integration of utility relocations within highway contracts.

Table 16. *Satisfaction Ratings for In-contract Utility Relocations (1 = very unsatisfied; 2 = unsatisfied; 3 = neutral; 4 = satisfied; 5 = very satisfied)*

Utility type	Mean	Std Deviation	Variance	Sample Size
Stormwater	4	0.63	0.4	5
Wastewater	3.75	0.66	0.44	8
Water supply	3.73	0.77	0.6	15
Oil and gas	3.5	0.5	0.25	4
Electric	3.33	0.47	0.22	6
Communication	3.29	0.45	0.2	7

4.8 State DOT Decision Process for Including In-contract for Utility Relocations

In this section, the respondents were asked to describe State DOTs' process of making decision on the inclusion of utility relocations in the highway contract. This process was reported to typically involve multiple considerations and approaches. These include assessing the construction phasing and the willingness of utility owners to allow contractors to execute the work, potential conflicts with state project designs and preferences of municipalities, as well as encouraging utility owners to permit inclusion in contracts. Additionally, factors such as cost-benefit analysis, legal statutes, reimbursement requirements for municipal water utilities, communication and coordination with utility companies, validation of benefits, resource availability, and early-stage design meetings all play crucial roles in the decision-making process. Overall, the response highlights the necessity for thorough assessment and collaboration to ensure successful relocation outcomes.

4.9 Manual Content Analysis of State Utility Manuals

We conducted an in-depth manual content analysis, with the aim of determining common patterns/language used in state utility manuals. The sample language found for each topic was carefully reviewed by the research team using the annotated system shown in Table 18. Specifically, we labeled the samples with the following nine specific categories: schedule, dispute, reimbursement, deadline, submittal, permit, crossing signs, in-contract, and department. The samples were color-coded accordingly. Under each category, a set of questions was then developed to help us extract information from the sample requirements.

Table 17. *Content Analysis Structure*

Attribute	Color code	Topic questions	Sample size	Data Type
Schedule		Is schedule of relocation submission required?	72	Binary
		Schedule document is in which format?		Category
		Schedule document is submitted by whom?		Category
		Who is responsible for change order?		Category
		Who is responsible for utility work progress inspection?		Category
Dispute		Is dispute resolution described in the provision?	13	Binary
		Dispute is resolve by whom?		Category
Reimbursement		Reimbursement letters/forms is prepared by whom?	42	Category
		Types of financial incentives?		Category
		Are betterments reimbursable or not?		Binary
		Is in-kind relocation reimbursable or not?		Binary

Deadline		Is deadline specified or not?	46	Binary
		What is the required duration (hrs) expected to notify state before any work commences on utility line?		Category
		What is the required duration (hrs) expected to notify state after any work has been done on utility line?		Category
Submittal		Is submittal required or not?	27	Binary
		Who submits the utility agreement applications?		Category
		Who receives agreement submission?		Category
		How many documents are expected to be submitted?		Category
Permit		Is a utility relocation permit required?	54	Binary
		Who is the contact person to notify regarding utility relocation permission?		Category
		Permit application is done through?		Category
		Permit application is submitted to?		Category
Crossing		Are signs provided for utility crossing?	27	Binary
		Who provides the type of sign for utility crossing?		Category
		Who installs the sign on roadway?		Category
In-contract		Which document is provided when relocation is awarded in-contract?	2	Category
		What is the name for the process of going in-contract?		Category
Department Duty		Who is in charge of handling relocation in the department?	7	Category
		Prior rights are determined when?		Category
		What must be provided to establish a ROW?		Category
		Which department has the right to purchase utility easements?		Category

The content analysis generated a database of 276 annotated clauses (See Appendix D for the sample language of different categories). With respect to common specific requirements, the study findings are summarized in Table 19. For example, schedule documents are typically required to be submitted in printed format and mailed to the highway agency. The notification deadline prior to any utility work is often 48 hours. Typical financial incentives are cash bonuses and cost-sharing. The database developed from the annotated clause examples can be implemented to advance the current utility drafting practices

at SCDOT. It provides the agency with systematic references to the common language used in other states, thus eliminating the extended time required for document review and providing the department with a process for writing and updating manuals to meet current standards. However, the structure database developed is not expected to eliminate the process of interpreting and drawing inferences from the usage of utility manuals. This process is also not meant to substitute proper legal understanding before implementation, as consultation with legal personnel is necessary.

Table 18. *Content Analysis Results*

Topic	Categorical Topic Question	Answers
Schedule	Schedule document is in which format?	Printed format
		mail format
	Schedule document is submitted by whom?	utility owner
	Who is responsible for change orders?	Construction Region Engineer
	Who is responsible for utility work progress inspection?	Representatives of the Construction Region Engineer
Dispute	Dispute is resolve by whom?	procedures and mediation boards
		Chief Engineer
		Offeror
Permit	Who is the contact person to notify regarding utility relocation permission?	Area Permit Inspector
		Division of Maintenance and Operations Permit Section
		Regional Director DOT
		State DOT
	Permit application is done through?	GUPS (Georgia Utilities Permitting System)
		Encroachment Permit Processing System (EPPS).
	Permit application is submitted to?	District Utilities Engineer
		District Public Works Office
		Department's permit application
Deadline	Required duration (hours) expected to notify state before any work commence on utility line?	
		48 hours
	Required duration (hours) expected to notify state after any work has been done on utility line?	48hrs
Reimbursement	Reimbursement letters/forms are prepared by whom?	state utility liaison
		Utilities Engineer
		Local Government Division
		Local Public Agencies

		Utility owner
		Regional Utilities Manager or designee
	Types of financial incentives?	Cash bonuses
		Incentives/Disincentives
		Cost-sharing
		No-excuse incentives
		Contractor-provided financial incentives
		Gainshare–painshare
Crossing	Who provides the type of sign for utility crossing?	Department
		Utility firm or permittee
		HSIP coordinator
	Who installs the signs on roadway?	utility owner
		utility firm or permittee
Submittal	Who submits the utility agreement applications?	Utility owner
	Who receives agreement submission?	Region Engineer
	How many documents are expected to be submitted?	Two
Department	Who is in charge of handling relocation in the department?	Department Project Manager
	Prior rights are determined when?	It is a private property
		There is a right-of-way under a previous project
	What must be provided to establish a ROW?	documentation for review
		easement or "prior rights" documentation
		prior rights documents
In-contract	Which document is provided when relocation is awarded in-contract?	Memorandum of Understanding (MOU)
	What is the name for the process of going in-contract?	Utility Construction Request

4.10 Automatic Content Analysis of State Utility Manuals

The manual content analysis described above provides a well-structured database of sample clauses. However, this manual process is time-consuming as the corpus of sample clauses expands. Due to the study's limitations in time and access to legal documents from other state DOTs, the developed corpus remains relatively small. Future additions to the existing database will be necessary. Once it is significantly enlarged, relying solely on manual content analysis would become inefficient, necessitating assistance

from automated methods. For this reason, as part of this study, we proposed an automated framework using Natural Language Processing (NLP), a branch of Artificial Intelligence (AI), to support the content analysis of text documents. Specifically, this framework adopts Latent Dirichlet Allocation (LDA) topic modeling, as illustrated in Figure 15, aiming to automatically categorize a given set of clauses into separate topic clusters. We implemented the framework on a corpus of 276 clauses. Due to the small size of our dataset, the true power of LDA topic clustering over manual clause categorization may not be as noticeable compared to scenarios where we have larger datasets and manual annotation is impractical. The methodology used for the topic clustering in the study is detailed below. The efficacy of the modeling approach need to be further validated before the results can be practically adopted.

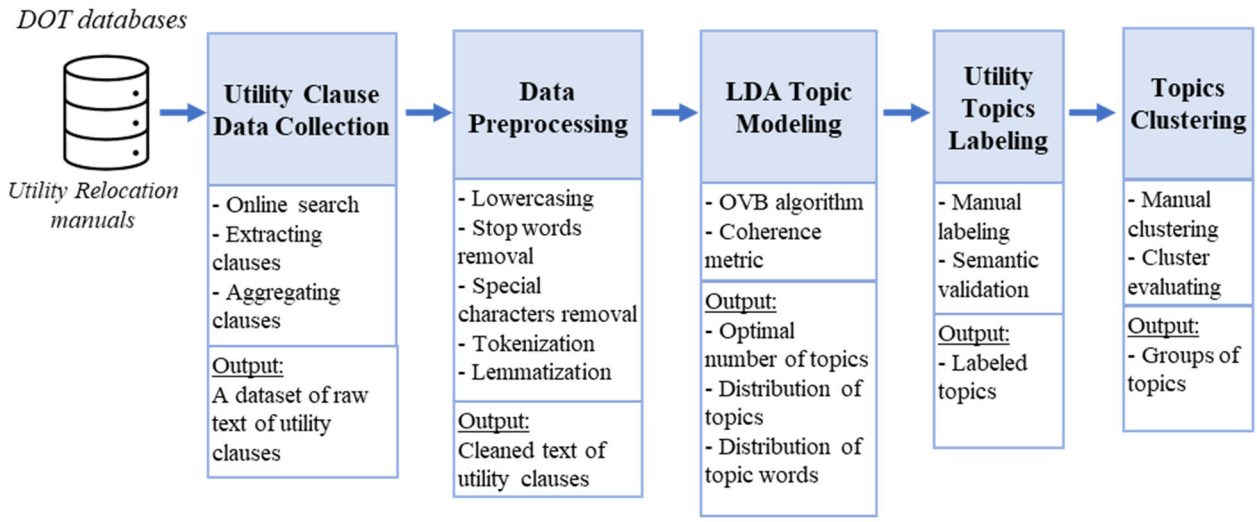


Figure 15. *NLP Research Methodology*

The LDA algorithm produced a set of 6 separate topics from the input corpus of legal utility-related clauses, where each topic is represented by a probability distribution over the words in the corpus. To identify the label for each of the 6 topics, the top eight words with the highest probability for each topic were extracted (as depicted in Table 20). A manual labeling process was used to assign human-readable labels to the topics identified by LDA. The resulting labels provide a better understanding of the topics and help to interpret the LDA results in a more meaningful way. The labeling process resulted in the categorization of 6 distinct labeled topic categories of the sample clauses. As shown in the table, these areas were identified as dispute resolution and communication, project management and government regulations, permit and relocation, planning and scheduling, infrastructure design, and utility right-of-way and pipeline design.

Table 19. *Topic Labeling Results*

LDA outputs		Topic name
Topic Number	**Highest Probable Keywords**	
Topic 1	mediation, arbitration, submit, notification, rule, recommendation, mediator, conflict	Dispute resolution and communication
Topic 2	project, government, cost, responsibility, contractor, agreement, certification, construction	Project management and government regulations
Topic 3	permit, approval, adjustment submittal, ensure, prior, final review, authorize	Permit and relocation
Topic 4	plan, schedule, date, owner, day, deadline, submit, delay	Planning and scheduling
Topic 5	facility, crossing, highway, installation, exist, location, alignment, cut	Infrastructure design
Topic 6	right-of-way, facility, control, encasement, casing, design, pressure, line	Utility right-of-way and pipeline design

The co-occurrence relation between the topics was further analyzed. The results are depicted in Figure 16. Each bubble corresponds to a specific topic, with the size indicating the frequency of that topic within the corpus. The overlapping area reflects the number of words two certain topics have in common. This visualization provides an intuitive assessment of topic proximity, aiding in identifying similarities and co-occurrence. A shorter distance signifies closer topic similarity, while more distantly separated circles suggest more diverse word distributions across topics. For instance, the circles for "dispute resolution and communication" (Topic 1) and "project management and government regulations" (Topic 2) overlap, indicating shared keywords. Additionally, the visualization illustrates the categorization of labeled topics into four clusters. For example, "dispute resolution and communication" (Topic 1) and "project management and government regulations" (Topic 2) in Cluster 1 exhibit close relationships, whereas "infrastructure design" (Topic 5) and "utility right-of-way and pipeline design" (Topic 6) are grouped in Cluster 2.

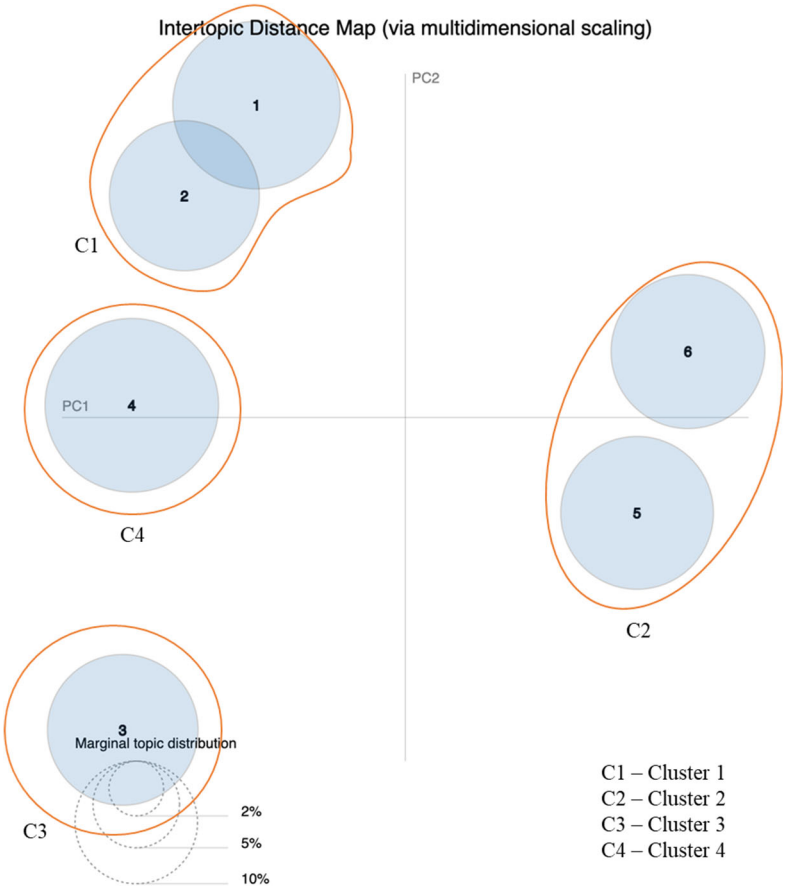


Figure 16. *Topic Visualization*

4.11 Concluding Remarks

This chapter presents the survey of current practices among state DOTs regarding utility contract methods and legal language usage. The study found that the in-contract method has been used for several types of utility services, often for water supply and wastewater systems. Most states reported that this method offered advantages over the utilities relocating themselves, specifically enabling improved schedule and traffic control. Utilities relocating their lines themselves, however, were reported to offer better relocation design at a lower cost because of the familiarity of utility owners' expertise. Another major deliverable of the survey undertaken in this report is a systematic database of annotated legal language examples used in utility agreements. The database provides SCDOT staff with a structured source of language examples for various topics including schedule, dispute, permit, incentives/disincentives which can be used to appropriately adapt legal provisions.

5. Survey of SCDOT Utility Owners

5.1 Participant Demographic Information

This survey garnered feedback from a range of utility companies across South Carolina, encompassing sectors such as water supply, wastewater, oil and gas, electric, and communication, as illustrated in Figure 17. Over fifty percent of respondents represent entities involved in water supply, wastewater, oil and gas distribution, and electric utilities. However, electric transmission, stormwater, and oil and gas transmission sectors were represented by only one to two participants each. According to Figure 18, the majority of respondents hold positions as utility coordinators within their respective organizations. Other main participants involve utility consultants, designers, and inspectors. There was only one SUE engineer participated in the study.

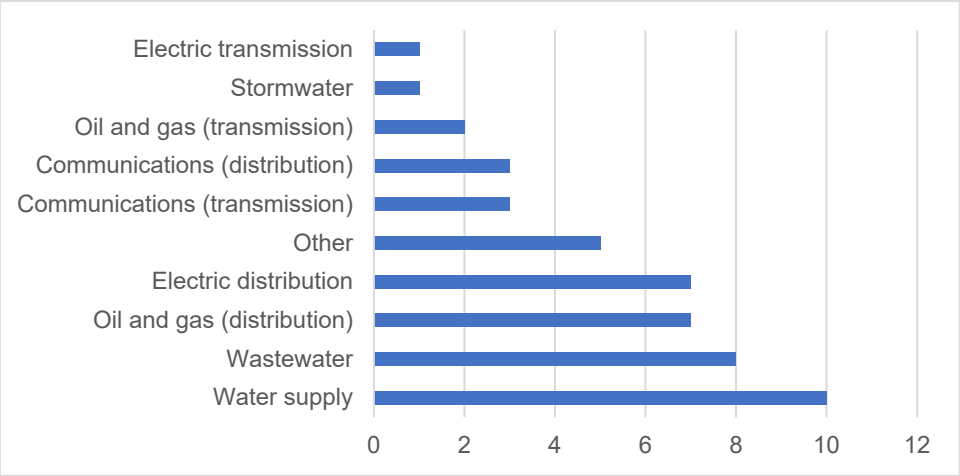


Figure 17. *Types of Utilities Owned by the Respondents*

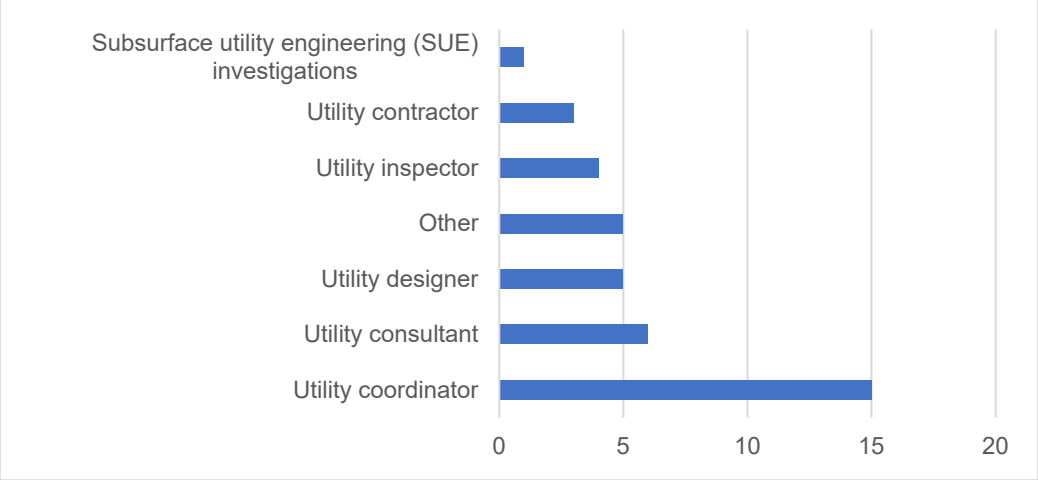


Figure 18. *Respondents' Expertise*

5.2 Utility Owners' Perceived Benefit of the In-contract Method Compared to the Utility Relocation Done by the Utility Owners

Figures 19 and 20 present the results concerning utility owners' perceived advantages of the in-contract methods compared to conventional methods, for both wet and non-wet utilities, respectively. These benefits were evaluated based on the same eight criteria outlined in Section 4.3. The figures indicate a clear preference among utility owners' representatives for the in-contract method, particularly evident for water supply and wastewater utilities (Figure 19). In these categories, few participants disagreed with the listed advantages of the new in-contract approach. However, the superiority of the in-contract method for other utility types could not be confirmed. Notably, approximately half of the participants expressed skepticism regarding the benefits of the new method for oil and gas and communication utilities (Figure 20).

Across all types of utilities, Criterion 1 (enhanced coordination) and Criterion 2 (reduction of delays) received the highest levels of agreement from utility owners, while Criterion 4 (cost reduction) experienced the highest levels of disagreement. Interestingly, the data showed a notable contradiction between the perspectives of utility owners and those of State DOTs. Highway agencies appear more inclined towards implementing the in-contract method, whereas utility owners remain skeptical about its effectiveness.

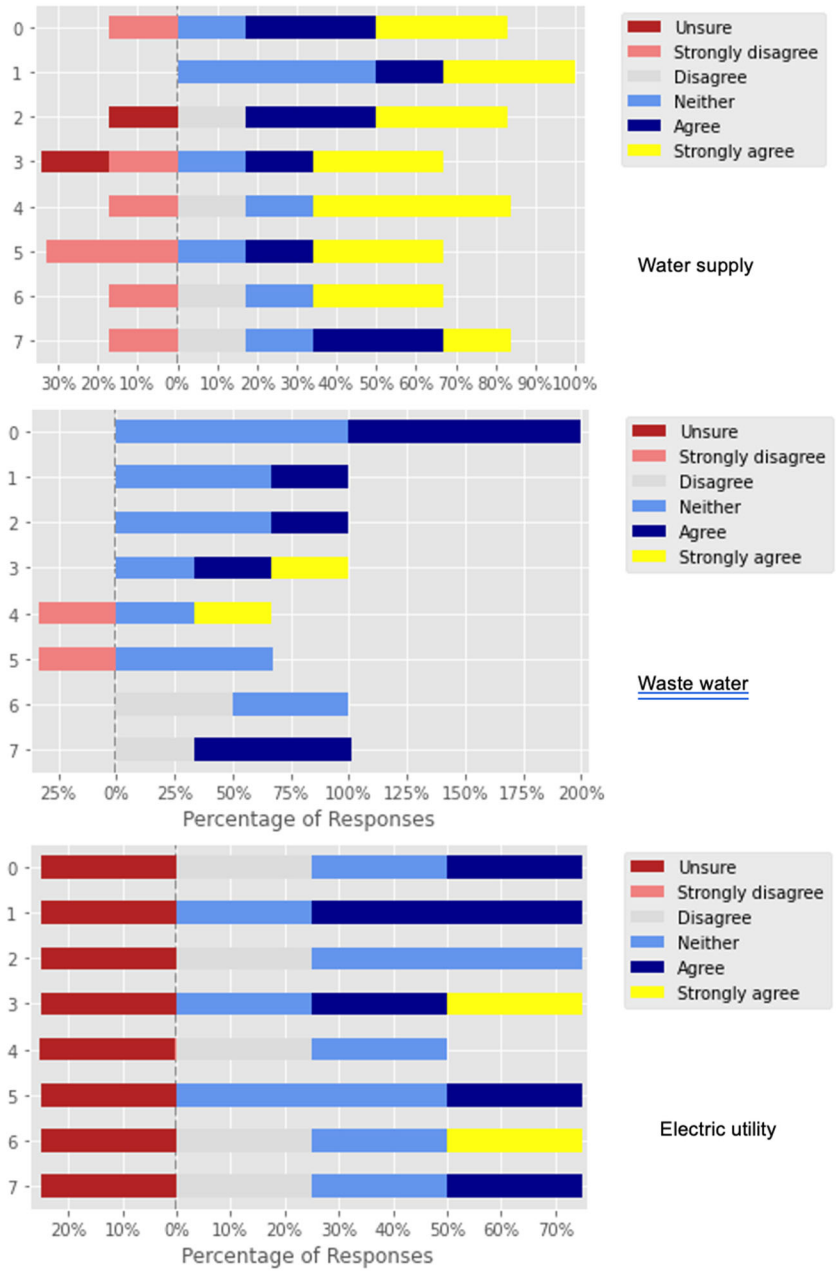


Figure 19. *Perceived agreement on the relative benefits of the in-contract method for wet utilities*

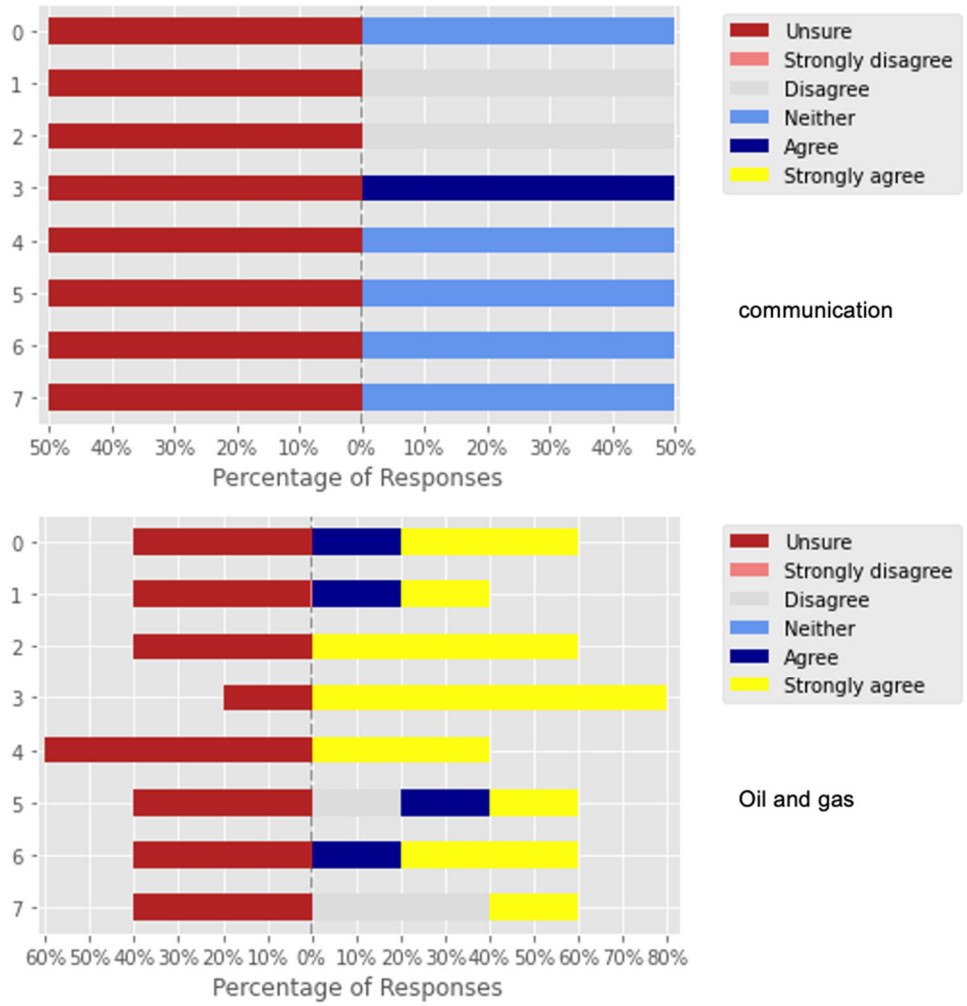


Figure 20. *Perceived agreement on the relative benefits of the in-contract method for non-wet utilities*

5.3 Utility Owners' Perspective on Benefits of Utility Relocation Handled by the Utility Owner

Participants conveyed their belief that allowing owners to perform their own utility relocation would yield several advantages. Firstly, there is an emphasis on achieving higher product quality, as owners prioritize the durability and longevity of replacements or relocations. Additionally, utility owners possess an in-depth understanding of their systems, enabling them to execute tasks more effectively compared to contractors. This often leads to cost savings, as owners can typically manage relocations at a lower expense and have the flexibility to select contractors. Furthermore, utility owners exert greater control over schedules, facilitating more efficient and timely installations that comply with required codes. This heightened control over the process also results in improved quality assurance and a diminished risk of work failing to meet proper standards.

5.4 Utility Owners' Perspective on Risk of In-contract Utility Relocation

Participants highlighted various risks associated with including utility relocation in highway contracts. These risks encompass a lack of expertise, which may lead to unsatisfactory work and inferior outcomes. Another concern raised is the potential use of incorrect material types, resulting in inefficiencies and compromised utility functionality. Inadequate communication regarding the as-built plan is also identified as a risk, potentially leading to discrepancies and challenges during the relocation process.

Additionally, owners stressed the importance of prioritizing water/waste and gas utilities due to their critical significance and the potential repercussions of mishandling them. These risks underscore the necessity for thorough planning, effective communication, and prioritization to address challenges and ensure successful utility relocations within highway contracts.

Furthermore, representatives highlighted the risk of utility relocation delays during project delivery, which could present additional challenges. These include increased costs due to extended project timelines and associated expenses, difficulties in coordinating with infield operations, potential claims from general contractors or business owners for delays impacting their operations and access, challenges in securing specialty contractors and necessary materials, heightened service interruptions and delays for utility customers, potential non-compliance with contracted volumes or customer demands, delays in permitting processes, unexpected utility locates or unmarked utilities not known by engineers, dependency on the completion of other utility relocations before work can commence, undisclosed design changes requiring modifications, and a shortage of personnel to complete the relocation work. These risks may result in financial implications, customer dissatisfaction, project disruptions, and coordination challenges among various project stakeholders.

5.5 Utility Owners' Satisfaction Level of Utility Relocations going In-contract

The survey data indicates a neutral experience level among respondents regarding the in-contract process across multiple projects. Across various project contexts, the overall sentiment towards the in-contract method remains neutral. The mean satisfaction score of 3.71, with a standard deviation of 0.88, suggests a moderate level of consistency in respondent perceptions. This is consistent with the results reported in Section 5.2 which confirms the skepticism among utility owners about the actual benefits of the new method.

5.6 Utility Owners' Perspective on Incentives and Strategies for In-contract Utility Relocation

In order to encourage utility owners to incorporate their utility relocations into highway contracts, representatives from utility owner organizations suggest that SCDOT implement a range of strategies and

incentives. These include assuming financial responsibility for relocation costs, improving communication between SCDOT and utility owners, offering prior rights and benefits, educating owners about the advantages of participating in contracts, ensuring consistency and coordination among SCDOT district engineers, increasing cost-sharing arrangements, constructing communications "duct banks" to reduce individual relocations, permitting on-site monitoring and reimbursement, involving utility owners in early planning stages, fostering a collaborative approach, facilitating information sharing and learning opportunities, supporting local contractors, assisting in as-built data collection, implementing financial penalties for delays, and establishing a dedicated construction department to collaborate closely with utilities. These measures would ease financial burdens, enhance communication and coordination, foster collaboration, and provide incentives and assistance to utility owners, ultimately leading to a smoother and more efficient relocation process.

To reduce delays in utility relocations, the SCDOT should focus on improving planning and communication, involving all parties early in the process. Clear and consistent communication should be maintained, ensuring that final elevation changes are communicated to all utilities. Encouraging in-contract work on Design-Build projects and including a wider range of utilities can enhance coordination. The SCDOT should aim for consistency among its Engineering Districts and implement more thorough SUE practices. Utility involvement should be prioritized at the initial stages, and relocation phasing plans should be included in design contract documents for better coordination. Frequent communication, additional time incorporated into the contract for relocations, and certification of right-of-way prior to utility certification can help mitigate delays. Improving the encroachment process, expediting the change order process, and ensuring better feedback from the SCDOT are also crucial steps. Conducting public and private utility location surveys, verifying depths through vacuum excavation, and enhancing collaboration between construction contractors and utilities are recommended. Ultimately, comprehensive planning, effective communication, and streamlined processes are key to reducing delays in utility relocations.

To engage utility owners more effectively, the SCDOT should focus on understanding the financial constraints of utility companies and work toward minimizing costs and rates. Early and consistent communication is crucial, ensuring that utility owners are kept informed throughout the project. The SCDOT can appoint a dedicated liaison who has the authority to engage all parties involved and facilitate activities such as prompt right-of-way surveys and temporary access construction. Encouraging utility owners to attend pre-construction and regular construction progress meetings, making them feel like they are part of the team, can enhance collaboration. The SCDOT should provide notifications of schedules and changes, incorporate existing utilities into early surveys to minimize the need for multiple locates, and improve the identification of potential conflicts during design stages. Building a better understanding of the challenges faced by utility owners and ensuring their participation in project development can also contribute to effective engagement. Moreover, the SCDOT should improve participation in utility-related meetings, provide timely feedback on projects, and communicate long-term plans early. Enhanced communication, joint venture teams, and consequences for lack of execution can further strengthen the relationship between the SCDOT and utility owners, fostering a more effective and efficient process.

5.7. Concluding Remarks

The survey of South Carolina utility owners offers a comprehensive perspective on past in-contract utility relocations, providing insights into the benefits, risks, and actionable strategies to ensure efficient utility relocations for highway projects. The participants, who represent diverse professionals from various utility companies, contributed significantly to our comprehensive understanding of the historical challenges and opportunities. The perceived advantages of the in-contract method compared to utility relocation solely managed by utility owners reveal a consensus among respondents that the in-contract approach provides benefits across various utility types. On the other hand, the benefits of utility relocation managed by utility owners include the depth of knowledge and the quality control advantages that they bring to the process. Their ability to ensure higher product quality, cost-effectiveness, and adherence to schedules enhances the value of utility relocation efforts. Participant responses underscore such potential disadvantages of the in-contract method as limited experience, errors in material selection, and lack of sharing as-built plans. Lastly, the recommendations for enhancing in-contract utility relocations such as clear communication, collaborative involvement, proactive planning, and an understanding of financial constraints are recurring themes found throughout the recommendations.

6. Data Analysis, Recommendations, and Implementation

This section presents a comprehensive discussion of Task-5, the follow-up survey of the SCDOT personnel who participated in the focus groups. Specifically, it includes a delay factor criticality analysis, an evaluation of the perceived effectiveness of various previously identified strategies, and a mapping of critical factors to the strategies addressing them. This last step, the mapping of strategies to critical factors, led to the development of the recommendations proposed at the end of this section.

6.1. Critical Assessment of Utilities-related Delay Factors

In Section 3, we analyzed the factors across various project phases that SCDOT personnel identified in their focus groups as causing transportation delays. These factors, however, were not quantitatively assessed for relative criticality. In other words, a factor that caused a small delay during one past project and another that caused considerable delay on multiple projects were indistinguishable in terms of their criticality. Subsequently, a follow-up survey was developed as part of Task-5 to evaluate the relative criticality of various delay factors identified in Task-3. These delay factors were categorized into multiple project phases, as can be seen in the questionnaire used in this follow-up survey, which is included in Appendix-A.2.

In this questionnaire, the respondents were asked to indicate how strongly they agreed or disagreed with the statement that each factor in different project phases caused significant delays on past transportation projects. In addition to the SCDOT personnel who participated in the focus groups in Task-3, the survey was shared with multiple external consultants who frequently handle utility coordination and related tasks to support SCDOT's transportation project delivery. A total of 16 valid responses were received with 13 of them from SCDOT personnel and three from external consultants. The survey responses were then quantitatively assessed based on critical scores of -2 for strongly disagree, -1 for disagree, 0 for neutral, 1 for agree, and 2 for strongly agree.

Figures 21, 22, and 23 illustrate the distribution of the criticality scores for each factor in the planning and preliminary design, final design, and construction phases, respectively. Table 19 summarizes the criticality scores averaged across the overall respondent group for all the factors related to the different project phases, and Table 20 summarizes the criticality scores averaged only for the consultant respondent group. Although only three consultants responded to the survey, their perspectives are documented as they are external agents closely associated with transportation project delivery. Furthermore, respondents wrote in a few factors that they strongly believed to have caused significant project delays as noted in the footnotes of Tables 19 and 20. Since these written-in factors were not consistently assessed by all the participants, they were not assigned a criticality score.

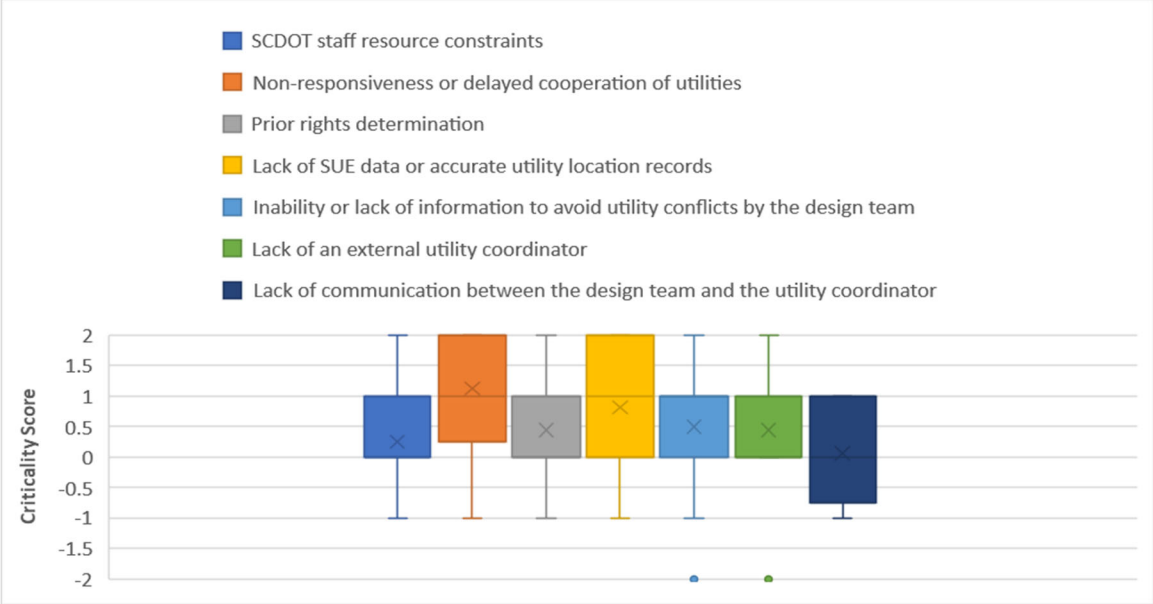


Figure 21. *Relative Criticality of Delay Factors in Planning and Preliminary Design Phase*

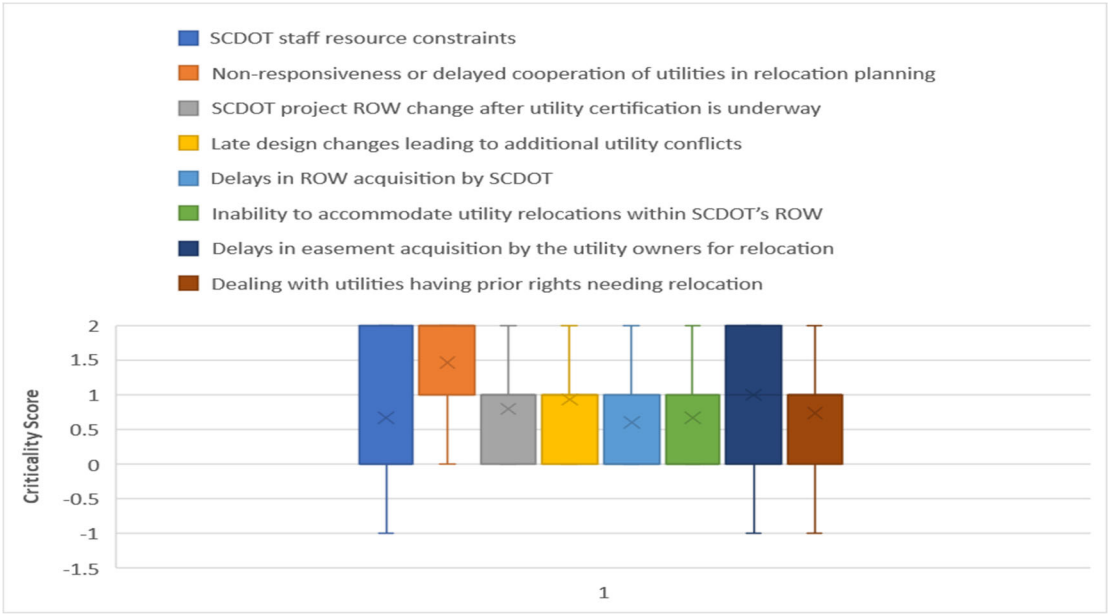


Figure 22. *Relative Criticality of Delay Factors in Final Design Phase*

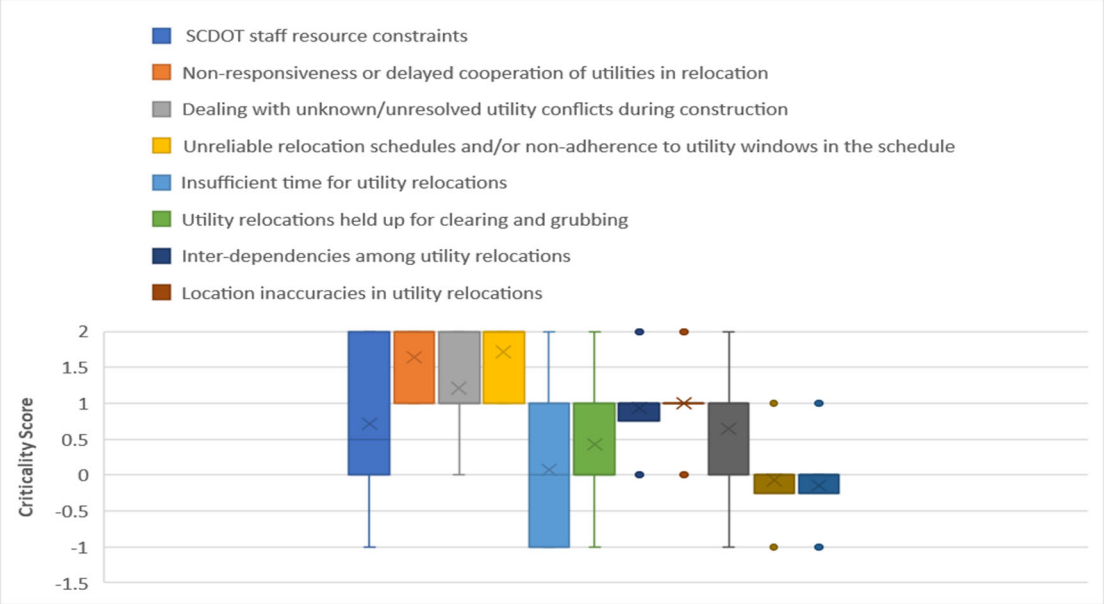


Figure 23. *Relative Criticality of Delay Factors in Planning and Preliminary Design Phase*

Table 20. *Average Criticality Scores Across All Respondents*

Planning & Early Design	Average Criticality
Non-responsiveness or delayed cooperation of utilities	1.13
Lack of SUE data or accurate utility location records	0.81
Inability or lack of information to avoid utility conflicts by the design team	0.50
Prior rights determination	0.44
Lack of an external utility coordinator	0.44
SCDOT staff resource constraints	0.27
Lack of communication between the design team and the utility coordinator	0.06
Long time period between initial contact letters and plan**	N/A
Final Design Phase	**Average**
Non-responsiveness or delayed cooperation of utilities in relocation planning	1.47
Delays in easement acquisition by the utility owners for relocation	1.00
Late design changes leading to additional utility conflicts	0.93
SCDOT project ROW change after utility certification is underway	0.80
Dealing with utilities having prior rights needing relocation	0.73
SCDOT staff resource constraints	0.67
Inability to accommodate utility relocations within SCDOT's ROW	0.67
Delays in ROW acquisition by SCDOT	0.60
Uniformity w/ submittal requirements**	N/A
Construction Phase	**Average**
Unreliable relocation schedules and/or non-adherence to utility windows in tl	1.71
Non-responsiveness or delayed cooperation of utilities in relocation	1.64
Dealing with unknown/unresolved utility conflicts during construction	1.21
Location inaccuracies in utility relocations	1.00
Inter-dependencies among utility relocations	0.93
SCDOT staff resource constraints	0.71
Material, labor, or equipment shortages due to market conditions	0.69
Utility relocations held up for clearing and grubbing	0.43
Insufficient time for utility relocations	0.07
Evaluating reimbursable relocations for compliance	-0.07
Inaccurate or unsatisfactory in-contract utility relocations	-0.14
Not having external utility coordinator on board for construction phase**	N/A

***This factor was explicitly added by a respondent and only had one criticality rating of 2.0*

Table 21. *Average Criticality Scores Across Consultant Respondents*

Planning & Early Design	Average Criticality
Non-responsiveness or delayed cooperation of utilities	1.33
Lack of SUE data or accurate utility location records	1.00
Lack of an external utility coordinator	0.67
Inability or lack of information to avoid utility conflicts by the design team	0.33
SCDOT staff resource constraints	0.00
Prior rights determination	0.00
Lack of communication between the design team and the utility coordinator	0.00
Long time period between initial contact letters and plan**	N/A
Final Design Phase	**Average**
Non-responsiveness or delayed cooperation of utilities in relocation planning	2.00
Inability to accommodate utility relocations within SCDOT's ROW	1.67
Delays in easement acquisition by the utility owners for relocation	1.67
SCDOT staff resource constraints	1.00
Late design changes leading to additional utility conflicts	1.00
SCDOT project ROW change after utility certification is underway	0.67
Dealing with utilities having prior rights needing relocation	0.67
Delays in ROW acquisition by SCDOT	0.33
Uniformity w/ submittal requirements**	N/A
Construction Phase	**Average**
Unreliable relocation schedules and/or non-adherence to utility windows in tl	2.00
Non-responsiveness or delayed cooperation of utilities in relocation	1.50
Utility relocations held up for clearing and grubbing	1.50
SCDOT staff resource constraints	1.00
Inter-dependencies among utility relocations	1.00
Material, labor, or equipment shortages due to market conditions	1.00
Dealing with unknown/unresolved utility conflicts during construction	0.50
Location inaccuracies in utility relocations	0.50
Insufficient time for utility relocations	-0.50
Inaccurate or unsatisfactory in-contract utility relocations	-0.50
Evaluating reimbursable relocations for compliance	-1.00
Not having external utility coordinator on board for construction phase**	N/A

***This factor was explicitly added by a respondent and only had one criticality rating of 2.0*

The following factors were found to be most critical based on an aggregated threshold criticality score of 0.5; written-in factors by few participants are also included with ** denotation.

<u>Planning and early design phase (Preliminary Design)</u>

1. Non-responsiveness or delayed cooperation of utilities
2. Lack of SUE data or accurate utility location records
3. Inability or lack of information to avoid utility conflicts by the design team
4. Long period between initial contact letters and plans (**_written-in by a participant_**)

The consultants' responses indicate that lack of an external utility coordinator was also critical with an average score of over 0.5.

Final design phase

1. Non-responsiveness or delayed cooperation of utilities in relocation planning
2. Delays in easement acquisition by the utility owners for relocation
3. Late design changes leading to additional utility conflicts
4. SCDOT project ROW change after utility certification is underway
5. Dealing with utilities having prior rights needing relocation
6. SCDOT staff resource constraints
7. Inability to accommodate utility relocations within SCDOT's ROW
8. Delays in ROW acquisition by SCDOT
9. Uniformity with submittal requirements (****written-in by a participant***)

"Inability to accommodate utility relocations within SCDOT's ROW" was rated to be more critical by the consultants than the overall respondent group. Furthermore, "Delays in ROW acquisition by SCDOT" was not rated to be as critical by the consultants as it was by the overall respondent group. It is possible that the participants do not recognize ROW acquisition delays as they may be used to seeing ROWs acquired as late as post letting. In other words, this factor may be more critical in reality than the survey responses indicate.

Construction phase

1. Unreliable relocation schedules and/or non-adherence to utility windows in the schedule
2. Non-responsiveness or delayed cooperation of utilities in relocation
3. Dealing with unknown/unresolved utility conflicts during construction
4. Location inaccuracies in utility relocations
5. Inter-dependencies among utility relocations
6. SCDOT staff resource constraints
7. Material, labor, or equipment shortages due to market conditions
8. Not having an external utility coordinator on board for construction phase (****written-in by a participant***)

The consultant respondent group rated "Dealing with unknown/unresolved utility conflicts during construction" and "Location inaccuracies in utility relocations" to be less critical than the overall respondent group. The consultant respondent group rated "Utility relocations held up for clearing and grubbing" to be considerably more critical than the overall respondent group. Furthermore, the factors "Insufficient time for utility relocations," "Inaccurate or unsatisfactory in-contract relocations," and "Evaluating reimbursable relocations for compliance" were not found to be critical based on the survey results.

Finally, the delay factors from the three project phases were combined under a single umbrella term for further analysis as shown in Table 21. The relative criticality scores of similar factors such as "non-responsiveness of utility owners" across the phases are simply averaged.

Table 22. *Delay Factors in Decreasing Order of Criticality*

Delay Factors		Criticality Score
CF1	Unreliable utility relocation schedule or non-adherence to utility windows	1.71
CF2	Non-responsiveness of utilities and lack of consequences thereof	1.41
CF3	Dealing with unknown/unresolved conflicts during construction	1.21
CF4	Delays in ROW easement acquisition for utility relocations	1.00
CF5	Location inaccuracies in utility relocations	1.00
CF6	Late design changes leading to additional utility conflicts	0.93
CF7	Interdependencies among utility relocations	0.93
CF8	Lack of or delay in acquiring accurate utility location data and SUE investigations	0.81
CF9	SCDOT project ROW changes after utility certification is underway	0.80
CF10	Dealing with utility relocations with prior rights	0.73
CF11	Market conditions leading to delays	0.69
CF12	SCDOT staff resource constraints	0.69
CF13	Inability to accommodate utilities in SCDOT's ROW for relocations	0.67
CF14	Delays in ROW acquisition by SCDOT	0.60
CF15	Inability or lack of information to avoid utility conflicts by the design team	0.50
CF16	Relocations held up for clearing and grubbing	0.43

The project recommendations are primarily based on the overall responses to delay factor criticality while giving due consideration to the perspectives of the limited number of consultants where appropriate. Furthermore, as with any survey, the insights obtained are highly dependent on the opinions of the respondents and not based on sophisticated delay-related data analysis. Therefore, the reliability of these relative criticality ratings of various delay factors should be considered bearing this in mind as well as taking into consideration the limited number (24) of responses, which were not necessarily consistent. Even with these limitations, these insights form the basis for developing targeted project recommendations.

6.2. Evaluation of Perceived Effectiveness of Various Best Practices or Strategies

Best practices or strategies that were either reported to be effective in addressing various utilities-related delays, identified as being practiced at other states, or suggested by SCDOT personnel and in-state utility owners were synthesized to assess their suitability and effectiveness. These strategies, shown in Table 22, were included in a follow-up survey given to the 16 SCDOT personnel and the external utility consultants to evaluate their perceived effectiveness in minimizing overall project delays. As can be seen in the survey instrument in Appendix A.3, the participants were specifically asked to indicate how strongly they agree or disagree with the statement that each of the strategies will be effective in minimizing utility-related

project delays assuming they were legally permissible. The aggregated effectiveness scores of all the strategies are summarized in Table 22 in the decreasing order of effectiveness.

Table 23. *Perceived Effectiveness of Strategies Sorted Based on Overall Respondent Scores*

Strategies		Overall Avg. Effectiveness	Consultant-Avg.
S1	Engage utility owners very early in the project and maintain frequent communication	1.33	1.67
S2	Have a service contract for pre-letting clearing and grubbing work	1.27	1.67
S3	Impose liquidated damages or penalize in other ways to make the utilities more accountable to SCDOT's needs	1.27	1.67
S4	Provide sufficient time for utilities to plan and relocate	1.20	1.67
S5	Promote use of adequate SUE investigations	1.20	1.67
S6	Target obtaining utility location data prior to 30% design completion	1.13	1.33
S7	Train SCDOT personnel to better handle utility conflict management	1.13	1.33
S8	Better coordinate ROW acquisition with utilities seeking private easements	1.07	2.00
S9	Avoid late design/ROW changes	1.00	1.67
S10	Extend utility coordination into the construction phase and have external consultants do inspection to ensure relocations are accurately completed	0.80	1.67
S11	Eliminate the sunset clause in the Senate Bill 401 that enables reimbursements for wet utility relocations	0.67	2.00
S12	Expedite completion of ROW plans and acquiring ROW	0.47	0.33
S13	SCDOT should acquire ROW to accommodate utility relocations	0.33	2.00
S14	Compensate utilities for avoidable rework arising from SCDOT's changed project needs	0.27	1.00
S15	Have the utilities pay for less expensive design changes than relocations	0.27	-0.67
S16	Develop cost-sharing or other incentives for non-reimbursable relocations by small utilities	0.13	0.33
S17	Pay utility owners for accurate location information as would SCDOT pay SUE consultants for the same	0.00	-0.67
S18	Use external consultants for utility coordination from concept/ pre-scoping through construction phase**	N/A	N/A
S19	Pay for all utility relocations subject to schedule compliance**	N/A	N/A

***This strategy was explicitly added by a respondent and only had one effectiveness rating of 2.0*

As can be seen from the results in Table 22, the majority of the strategies included in the survey were perceived to be effective. Strategy-18 (S18) is similar to strategy-10 (S10) and, therefore, was excluded from further analysis. Using a threshold value of 0.5 for the perceived aggregated effectiveness score, the following strategies were shortlisted for further consideration:

1. Engage utility owners early in the project and maintain frequent communication
2. Have a service contract for pre-letting clearing and grubbing work
3. Impose liquidated damages or penalize in other ways to make the utilities more accountable to SCDOT's needs
4. Provide sufficient time for utilities to plan and relocate
5. Promote use of adequate utility investigations
6. Target obtaining utility location data prior to 30% design completion
7. Train SCDOT personnel to better handle utility conflict management
8. Better coordinate ROW acquisition with utilities seeking private easements
9. Avoid late design/ROW changes
10. Extend utility coordination into the construction phase and have external consultants do inspection to ensure relocations are accurately completed

11. Eliminate the sunset clause in the Senate Bill 401 that enables reimbursements for wet utility relocations

The consultant group perceived the following strategies not included in the above list to be effective:

12. SCDOT should acquire ROW to accommodate utility relocations
13. Compensate utilities for rework resulting from SCDOT's changed project needs

Furthermore, as can be seen in Table 22, the consultant group perceived the following strategies to be more effective than the overall respondent group:

1. Better coordinate ROW acquisition with utilities seeking private easements
2. Avoid late design/ROW changes
3. Extend utility coordination into the construction phase and have external consultants do inspection to ensure relocations are accurately completed
4. Eliminate the sunset clause in the Senate Bill 401 that enables reimbursements for wet utility relocations

It should be noted that some of the strategies perceived to be effective may not be legally permissible at the current time. Furthermore, some strategies may also cost the SCDOT a significant amount of money to implement. Lastly, most of the strategies, if implemented, require the SCDOT to change its utilities-related processes. Therefore, despite being perceived to be effective, there are legal, financial, and process-related hurdles for them to be practical for implementation. These aspects are further discussed in the Recommendations Section.

Mapping of Strategies to Critical Delay Factors

The 16 utilities-related delay factors identified as in Table 21 are mapped with strategies found to be effective from the list in Table 22 based on relevance and suitability in minimizing delays. Figure 24 illustrates this mapping, with Figure 25 depicting this mapping in a matrix format.

Delay Factors		Strategies	
CF1	Unreliable utility relocation schedule or non-adherence to utility windows	Use external consultants for utility coordination from concept/ pre-scoping through construction phase** (similar strategy as S18)	S18
CF2	Non-responsiveness of utilities and lack of consequences thereoff	Pay for all utility relocations subject to schedule compliance**	S19
CF3	Dealing with unknown/unresolved conflicts during construction	Engage utility owners very early in the project and maintain frequent communication	S1
CF4	Delays in ROW easement acquisition for utility relocations	Have a service contract for pre-letting clearing and grubbing work	S2
CF5	Location inaccuracies in utility relocations	Impose liquidated damages or penalize in other ways to make the utilities more accountable to SCDOT's needs	S3
CF6	Late design changes leading to additional utility conflicts	Provide sufficient time for utilities to plan and relocate	S4
CF7	Interdependencies among utility relocations	Promote use of adequate SUE investigations	S5
CF8	Lack of or delay in acquiring accurate utility location data and SUE investigations	Target obtaining utility location data prior to 30% design completion	S6
CF9	SCDOT project ROW changes after utility certification is underway	Train SCDOT personnel to better handle utility conflict management	S7
CF10	Dealing with utility relocations with prior rights	Better coordinate ROW acquisition with utilities seeking private easements	S8
CF11	Market conditions leading to delays	Avoid late design/ROW changes	S9
CF12	SCDOT staff resource constraints	Extend utility coordination into the construction phase and have external consultants do inspection to ensure relocations are accurately completed	S10
CF13	Inability to accommodate utilities in SCDOT's ROW for relocations	Eliminate the sunset clause in the Senate Bill 401 that enables reimbursements for wet utility relocations	S11
CF14	Delays in ROW acquisition by SCDOT	Expedite completion of ROW plans and acquiring ROW	S12
CF15	Inability or lack of information to avoid utility conflicts by the design team	SCDOT should acquire ROW to accommodate utility relocations	S13
CF16	Relocations held up for clearing and grubbing	Compensate utilities for avoidable rework arising from SCDOT's changed project needs	S14

Figure 24. *Mapping of Perceived Effective Strategies to Suitable Critical Delay Factors*

	↓Strategies\Critical Delay Factors →	CF1 Unreliable utility relocation schedule or non-adherence to utility windows	CF2 Non-responsiveness of utilities and lack of consequences thereoff	CF3 Dealing with unknown/unresolved conflicts during construction	CF4 Delays in ROW easement acquisition for utility relocations	CF5 Location inaccuracies in utility relocations	CF6 Late design changes leading to additional utility conflicts	CF7 Interdependencies among utility relocations	CF8 Lack of or delay in acquiring accurate utility location data and SUE investigations	CF9 SCDOT project ROW changes after utility certification is underway	CF10 Dealing with utility relocations with prior rights	CF11 Market conditions leading to delays	CF12 SCDOT staff resource constraints	CF13 Inability to accommodate utilities in SCDOT's ROW for relocations	CF14 Delays in ROW acquisition by SCDOT	CF15 Inability or lack of information to avoid utility conflicts by the design team	CF16 Relocations held up for clearing and grubbing
S19	Pay for all utility relocations subject to schedule compliance**	x	x		x	x											
S1	Engage utility owners very early in the project and maintain frequent communication		x						x	x	x					x	
S2	Have a service contract for pre-letting clearing and grubbing work																x
S3	Impose liquidated damages or penalize in other ways to make the utilities more accountable to SCDOT's needs	x	x														
S4	Provide sufficient time for utilities to plan and relocate	x			x			x									
S5	Promote use of adequate SUE investigations								x								
S6	Target obtaining utility location data prior to 30% design completion								x							x	
S7	Train SCDOT personnel to better handle utility conflict management			x		x			x				x		x		
S8	Better coordinate ROW acquisition with utilities seeking private easements				x									x			
S9	Avoid late design/ROW changes		x														
S10	Extend utility coordination into the construction phase and have external consultants do inspection to ensure relocations are accurately completed	x		x		x		x					x				
S11	Eliminate the sunset clause in the Senate Bill 401 that enables reimbursements for wet utility relocations																
S12	Expedite completion of ROW plans and acquiring ROW						x			x					x		
S13	SCDOT should acquire ROW to accommodate utility relocations				x						x			x			
S14	Compensate utilities for avoidable rework arising from SCDOT's changed project needs		x				x			x							

Figure 25. *Mapping of Perceived Effective Strategies to Critical Delay Factors*

Below we discuss how the strategies relate to the delay factors and critical obstacles in the utility processes. The numerical bullet points highlight the issues (critical factors) where are the roman numbered bullet points highlight potential solutions. While these bullet points don't necessarily directly correspond to the critical factors and strategies outlined in Tables 21 and 22, they from the basis for the mapping presented in Figures 24 and 25.

1. Utility owners do not necessarily know the location of all their assets, potentially leading to conflicting identification issues and unexpected issues later in the construction phase
    i. When unsure, complete utility investigations, especially for projects with high delay consequences
    ii. Target securing utility location information prior to 30% design completion
2. Inadequate engagement of utilities prior to completion of ROW plans due to their prior experiences of having to rework their relocation designs or schedule issues due to late changes to transportation project design and schedule
    i. Try to avoid late changes to transportation project design
    ii. Establish that SCDOT recognizes the burden late transportation project changes have on utilities, and effectively communicate a vision of early engagement and partnering with utility owners to minimize conflicts and relocation impacts. Be willing to compensate for any avoidable rework if the utilities are not at fault, especially smaller utilities that may need to spend a considerable amount of money on relocation design compared to their annual operating budget. Be consistent in communicating schedule delays from the SCDOT side which may benefit utility owners by providing additional time for them to complete their work
    iii. Early engagement of utilities could lead to conflict avoidance or "negotiated savings" for the utility where it could pay for less expensive design changes than having to relocate their lines
    iv. Local/regional relationships between the SCDOT and utility personnel have proven to be effective in earning each other's trust which would lead to accountability. Cultivate such relationships across the districts and demonstrate the vision of partnering with utility owners for a win-win outcome. *Agency-level meetings regularly scheduled (e.g., monthly, to discuss long-range projects, policies, incentives, etc.), ** Project-level meetings regularly scheduled, *** Personnel-level meetings on as-need basis
    v. Streamline communication between utility coordinators and design teams
3. Delays in ROW acquisition for transportation project construction (sometimes past letting) may leave little time for utilities to relocate as planned
    i. SCDOT needs to prioritize completion of ROW plans and early acquisition of the ROW
    ii. Explore earlier relocation opportunities
4. Inability to acquire ROW for utility relocations because of current state statutes
    i. Consider amending the legal statutes to allow SCDOT to acquire additional ROWs to accommodate relocating utilities, especially those with prior rights

5. Lack of leverage for SCDOT to get the utilities to meet its needs in a timely manner
    i. Consider making the language in the encroachment permit stronger to make the utilities feel more accountable for meeting SCDOT's needs. Consider potential penalties for schedule/cost overruns. Have a mechanism for imposing liquidated damages on utility companies that fail to meet agreed upon utility relocation dates. Cite examples from other states where this is the case
6. Determining prior rights can be a slow process causing delays
    i. Detailed right-of-way plans, when used with information provided by utility owners, provide information about property rights
7. Many utility relocations are non-reimbursable making it harder for the utility owners to prioritize SCDOT needs
    i. The sunset clause of Senate Bill 401 needs to be eliminated and opportunities for compensating for non-wet utility relocations need to be actively explored for projects with high consequences for delays
8. ROW acquisition and utility easement acquisition may not be coordinated, causing delays as the utilities may need to wait until the SCDOT has acquired their ROW
    i. It may be helpful if the SCDOT would acquire ROW for utility relocations given the utilities pay for it; at the very least the acquisition process could be better coordinated
9. ROW certification and utility certification need to be coordinated so that ROW changes won't affect utility relocation plans
    i. Utility coordinators should engage with the ROW office to track the progress of ROW acquisition to identify potential ROW changes
10. Staff resource constraints and institutional knowledge transfer and training programs for junior staff
    i. Make training available to junior designers on being conflict-aware and establish a mechanism to transfer institutional knowledge
11. No accurate inspection performed to verify that utilities are indeed installed (through encroachment) or relocated to the locations approved by the SCDOT
    a. An incorrect relocation could delay and cause cost overruns for other relocating utilities and lead to future conflict detection
        i. Determine who should bear the inspection cost and effort—the SCDOT directly or through a consultant
        ii. Utility coordination needs to be extended into the construction phase
12. Utility relocations need clearing and grubbing completed by the general contractor, both of which need to be coordinated
    i. Pre-letting clearing and grubbing by a separate contractor has proven to be helpful; utility windows in the project schedule are also intended to address this issue
13. Design and as-built utility plans submitted to the SCDOT are not necessarily utilized for conflict identification in the early design phase

i. Consider maintaining a centralized repository of submitted design and as-built plans from encroaching/relocating utilities for future reference to support design. Accurate as-built plans would be immensely helpful for future utility conflict minimization and resolution
ii. Explore getting GIS data from some gas and wet utilities to support transportation project design; it should be noted that non-disclosure agreements between some utility owners and the SCDOT were previously developed which may be revived with the support of SCDOT's GIS division

14. It is possible to have a new utility line installed by encroachment to be in conflict with a planned transportation construction project whose utility relocation certification is completed but the utility is not yet relocated
    i. SCDOT and the encroaching utilities both need to be aware of planned construction projects to avoid new installations that may come in conflict when the planned relocations are undertaken. This may need to be made a requirement as part of the encroaching permit requesting process

6.3. Project Recommendations

The following general recommendations are presented to the SCDOT for consideration to improve utility coordination processes with a focus on minimizing overall transportation project delays. Some of these recommendations might have financial, legal, and/or procedural challenges affecting their adoption and implementation. However, our intent is to suggest strategies that would likely yield benefits in terms of efficient transportation project delivery. The type of implications and/or requirements--financial (F), legal (L), and procedural (P)—are indicated in parentheses for each recommendation.

1. Engage utility owners early in the project and maintain frequent communication (P). Promote strong and trustworthy working relationships among the SCDOT/external utility coordinators/design firms and utility owners to avoid potential conflicts and explore less expensive project design changes to avoid relocating utilities. These meetings can generally be organized at three hierarchical levels:
    d. Agency-level meetings regularly scheduled, for example monthly, to consistently discuss long-range projects, policies, incentives, and other pertinent topics; A specific suggestion for an agenda item at these meetings is to make a reference to the interactive project map on SCDOT's website for checking upcoming construction projects
    e. Project-level meetings regularly scheduled
    f. Personnel-level meetings on as-needed basis
2. Modify the encroachment permit language to suggest that potential liquidated damages would be assessed in a reasonable way if relocations for utilities without prior rights were to delay the transportation project. For example, MassDOT, Washington DOT, TxDOT, NCDOT have mechanisms for penalizing utilities that are non-compliant. GADOT also uses language suggesting the utility will be liable for any costs associated with its failure to remove or relocate upon due notice. Some languages references/suggestions are included in Appendix-D ***(L).***

    a. It should, however, be noted that this recommendation may not be as effective as it may seem. For example, documentation to prove that utilities have caused project delays in order to claim liquidated damages may be difficult to obtain in practice. Thus, the intent is that the suggestion of this threat may itself motivate utilities to be more responsive to SCDOT's needs.
3. Provide sufficient time for utilities to plan and relocate and improve the requirements of the utility relocation schedule to make them robust with sufficient detail so that they can be better integrated with the construction project schedule ***(P).***
    a. It should, however, be noted that there might be valid reasons that need to be reasonably accommodated for utilities to adhere to windows for relocations; for example, hurricanes and other extreme weather events may impact the availability of their human resources to attend to SCDOT's needs.
4. Promote use of adequate utility investigations including below and above ground facilities in accordance with ASCE 38-22 Standard ***(P, F)***
5. Train SCDOT personnel to better handle utility conflict management ***(P, F)***
6. Better coordinate ROW acquisition with utilities seeking private easements ***(P).***
7. Try to avoid late design changes; when unavoidable, effectively communicate these changes with relevant utility owners and compensate utility owners for design and relocation rework **(P, L, F)**
8. Extend utility coordination into the construction phase to reduce the burden on the SCDOT staff, and maintain continuity in utility coordination from the design to the construction phases, preferably with the same coordinator ***(P, F)***
9. Have construction engineering and inspection (CEI) consultants be responsible for inspection and as-built documentation of utility relocations in accordance with ASCE 75-22 Standard ***(P, F)***
10. Explore the possibility of acquiring ROWs for utility relocations outside SCDOT's ROW, at least for utilities with prior rights ***(L, P, F).*** The state of practice in this regard varies across the country, with several states being able to acquire replacement ROWs for utility relocations whether they choose to do so or not, while others not able to. Many states acquire more ROW for transportation purposes to accommodate utilities that need to be relocated. Some states explicitly mention utilities as inclusive with transportation purposes
11. Streamline communication between utility coordinators and the design team ***(P).*** Utility location data effectively relayed to the design team in the early design phase can help prevent major utility conflicts; consider having design teams interface with utility coordinators regularly
12. Explore early utility relocation opportunities ***(P)***
13. Encourage utility coordinators to engage with the ROW office to track progress of ROW acquisition to identify early both utility property interests and situations that are going to affect utility relocation schedules; for example, utility coordinators may need to know of condemnations which would be time-consuming ***(P)***
14. Have an on-call service contract for pre-letting clearing and grubbing work so that it can be decoupled from the transportation project contract to make this option more readily available ***(P, L, F).*** However, utility relocations may still be delayed despite having this service contract if ROW acquisition is delayed. Therefore, this recommendation will likely be effective only when ROW acquisition is completed early enough for an on-call clearing and grubbing contractor to prepare the site for utility relocations.

15. Consider the feasibility of continuing to reimburse wet utilities for schedule-compliant relocations beyond the current senate bill time limit; additionally, explore opportunities for non-reimbursable relocations to become part of the transportation contract, subject to an advance funding agreement mechanism ***(L, F)***
    a. Success story of in-contract relocations for Carolina Crossroads-3 design build project noted where even telecom and gas utility owners agreed to go in-contract for their relocations; the SCDOT acquired ROW (possibly due to fewer parcels that needed to be acquired) in the pre-letting phase of this project which will hopefully eliminate many delays for the design build contractor; the SCDOT also conducted a QLB and in some instances a QLA SUE for this project in the pre-letting phase
16. The SCDOT and the encroaching utilities by permit both need to be aware of planned construction projects to avoid new installations that may conflict when these planned relocations are undertaken ***(P)***
    a. Include a step in the permitting process to verify if the proposed installation is in conflict with a planned project or relocatable utilities
    b. The SCDOT may consider charging utilities for review and inspection to ensure the encroaching utilities are installed correctly as per the submitted plans
17. Explore the possibility of requiring right-of-way certification completed prior (~2 months) to utility certification ***(P)***

6.4. Implementation Plan

As cautioned earlier, not all these recommendations can be readily implemented because of financial and/or legal implications. The procedural recommendations--R1, R3, R4, R6, R11, R12, R13, R16, and R17--would be the easiest as they do not require amendments approved by the state legislature nor financial planning by the SCDOT. Recommendations focused on the strategies seen in the top left quadrant of Figure 25 would be most impactful as they are perceived to be more effective than others and can address the most critical delay factors. For example, Recommendation R1, which is related to Strategy S1, is a procedural strategy that is already being implemented by the SCDOT to a certain degree, but it could be more uniformly and systematically implemented state-wide. Similarly, implementation of Recommendation R3 related to Strategy S4 in the top left quadrant in Figure 25 would also be impactful. Furthermore, recommendations needing legal statutory changes--for example, R2, R7, R10 and R15--may deserve consideration because several have been successfully implemented by other states.

Finally, the project team presented the findings of this study along with the proposed recommendations as part of a training workshop delivered to SCDOT personnel and few consultants at the end of the research project period. Additionally, co-PI Dr. Cesar Quiroga offered a two-part training at the same workshop. The first segment of the training focused on the framework for managing the utility process whereas the second segment focused on strategies to manage utility conflicts. The workshop was well received with great interaction with the speakers.

References

1. FHWA. (2002). Avoiding Utility Relocations.

2. Ellis, R. D., & Lee, S. H. (2005). Developing Best Practices for Avoiding Utility Relocation Delays. Construction Research Congress 2005: Broadening Perspectives - Proceedings of the Congress, 1–9. https://doi.org/10.1061/40754(183)100

3. El-Rayes, K., Liu, L. Y., El-Gohary, N., Golparvar-Fard, M., & Ignacio, E.-J. (2017). Best Management Practices and Incentives to Expedite Utility Relocation: Final Report. Illinois Center for Transportation. https://doi.org/10.21949/1503647

4. USGAO. (1999). Impacts of Utility Relocations on Highway and Bridge Projects.

5. Gwinn, S. W. (2006). Factors that delay active construction projects and potential solutions. https://dc.statelibrary.sc.gov/handle/10827/6419

6. Jaselskis, E. J., Jhala, A., Banerjee, S., Potts, C., Alsharef, A. F., Alainieh, O. K., & Gaharwar, S. S. (2021). Communicate lessons, exchange advice, record (clear) database development (No. FHWA/NC/2019-15). North Carolina State University. Research and Development Unit. Available at: https://connect.ncdot.gov/projects/Value-Management/CLEAR-Program/Documents/RP2019-15%20NCDOT%20CLEAR%20Final%20Interim%20Report%20v1.pdf. Accessed: 08/09/2022.
7. GAO, *Transportation Infrastructure: Impacts of Utility Relocations on Highway and Bridge Projects.* U.S. General Accounting Office, Washington, D.C., GAO/RCED-99-131, 1999. Available at: https://www.gao.gov/assets/rced-99-131.pdf. Accessed: 04/05/2022.
8. American Association of State and Highway Transportation Officials, *Right of Way and Utilities Guidelines and Best Practices.* U. S. Department of Transportation, Federal Highway Administration, 2004.
9. Federal Highway Administration, *Avoiding Utility Relocations.* U.S. Department of Transportation, Washington D.C., 2002. Available at: https://www.dot.ga.gov/partnersmart/utilities/documents/avoidingutlrelocations.pdf. Accessed: 08/09/2022.
10. Hedemann , S.M. "Duration Quantification and Opportunities for Improvement in the Texas Department of Transportation's Utility Relocation Process." M.S. Thesis, Department of Civil, Architectural and Environmental Engineerinstg, The University of Texas at Austin, Austin, TX, 2006.
11. O'Connor, J. T., Caldas, C. H., Chou, C. C., Stroka, A., & Goldman, G. K. (2007). Effectiveness of the combined transportation and utility construction strategy (No. FHWA/TX-07/0-4997-1). Available at: http://www.utexas.edu/research/ctr/pdf_reports/0_4997_1.pdf. Accessed: April 21, 2022.
12. *National Utility Review: Utility Coordination Process.* Office of Infrastructure, Federal Highway Administration, FHWA-HIF-18-039, June 2018. Available at: https://www.fhwa.dot.gov/utilities/hif18039.pdf. Accessed: 04/05/2022.
13. Quiroga, C., Kraus, E., Scott, P., Swafford, T., Meis, P., & Monday, G. (2012). Identification of utility conflicts and solutions (No. SHRP 2 Report S2-R15B-RW-1). Available at: https://nap.nationalacademies.org/catalog/22819/identification-of-utility-conflicts-and-solutions. Accessed: 08/09/2022.
14. Vilventhan, A., & Kalidindi, S. N. (2016). Interrelationships of factors causing delays in the relocation of utilities: A cognitive mapping approach. Engineering, construction and architectural management, 23(3), 349-368, doi: https://doi.org/10.1108/ECAM-10-2014-0127.

15. Thomas, H. R., & Ellis, R. D. (2001). Avoiding delays during the construction phase of highway projects (No. NCHRP Project 20-24, Task 12). Available at: https://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-24(12)_FR.pdf. Accessed: 04/05/2022.
16. Ellis, R. D., and Thomas, H. R.(2003). "The Root Cause of Delays in Highway Construction." presented at the Transportation Research Board 2003 Annual Meeting, Washington D.C., January 2003. Available at: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.472.785&rep=rep1&type=pdf#:~:text=It%20is%20no%20coincidence%20that,engineering%20and%20construction%20(3).
17. Gwinn, S.W., 2006. Factors that delay active construction projects and potential solutions. South Carolina State Documents Depository. Available at: https://dc.statelibrary.sc.gov/bitstream/handle/10827/6419/CPM_Factors_that_Delay_Active_2006-2-1.pdf?sequence=1&isAllowed=y. Accessed: 04/05/2022.
18. National Highway Institute. *Preparing and Communicating Effective Utility Relocation Requirements.* National Highway Institute, Federal Highway Administration, Course FHWA-NHI-134117, 2022. Available at: https://www.nhi.fhwa.dot.gov/course-search?tab=0&key=134117&sf=0&course_no=134117. Accessed: 04/05/2022.
19. Quiroga, C., Naranjo, J. and Campbell, J., 2023. Acquiring Utility Property Interests and Reimbursing Utility Relocation Costs: A Guide. NCHRP Research Report, (NCHRP Project 11-08).
20. Quiroga, C., Naranjo, J., Kraus, E. and Campbell, J., 2023. Acquisition of Utility Property Interests and Compensation Practices for Utility Relocations (No. NCHRP Project 11-08).
21. Transportation Research Board. "NCHRP 15-69 Utility Conflict Impacts During Highway Construction." The National Academies of Sciences, Engineering, and Medicine. https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4758 (Accessed 01/20/2024).
22. Massachusetts General Laws. 2024. Chapter 6C, Section 44. Functional replacement of real property in public ownership; relocation of utility or utility facility.
23. Texas Public Laws. 2024. Chapter 203, Section 094. Transportation Code Section.
24. Quiroga, C., Li, Y., Kraus, E., & Le, J. (2013). Optimizing utility owner participation in the project development and delivery process (No. FHWA/TX-13/0-6624-1). Texas. Dept. of Transportation. Research and Technology Implementation Office..
25. TxDOT, *ROW Utilities Manual.* Texas Department of Transportation, Austin, TX, Manual 2020. Available at: http://onlinemanuals.txdot.gov/txdotmanuals/utl/utl.pdf. Accessed: 08/09/2022.
26. Chou, C. C., Caldas, C. H., O'Connor, J. T., Sroka, A. W., & Goldman, G. K. (2009). Identification of decision drivers for the strategy of incorporating utility relocations into highway construction contracts. Journal of construction engineering and management, 135(9), 812-818. [Online]. Available: https://ascelibrary.org/doi/abs/10.1061/(ASCE)0733-9364(2009)135:9(812).
27. Goldman, G. K. (2005). Combined transportation and utility construction: analysis of approach (Doctoral dissertation).
28. O'Connor, J. T. , Caldas, C. H. , Goldman, G., and Chou, C. C. (2005) *Combined Transportation and Utility Construction: Analysis of Approach.* in "TxDOT Research Project 0-4997 Product, vol. 1.
29. (21) Zembillas, N. M., & Beyer, B. J. (2004). Proactive utilities management: Conflict analysis and subsurface utility engineering. In Pipeline Engineering and Construction: What's on the Horizon? (pp. 1-6).
30. North, B. (2001). "Utility Managers' Meeting," Proceeding of the 2001 AASHTO/FHWA Right of Way and Utilities Conference.
31. New York State Department of Transformation, *Highway Design Manual.* 2015. Available at: https://www.dot.ny.gov/divisions/engineering/design/dqab/hdm/hdm-repository/hdm13.pdf. Accessed: 07/31/2022.

32. Georgia Department of Transportation, *Utility Accommodation Policy and Standards.* 2016. Available at: https://www.dot.ga.gov/PartnerSmart/utilities/Documents/2016_UAM.pdf. Accessed: 07/29/2022.
33. Michigan Department of Transportation, *Road Design Manual.* 2018. Available at: https://mdotjboss.state.mi.us/stdplan/getStandardPlanDocument.htm?docGuid=13221f1c-1e2b-4f2b-a059-eb722ec2055f. Accessed: 07/31/2022.
34. Department of Transportation, *Utility Relocations from Public Highway Right-of-Way Under TCA § 55-5-804.* 2007. Available at: https://www.tn.gov/content/dam/tn/tdot/right-of-way-division/CH86Policy.pdf. Accessed: 07/31/2022.
35. Quiroga, C. (2019). "How the Six Pillars of Utility Engineering Can Improve Project Delivery." in *98th Annual Meeting, Transportation Research Board*, Washington D.C.
36. Quiroga, C. A. (2020). "Six Pillars of Utility Engineering." in *106th Purdue Road School*, West Lafayetta, Purdue University.
37. Quiroga , C., McCleve, J., Lee, R., Kraus, E., Anspach, J., Sturgill, R., Sturgill, N., Johnston, J., and Cooper, J. (2010). "Strategic Research Needs in the Area of Utilities." *Centennial Papers,* pp. 1-16, [Online]. Available: https://onlinepubs.trb.org/onlinepubs/centennial/papers/AFB70-Final.pdf.
38. Ellis, Jr, R. D., & Lee, S. H. (2005). Developing best practices for avoiding utility relocation delays. In Construction Research Congress 2005: Broadening Perspectives (pp. 1-9)., doi: https://doi.org/10.1061/40754(183)100. 08/09/2022.
39. El-Rayes, K., Liu, L., El-Gohary, N., Golparvar-Fard, M., & Ignacio, E. J. (2017). Best Management Practices and Incentives to Expedite Utility Relocation. FHWA-ICT-17-013. Available at: https://www.ideals.illinois.edu/bitstream/handle/2142/96662/FHWA-ICT-17-013.pdf?sequence=2. Accessed: 04/05/2022.
40. *Improving Coordination with Utilities (R01A, R01B, R15B).* in "SHRP2 Solutions," American Association of State Highway and Transportation Officials,, 2019. Available at: http://shrp2.transportation.org/Pages/UtilityRelatedProducts.aspx. Accessed: 09/21/2021.
41. Quiroga, C., Kraus, E., & Le, J. (2010). Strategies and Recommendations for Integrating Utility and Environmental Processes at TxDOT: Workshop Materials (No. Product 0-6065-P1).
42. Campbell, J., Solomon, G., Fawver, G., Lorello, R., Mathis, D., Quiroga, C., Rhinehart, B., Ward, B., Zaharewicz, J. and Zembillas, N. (2009). Streamlining and integrating right-of-way and utility processes with planning, environmental, and design processes in Australia and Canada (No. FHWA-PL-09-011). United States. Federal Highway Administration. Office of International Programs..
43. Transportation Research Board. "NCHRP Synthesis 20-05/Topic 53-04 [Active (Synthesis)] Practices for the Collection, Use, and Management of Utility As-Built Information." The National Academies of Sciences, Engineering, and Medicine. https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=5109 (Accessed 04/22/2022.
44. ASCE, "Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data." 2002: American Society of Civil Engineers.
45. Sterling, R., Anspach, J., Allouche, E., Simicevic, J., Rogers, C, Weston, K. E., and Hayes, K. (2009). "Encouraging Innovation in Locating and Characterizing Underground Utilities." *SHRP2 Transportation Research Board, USA*.
46. Dolatabad, S. A., Doree, A. G., olde Scholtenhuis, L. L., & Vahdatikhaki, F. (2017). Review of Detection and Monitoring Systems for Buried High Pressure Pipelines.
47. Jeong, H. S., Abraham, D. M., & Lew, J. J. (2004). Evaluation of an emerging market in subsurface utility engineering. Journal of construction engineering and management, 130(2), 225-234, doi: 10.1061/(asce)0733-9364(2004)130:2(225).
48. Sinha , S. K., Thomas , H. R., Wang , M., and Jung , Y. J. (2007). *Subsurface Utility Engineering Manual.* Pennsylvania Transportation Institute, Pennsylvania Department of Transportation,

Harrisburg, Pennsylvania, August 20, 2007. Available at: https://www.dot.state.pa.us/public/Bureaus/design/UTILITYS%20SHARED/PTI%202008-02%20Final%20Report%2024Oct07_s.pdf. Accessed.
49. Pennsylvania Department of Transportation, *Design Manual Part 5. Utility Relocation.* Pennsylvania Department of Transportation, Harrisburg, Pennsylvania, Manual 2019. Available at: http://www.dot.state.pa.us/public/pubsforms/Publications/PUB%2016M/PUB%2016M.pdf. Accessed: 04/22/2022.
50. Georgia Department of Transportation, *SUE Utility Impact Rating Form.* Georgia Department of Transportation, Atlanta, Georgia, 2008. Available at: https://view.officeapps.live.com/op/view.aspx?src=http%3a%2f%2fwww.dot.ga.gov%2fPartnerSmart%2futilities%2fDocuments%2fGDOTSUE_Project%2520UtilityImpactRatingForm_09-17-08.doc&msclkid=d9608b94ae6111ecbedef8027d5b1fc4. Accessed: 04/22/2022.
51. Georgia Department of Transportation, *Georgia Department of Transportation SUE Request Form.* Georgia Department of Transportation, Atlanta, Georgia, 2008. Available at: https://view.officeapps.live.com/op/view.aspx?src=http%3a%2f%2fwww.dot.ga.gov%2fpartnersmart%2futilities%2fdocuments%2fgdotsue_projectrequestform_09-17-08.doc&msclkid=50383f44ae6811eca7d2c9f44df3f492. Accessed: 04/22/2022.
52. Georgia Department of Transportation, *Utility Accommodation Policy and Standards Manual.* Georgia Department of Transportation, Atlanta, Georgia, 2018. Available at: https://www.dot.ga.gov/PartnerSmart/utilities/Documents/2016_UAM.pdf. Accessed: 04/22/2022.
53. Georgia Department of Transportation. "GDOT Conflict Matrix " Georgia Department of Transportation. http://www.dot.ga.gov/PartnerSmart/utilities/Pages/Details.aspx?categoryID=15 (Accessed March 28, 2022, 2022).
54. Georgia Department of Transportation, *SUE Deliverable Checklists.* Georgia Department of Transportation, Atlanta, Georgia, 2021. Available at: http://www.dot.ga.gov/PartnerSmart/utilities/Documents/GDOT%20SUE%20Deliverable%20Checklists.zip. Accessed: 04/22/2022.
55. Washington State Department of Transportation, *Utilities Manual.* Washington State Department of Transportation, Olympia, Washington, 2019. Available at: https://www.wsdot.wa.gov/publications/manuals/fulltext/M22-87/Utilities.pdf. Accessed: 04/22/2022.
56. California Department of Transportation, *Project Development Procedures Manual.* California Department of Transportation, Sacramento, California. Available at: https://dot.ca.gov/programs/design/manual-project-development-procedures-manual-pdpm. Accessed: 04/22/2022.
57. Quiroga, C., Anspach, J., Scott, P., & Kraus, E. (2018). Feasibility of mapping and marking underground utilities by state transportation departments (No. FHWA-HRT-16-019). United States. Federal Highway Administration. Available at: https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/16019/16019.pdf. Accessed: April 22, 2022.
58. Michigan Department of Transportation, *Geospatial Utility Infrastructure Data Exchange Procedural Manual.* Michigan Department of Transportation, Lansing, Michigan, 2019. Available at: https://www.michigan.gov/documents/mdot/GUIDE_Manual_660384_7.pdf. Accessed: 04/22/2022.
59. Federal Highway Administration. "State Transportation Innovation Councils." Federal Highway Administration. https://www.fhwa.dot.gov/innovation/stic/ (Accessed 04/22/2022.

60. Sterling, R., Allouche, E., Anspach, J., Matthews, J., Berchmans, J., & Simicevic, J. (2011). Development of the Selection Assistant for Utility Locating Technologies (No. SHRP 2 Report S2-R01-RW-2).
61. Quiroga, C., Tsapakis, I., Overman, J., Anderson, S., Harrison, L., Souder, A., Adkins, A., Cooney, R., Neblett, R. and Anderson, W.B. (2014). *Strategies to Optimize Real Property Acquisition, Relocation Assistance, and Property Management Practices.* T. N. A. Press, Washington D.C., Report 771, Available at: http://www.trb.org/Publications/Blurbs/171624.aspx. Accessed.
62. Chang, R. L.. (2005). "Durations for Acquiring Roadway Right of Way and Assorted Expediting Strategies." M. S. Thesis, Department of Civil, Architectural and Environmental Engineering, The University of Texas at Austin, Austin, TX.
63. *Utility Relocation and Accommodation on Federal-Aid Highway Projects.* Federal Highway Administration, Program Guide 2003. Available at: https://www.fhwa.dot.gov/reports/utilguid/if03014.pdf. Accessed: 08/09/2022.
64. Alabama Department of Transportation, *Permit Manual.* July 2022. Available at: https://www.dot.state.al.us/publications/Maintenance/pdf/Permits/PermitManual.pdf. Accessed: 07/29/2022.
65. California Department of Transportation, *Encroachment Permit Application Guide.* 2018. Available at: https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/encroachment-permits/ep-application-guide-booklet-a11y.pdf. Accessed: 07/29/2022.
66. Florida Department of Transportation, *Utility Accommodation Manual.* 2017. Available at: https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/programmanagement/programmanagement/utilities/docs/uam/uam2017.pdf?sfvrsn=d97fd3dd_0. Accessed: 07/29/2022.
67. Georgia Department of Transportation, *Installation, Relocation, and Management of Utilities on Public Rights-of-Way.* 2022, vol. Chapter 672-11. Available at: http://www.dot.ga.gov/PartnerSmart/Documents/BoardRules/GDOTRulesRegardingTheInstallationRelocationandManagementofUtilities_6-8-21.pdf. Accessed: 07/29/2022.

68. Quiroga, C., Kraus, E., and Li , Y. Recommendations for the Future of the UIR System. Texas Department of Transportation, Austin TX, Report 409119-4-08

69. Texas Administrative Code. 2024. Chapter 21, Section 21.37. Right of way: Utility Accomodation.
70. American Society of Civil Engineers. (2022). Standard Guideline for Investigating and Documenting Existing Utilities. American Society of Civil Engineers. https://doi.org/10.1061/9780784415870

Appendixes

Appendix-A: Questionnaire and survey instrument for engagement of SCDOT personnel

Appendix-B: Survey instrument used for surveying other state DOTs

Appendix-C: Survey instrument used for surveying in-state utility owners

Appendix-D: Language and other references from other states

Appendix A: Questionnaire for SCDOT Personnel

Introduction & Purpose

Utility-related issues are a significant cause of delays in transportation construction projects. Most projects have conflicts with existing utilities, and many of these conflicts are resolved by relocating utilities. However, issues while identifying and resolving utility conflicts can result in impacts such as delays and additional costs. The goal of the research project is to recommend best practices for minimizing impacts due to utility delays.

The purpose of this scheduled preliminary focus group is to gather fundamental information on: (a) the roles and responsibilities of different SCDOT personnel in utility conflict resolution; (b) the typical timeline of utility conflict resolution processes during the project development cycle; (c) the identification of the most critical issues causing delays; (d) the potential resolutions to the identified issues; and (e) the variation in design-bid-build and design-build projects when it comes to utility confliction resolution. There would be follow-up interviews with more specific questions.

Part-1: Few Questions to Facilitate an Interactive Discussion

1. How would you characterize the major types of transportation projects SCDOT manages?
2. How does SCDOT decide which project delivery method to use for a given type/size/location of a project?
3. How would you describe the current utility conflict management (UCM) processes at SCDOT from your perspective?
4. How does the UCM process vary from DBB to DB?
5. What exactly is your role in the utility conflict management process? Which all departments do you coordinate with?
6. Describe the process to identify and resolve utility conflicts at the district.
7. Based on your experiences, what are the most critical factors affecting utility conflict management to result in project delays? What suggestions would you offer to address these critical factors?
8. In general, how responsive are the utility companies in the whole UCM process? What suggestions would you offer to improve their responsiveness?
9. How would utilities going in contract with the general contractor improve UCM process? Which type of utilities do you think would entertain going in contract? At what cost/incentives?
10. Are there any regulations/policies at SCDOT that hinder the UCM process or work counter-productively?
11. Do you have any documents that would be helpful to this research?
12. What are your comments on the following flowcharts depicting the UCM process at SCDOT?

This follow-up survey is being conducted to quantitatively assess the criticality of various factors previously identified to be causing transportation project delays resulting from utility conflict management. A few strategies identified from the literature and other state DOTs are also being assessed for their perceived effectiveness in SC. Completion of this survey would approximately take 15 minutes. You may reach out to Dr. Kalyan Piratla at kpiratl@clemson.edu with questions or clarifications. We would greatly appreciate your time and valuable insights on this important research study.

Part-2: Assessment of Critical Factors Causing Project Delays

Based on your experience, ***how strongly do you agree that each of the following factors related to the stated project phase is significant in causing overall transportation project delay*** *resulting from utility conflict management?*

For each of the following factors, select one of the following scales: "Strongly disagree," "Disagree," "Neutral," "Agree," or "Strongly Agree"

Planning and preliminary design (~<30% design) phase

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
SCDOT staff resource constraints	○	○	○	○	○
Non-responsiveness or delayed cooperation of utilities	○	○	○	○	○
Prior rights determination	○	○	○	○	○
Lack of SUE data or accurate utility location records	○	○	○	○	○
Inability or lack of information to avoid utility conflicts by the design team	○	○	○	○	○
Lack of an external utility coordinator	○	○	○	○	○
Lack of communication between the design team and the utility coordinator	○	○	○	○	○
Other (name your own)	○	○	○	○	○
Other (name your own)	○	○	○	○	○

Final design (~30-100% design) phase

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
SCDOT staff resource constraints	○	○	○	○	○
Non-responsiveness or delayed cooperation of utilities in relocation planning	○	○	○	○	○
SCDOT project ROW change after utility certification is underway	○	○	○	○	○
Late design changes leading to additional utility conflicts	○	○	○	○	○
Delays in ROW acquisition by SCDOT	○	○	○	○	○
Inability to accommodate utility relocations within SCDOT's ROW	○	○	○	○	○
Delays in easement acquisition by the utility owners for relocation	○	○	○	○	○
Dealing with utilities having prior rights needing relocation	○	○	○	○	○
Other (name your own)	○	○	○	○	○
Other (name your own)	○	○	○	○	○

Construction phase

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
SCDOT staff resource constraints	○	○	○	○	○
Non-responsiveness or delayed cooperation of utilities in relocation	○	○	○	○	○
Dealing with unknown/unresolved utility conflicts during construction	○	○	○	○	○
Unreliable relocation schedules and/or non-adherence to utility windows in the schedule	○	○	○	○	○
Insufficient time for utility relocations	○	○	○	○	○
Utility relocations held up for clearing and grubbing	○	○	○	○	○
Inter-dependencies among utility relocations	○	○	○	○	○
Location inaccuracies in utility relocations	○	○	○	○	○
Material, labor, or equipment shortages due to market conditions	○	○	○	○	○
Evaluating reimbursable relocations for compliance	○	○	○	○	○
Inaccurate or unsatisfactory in-contract utility relocations	○	○	○	○	○
Other (name your own)	○	○	○	○	○
Other (name your own)	○	○	○	○	○

Part-3: Perceived Effectiveness of Strategies

Based on your assessment, ***how strongly do you agree that each of the following strategies will be significant for SCDOT in minimizing overall transportation project delay*** *resulting from utility conflict management? For the sake of answering this question, assume these strategies are legally permissible.*

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Pay utility owners for accurate location information as would SCDOT pay SUE consultants for the same	○	○	○	○	○
Engage utility owners very early in the project and maintain frequent communication	○	○	○	○	○
Target obtaining utility location data prior to 30% design completion	○	○	○	○	○
Eliminate the sunset clause in the Senate Bill 401 that enables reimbursements for wet utility relocations	○	○	○	○	○
Avoid late design/ROW changes	○	○	○	○	○
Compensate utilities for avoidable rework arising from SCDOT's changed project needs	○	○	○	○	○
Provide sufficient time for utilities to plan and relocate	○	○	○	○	○
Train SCDOT personnel to better handle utility conflict management	○	○	○	○	○
Extend utility coordination into the construction phase and have external consultants do inspection to ensure relocations are accurately completed	○	○	○	○	○
Have a service contract for pre-letting clearing and grubbing work	○	○	○	○	○

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
SCDOT should acquire ROW to accommodate utility relocations	○	○	○	○	○
Develop cost-sharing or other incentives for non-reimbursable relocations by small utilities	○	○	○	○	○
Promote use of adequate SUE investigations	○	○	○	○	○
Have the utilities pay for less expensive design changes than relocations	○	○	○	○	○
Impose liquidated damages or penalize in other ways to make the utilities more accountable to SCDOT's needs	○	○	○	○	○
Expedite completion of ROW plans and acquiring ROW	○	○	○	○	○
Better coordinate ROW acquisition with utilities seeking private easements	○	○	○	○	○
Other (name your own)	○	○	○	○	○
Other (name your own)	○	○	○	○	○

Appendix B: Out-of-State Survey Instrument

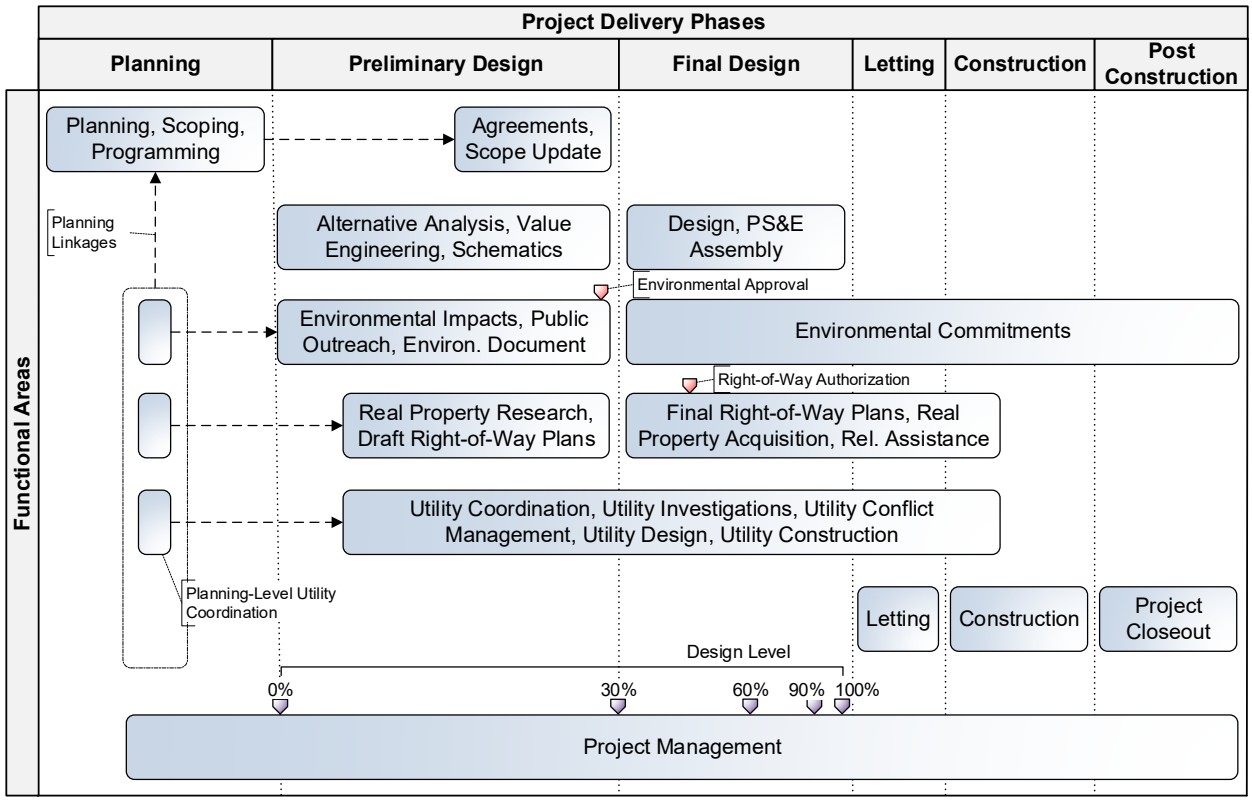
SCDOT SPR 756: Impact of Utility Delays on Project Delivery Survey Questionnaire

As part of the South Carolina Department of Transportation (SCDOT) Project SPR-756 (Impact of Utility Delays on Project Delivery), Clemson University and the Texas A&M Transportation Institute (TTI) are conducting a nationwide survey to obtain information about utility relocations in the highway contract.

Your participation is critical.
Completing the survey is voluntary and appreciated. To proceed, go to <insert survey link here>. The anticipated time to complete the survey is 15-20 minutes. To discontinue at any point during the survey, simply close your browser. The final report will only include aggregated results. All records will remain private, and no respondent names will be included in the report. The survey asks for some basic point of contact information so we can follow up, but only the Principal Investigator and research study personnel will access this information.
The survey webpage will remain open until June 30, 2022. Thank you in advance for your participation. In addition, please forward this invitation to others who might be interested in completing the survey. For additional information, please contact Kalyan Piratla (Liles Associate Professor, Glenn Department of Civil Engineering at Clemson University and Principal Investigator for this project) at kpiratl@clemson.edu.

Part 1 – Basic Information

1.1 Contact information:
First Name: _____
Last Name: _____
Title: _____
Office, Division, or Bureau: _____
Organization: _____
Email Address: _____
Phone Number: _____
1.2 What level is your office, division, or bureau within your organization:
○ Headquarters
○ District or region
○ Local
○ Other
1.2.1 If other, please specify: _____
1.3 **Figure 26** [Figure 26 below] shows a generic depiction of the highway project delivery process assuming a design-bid-build project delivery method. In what phases are you normally involved? **Select all that apply**. Note: If you are also involved in design-build projects, make sure to select the Design and construction box.
□ Planning (typically up to preparation of project scope)
□ Preliminary design (typically up to 30% PS&E)
□ Detailed design (typically 30–100% PS&E)
□ Construction (typically letting, construction, and project closeout)
□ Design and construction (for design-build projects)



Courtesy of the Texas A&M Transportation Institute

Figure 26. Highway Project Delivery Process (Design-Bid-Build Project Delivery Method)

Part 2 – Utility Relocations Included in the Highway Contract

This section includes questions about utility relocations that are included in the highway construction contract (also called in-contract, joint-bid, or combined highway-utility construction).

2.1 Select the type(s) of utility service which you would allow to go in the highway construction contract. [Select all that apply]

□ Water supply
□ Wastewater
□ Stormwater
□ Electric
□ Communications
□ Oil and gas
□ Other, please specify: _____

----------PAGE BREAK----------

[The following questions are repeated according to the number of utility services selected above. If no utility services are selected, the survey will skip to question 3.1]

{utility type} Facilities

2.2 What percentage of {utility type} utility relocations on highway projects are included in the highway construction contract?

[Use sliding bar going from 0% to 100%] {If the answer to question 2.4 is 0% then the survey skips to Part 3}

2.3Compared to {utility type} utility relocations that are handled directly by the utility owner, how strongly do you agree with the following statements regarding the benefits of in-contract relocations (1 = strongly disagree; 5 strongly agree)?

Benefit	Unsure	1	2	3	4	5
More effective utility coordination with the State DOT	○	○	○	○	○	○
Fewer utility relocation delays	○	○	○	○	○	○
Less difficulty obtaining relevant permits	○	○	○	○	○	○
Fewer utility facility strikes during construction	○	○	○	○	○	○
Lower utility relocation costs	○	○	○	○	○	○
Less paperwork to get utility relocation agreements executed	○	○	○	○	○	○
Less time and effort developing and getting approval for the utility relocation design	○	○	○	○	○	○
Less stringent requirements for including utility design plans, schedule, and cost estimate in the highway bid package	○	○	○	○	○	○

2.4 Please provide a list of benefits other than those mentioned in Question 2.3 when utility relocation is included in the highway contract.

_____
_____

2.5 Please provide a list of benefits when utility relocation is handled by utility owners.

_____
_____

----------PAGE BREAK----------

2.6 What are the risks associated with {a utility type} utility relocation going in the highway construction contract?

_____
_____

2.7 Across multiple projects, how satisfied are you overall with including {utility type} utility relocations in the highway contract (1 = very unsatisfied; 2 = unsatisfied; 3 = neutral; 4 = satisfied; 5 = very satisfied)?
[Use sliding bar going from “very unsatisfied” to “very satisfied”]

2.8 What is the process to decide if {a utility type} utility relocation is included in the highway construction contract?

_____
_____

2.9 Please provide references to state laws, regulations or manuals describing in-contract utility relocations.

_____
_____

----------PAGE BREAK----------

Part 3 – Sample contract language related to utility relocation work

The following questions refer to special provisions that are effective in reducing utility relocation delays. Please provide examples of special provisions in the following categories:

Utility relocations handled by utility owners:

3.1 Special provisions in utility relocation agreements that are effective in reducing utility relocation delays.

_____
_____

3.2 Special provisions in highway construction contracts that are effective in reducing utility relocation delays.

_____
_____

Utility relocations included in the highway contract:

3.3 Special provisions in utility relocation agreements that are effective in reducing utility relocation delays.

_____
_____

3.4 Special provisions in highway construction contracts that are effective in reducing utility relocation delays.

_____
_____

3.5 Please provide hyperlinks or references to the following documents: sample contracts, utility agreements, encroachment permits, and other documents related to the utility relocation process.

_____
_____

----------PAGE BREAK----------

Part 4 – Additional Information and Follow-Up

4.1 May we contact you or somebody else at your agency to further discuss utility-related issues?

○ Yes

○ No

4.2.1 If yes, please provide a point of contact to follow up (edit as needed):

First Name: _____

Last Name: _____

Title: _____

Division, Office, or Bureau: _____

Organization: _____

Email Address: _____

Phone Number: _____

Thank you for participating.

Appendix C: In-state Utility Survey Instrument

SCDOT SPR 756: Impact of Utility Delays on Project Delivery
In-state Survey Questionnaire – Utility Owners

As part of South Carolina Department of Transportation (SCDOT) Project SPR-756 (Impact of Utility Delays on Project Delivery), Clemson University and the Texas A&M Transportation Institute (TTI) are conducting a statewide survey to identify strategies leading to a more effective coordination with utility owners in South Carolina. **Your participation is critical**.

Completing the survey is voluntary and appreciated. To proceed, go to <insert survey link here>. The anticipated time to complete the survey is 10-15 minutes. To discontinue at any point during the survey, simply close your browser. The final report will only include aggregated results. All records will remain private, and no respondent names will be included in the report. The survey asks for some basic point of contact information so we can follow up, but only the Principal Investigator and research study personnel will access this information.

The survey webpage will remain open until June 30, 2022. Thank you in advance for your participation. In addition, please forward this invitation to others who might be interested in completing the survey.

For additional information, please contact Kalyan Piratla (Liles Associate Professor, Glenn Department of Civil Engineering at Clemson University and Principal Investigator for this project) at kpiratl@clemson.edu.

----------PAGE BREAK----------

Part 1 – Basic Information

1.1 Contact information:

First Name: _____
Last Name: _____
Title: _____
Office, Division, or Bureau: _____
Utility Company Name: _____
Email Address: _____
Phone Number: _____

----------PAGE BREAK----------

1.2 What level is your office, division, or bureau within your organization:

○ Headquarters
○ District or region
○ Local

○ Other.

1.2.1 If other, please specify: _____

1.3 Select the type(s) of utility service your organization provides in South Carolina.

○ Water supply
○ Wastewater
○ Stormwater
○ Electric transmission
○ Electric distribution
○ Communications (transmission)
○ Communications (distribution)
○ Oil and gas (transmission)
○ Oil and gas (distribution)
○ Other

1.3.1 If other, please specify: _____

1.4 What role(s) do you normally play within your organization while interacting with SCDOT on highway projects? Note: Select the roles closest to what you do, regardless of the title you have at your organization. **Select all that apply**.

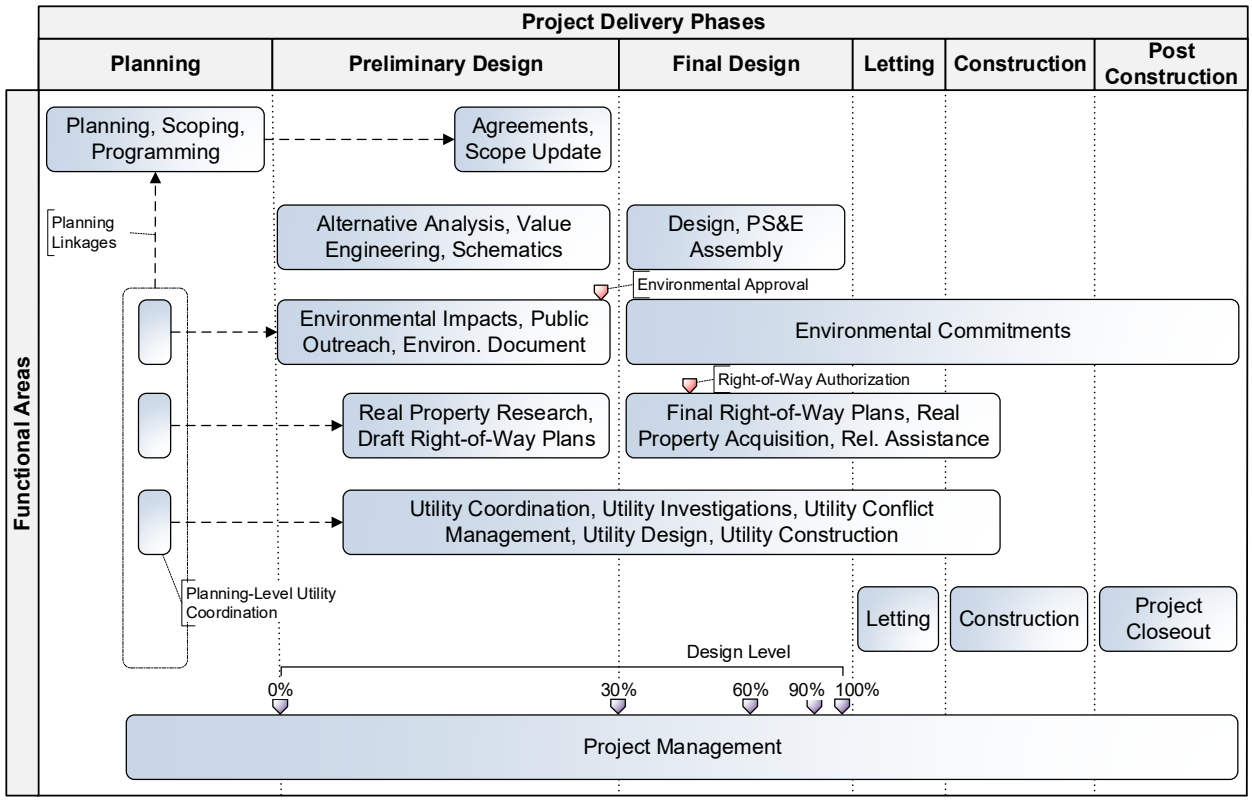
□ Utility coordinator
□ Utility designer
□ Utility consultant
□ Utility contractor
□ Utility inspector
□ Subsurface utility engineering (SUE) investigations
□ Other

1.4.1 If other, please specify: _____

----------PAGE BREAK----------

1.5 **Figure 26** [Figure 27 below] shows a generic depiction of the highway project delivery process assuming a design-bid-build project delivery method. In what phases are you normally involved? **Select all that apply**. Note: If you are also involved in design-build projects, make sure to select the Design and construction box.

□ Planning (typically up to preparation of SCDOT project scope)
□ Preliminary design (typically up to 30% SCDOT project design)
□ Detailed design (typically 30–100% SCDOT project design)
□ Construction (typically SCDOT project letting, construction, and project closeout)
□ Design and construction (for design-build projects)



Courtesy of the Texas A&M Transportation Institute

Figure 27. Highway Project Delivery Process (Design-Bid-Build Project Delivery Method).

----------PAGE BREAK----------

Part 2 – Potential Incentives for Utility Providers to Go In-Contract

This section includes questions about utility relocations that are included in the highway construction contract (also called in-contract, joint-bid, or combined highway-utility construction).

2.1 How familiar are you with S.C. Code § 57-5-880 (added by Senate Bill 401 in 2019)?

[Use sliding bar going from 0% to 100%]

2.2 How familiar are you with the SCDOT Utility Accommodation Policy?

[Use sliding bar going from 0% to 100%]

2.3 Select the type(s) of utility service for which you would like to provide feedback.

□ Water supply
□ Wastewater
□ Stormwater
□ Electric
□ Communications
□ Oil and gas

□ Other

----------PAGE BREAK----------

[The following questions are repeated according to the number of utility services selected above.]

{utility type} Facilities

2.4 What percentage of your {utility type} utility relocations on SCDOT projects are in-contract?

[Use sliding bar going from 0% to 100%] {If the answer to question 2.4 is 0% then the survey skips to question 2.11.}

2.5 Prior to the enactment of SB 401 in 2019, what percentage of {utility type} utility relocations on SCDOT highway projects were typically in-contract?

[Use sliding bar going from 0% to 100%]

2.6 Compared to {utility type} utility relocations that your company handles directly, how strongly do you agree with the following statements regarding the benefits of in-contract relocations (1 = strongly disagree; 5 strongly agree)?

Benefit	Unsure	1	2	3	4	5
More effective utility coordination with SCDOT	○	○	○	○	○	○
Fewer utility relocation delays	○	○	○	○	○	○
Less difficulty obtaining relevant permits	○	○	○	○	○	○
Fewer utility facility strikes during construction	○	○	○	○	○	○
Lower utility relocation costs	○	○	○	○	○	○
Less paperwork to get utility relocation agreements executed	○	○	○	○	○	○
Less time and effort developing and getting approval for the utility relocation design	○	○	○	○	○	○
Less stringent requirements for including utility design plans, schedule, and cost estimate in the highway bid package	○	○	○	○	○	○

----------PAGE BREAK----------

2.7 Please provide a list of benefits other than those mentioned in Question 2.6 when utility relocation is included in the highway contract.

_____
_____

2.8 Please provide a list of benefits when utility relocation is handled by utility owners.

_____
_____

2.9 Please provide a list of risks when utility relocation is included in the highway contract?

_____
_____

2.10 Based on your overall experience across multiple projects, please rate how positive your experience has been with the in-contract process (1 = very unsatisfied; 2 = unsatisfied; 3 = neutral; 4 = satisfied; 5 = very satisfied).

[Use sliding bar going from “very unsatisfied” to “very satisfied”]

----------PAGE BREAK----------

2.11 What strategies or incentives would you recommend SCDOT to implement, which would motivate utility owners to go in-contract for their utility relocations?

Idea 1:

_____
_____

Idea 2:

_____
_____

Idea 3:

_____
_____

----------PAGE BREAK----------

Part 3 – Strategies to Overcome Reasons for Delay in Utility Relocations

3.1 What are the risks associated with utility relocation delays during project delivery process?

Risk 1:

_____
_____

Risk 2:

_____
_____

Risk 3:

_____
_____

3.2 What strategies would you recommend SCDOT to implement to reduce or eliminate delays in utility relocations?

Strategy 1:
_____
_____

Strategy 2:
_____
_____

Strategy 3:
_____
_____

----------PAGE BREAK----------

Part 4 – Strategies to Engage Utility Owners During Project Delivery

4.1 What strategies would you recommend SCDOT to engage utility owners more effectively?

Strategy 1:
_____
_____

Strategy 2:
_____
_____

Strategy 3:
_____
_____

----------PAGE BREAK----------

Part 5 – Additional Information and Follow-Up

5.1 May we contact you or somebody else at your organization to further discuss utility-related issues?

○ Yes
○ No

5.1.1 If yes, please provide a point of contact to follow up (edit as needed):

First Name: _____
Last Name: _____
Title: _____
Division, Office, or Bureau: _____
Organization: _____

Email Address: _____

Phone Number: _____

Thank you for participating.

Appendix D: Language and other references from other states

In-Contract

"The Utility Construction Request is a request by a utility for NCDOT to include the construction of the utility relocation in NCDOT's highway contract. The Utility Construction Request should specify whether NCDOT will be responsible for managing the design of the relocation, or if the utility will provide plans for inclusion in the contract. Plans provided by the utility must conform to NCDOT standards." NCDOT

Reimbursement Of Betterments

"Utility facility betterments are not reimbursable. Examples of betterments are relocating aerial facilities to underground facilities and increasing facility capacity." – MassDOT

"A cost estimate is the most probable cost to relocate certain utility facilities. The estimate will include the cost to replace the facilities and provide the same level of service which existed prior to the undertaking of the project, as well as any costs for utility betterment on the project, as applicable. The UC will use a detailed cost estimate to prepare the reimbursable utility agreement. Additional guidance regarding cost estimates appears in 23 CFR 645.117 and the FHWA's Program Guide: Utility Relocation and Accommodation on Federal Aid Highway Projects." - Indiana DOT

"Reimbursements are made by the Department to the Utility for completed work on reimbursable projects. The Utility may request a single payment after completion of the project or may request partial payments at intervals of not less than 30 days, beginning 30 or more days after formal notification of Agreement approval from the Department, and after engineering, or relocation, has begun." - Alabama DOT

Incentives/Disincentives (Liquidated Damages)

"Cash bonuses: Monetary bonuses paid directly to utility companies or contractors for on-time or accelerated utility relocations. 2. Incentives/Disincentives (I/D): A contract structure that compensates the contractor for each day that identified milestones are completed ahead of schedule and assesses a deduction for each day the contractor overruns. 3. Cost-sharing: The first type of cost-sharing requires a utility company to pay a specified share of any additional cost over an agreed upon target price. The second type assigns the majority of utility-relocation costs not covered by federal funding to the utility company. 4. No-excuse incentives: A monetary bonus awarded to the utility company/contractor if milestone tasks are achieved by specified contract dates, regardless of any delays normally granted on construction projects. 5. Contractor-provided financial incentives: An agreement that places full responsibility for all utility relocations on the contractor instead of the state DOT. The contractor coordinates utility issues and provides incentives to utility companies for early completion. 6. Gainshare–painshare: A cooperative contractual relationship where all parties share benefits and risks." - Illinois DOT

"Upon notification in writing by the Department or it's Contractors that the Utility is liable for damages or delay costs, the Utility shall have 45 days from receipt of such letter to either pay the amount of the damages or delay costs to the Department or its Contractors or to request mediation. (See Section 2.8.D of this Manual and the Rules of the State Department of Transportation - Board Rule 672-19.)" - Georgia DOT

"The Utility shall have 45 calendar days from receipt of such letter to either pay the amount of the damages or delay costs to the Department or its Contractor or request a Petition for Mediation Board Hearing as prescribed in O.C.G.A. § 32-6-171 and GDOT Board Rule 672-19. To request a Petition for Mediation the Utility shall submit the Uniform Petition for Mediation form (see GDOT's Utilities webpages) and any associated information to each Party involved in the dispute in accordance with GDOT Board Rule 672-19-.06 Mediation Board Procedures" - Georgia DOT

"For incentive-based Force Account Agreements that entitle the utility owner to 50% (or other partial amount) reimbursement for relocation of their facilities, the District may authorize payment to the utility owner after all work is completed within the approved schedule. After the District determines that the utility owner has completed the work within the noted duration and in compliance with the Force Account Agreement, the District shall forward a memo to the MassDOT Utilities Engineer with a recommendation for payment of 50% (or other percentage as included in the Agreement) of the actual total costs incurred. The Utilities Engineer is responsible for executing an agreement amendment between MassDOT and the utility owner for the actual reimbursement costs. • The District shall retain full determination authority on whether a utility owner has met their schedule and for the percentage to be reimbursed, if any. • Special consideration for delays caused by events such as major storms will be taken into consideration on a case-by-case basis but may not be an excuse for not meeting the time duration submitted. • The District reserves the right to reject any time duration estimate submitted that is deemed excessive and unsubstantiated." - Mass DOT

"The utility company is not authorized to perform additional work until a completed TC 69-4 form, Utility/Rail Agreement Change Order, and justifying documentation have been reviewed, processed, and approved by the following authorities: Ø Utility supervisor (US), if the amount of the change order is $25,000 or less Ø US and Central Office Utilities and Rail Branch, if the change order amount exceeds $25,000 Upon written approval by the Transportation Cabinet (Cabinet), the utility company is authorized to proceed with the additional work. Failure of the company to obtain such written approval from the Cabinet prior to proceeding with the additional work specified in the change order may jeopardize compensation of costs." - Kentucky Transportation Cabinet

If the Utility fails to submit to the Department the aforementioned information submittal by the deadline, the Department may no longer be required to reimburse the costs of removal, relocation, or adjustment required to accommodate the said project. Upon failure to meet the given deadline, the Utility will be notified by written notice by the District Utilities Engineer. After the District Utilities Engineer reviews a project's schedule, written correspondence shall be sent to the affected Utilities on each project along with a deadline for the Utility to submit the

required information to the Department. The deadline shall be no less than 30 days and no more than 120 days; and the deadline should be set based on the complexity of the project and the amount of review the Utility has to perform. - Georgia DOT

Prior rights

If relocation is likely, URR will send an authorization letter to the utility company to begin its preliminary engineering relocation design and request prior rights documents. If the utility company has prior rights, URR will start the agreement process to pay for the relocation. URR will notify the utility company to relocate at its own expense if the utility company does not have prior rights. - Arizona DOT

Permits

Sample encroachment agreement - NCDOT

That the installation, operation, and maintenance of the above described facility will be accomplished in accordance with the party of the first part's latest UTILITIES ACCOMMODATIONS MANUAL, and such revisions and amendments thereto as may be in effect at the date of this agreement. Information as to these policies and procedures may be obtained from the Division Engineer or State Utilities Manager of the party of the first part.

That the said party of the second part binds and obligates himself to install and maintain the encroaching facility in such safe and proper condition that it will not interfere with or endanger travel upon said highway, nor obstruct nor interfere with the proper maintenance thereof, to reimburse the party of the first part for the cost incurred for any repairs or maintenance to its roadways and structures necessary due to the installation and existence of the facilities of the party of the second part, and if at any time the party of the first part shall require the removal of or changes in the location of the said facilities, that the said party of the second part binds himself, his successors and assigns, to promptly remove or alter the said facilities, in order to conform to the said requirement, without any cost to the party of the first part.

That the party of the second part agrees to provide during construction and any subsequent maintenance proper signs, signal lights, flagmen and other warning devices for the protection of traffic in conformance with the latest Manual on Uniform Traffic Control Devices for Streets and Highways and Amendments or Supplements thereto. Information as to the above rules and regulations may be obtained from the Division Engineer of the party of the first part.

That the party of the second part hereby agrees to indemnify and save harmless the party of the first part from all damages and claims for damage that may arise by reason of the installation and maintenance of this encroachment.

That the party of the second part agrees to restore all areas disturbed during installation and maintenance to the satisfaction of the Division Engineer of the party of the first part. The party of the second part agrees to exercise every reasonable precaution during construction and maintenance to prevent eroding of soil; silting or pollution of rivers, streams, lakes, reservoirs, other water impoundments, ground surfaces or other property; or pollution of the air. There shall be compliance with applicable rules and regulations of the North Carolina Division of Environmental Management, North Carolina Sedimentation Control Commission, and with ordinances and regulations of various counties, municipalities and other official agencies relating to pollution prevention and control. When any installation or maintenance operation disturbs the ground surface and existing ground cover, the party of the second part agrees to remove and replace the sod or otherwise reestablish the grass cover to meet the satisfaction of the Division Engineer of the party of the first part.

That the party of the second part agrees to assume the actual cost of any inspection of the work considered to be necessary by the Division Engineer of the party of the first part.

That the party of the second part agrees to have available at the construction site, at all times during construction, a copy of this agreement showing evidence of approval by the party of the first part. The party of the first part reserves the right to stop all work unless evidence of approval can be shown.

Provided the work contained in this agreement is being performed on a completed highway open to traffic; the party of the second part agrees to give written notice to the Division Engineer of the party of the first part when all work contained herein has been completed. Unless specifically requested by the party of the first part, written notice of completion of work on highway projects under construction will not be required.

That in the case of noncompliance with the terms of this agreement by the party of the second part, the party of the first part reserves the right to stop all work until the facility has been brought into compliance or removed from the right of way at no cost to the party of the first part.

That it is agreed by both parties that this agreement shall become void if actual construction of the work contemplated herein is not begun within one (1) year from the date of authorization by the party of the first part unless written waiver is secured by the party of the second part from the party of the first part.

During the performance of this contract, the second party, for itself, its assignees and successors in interest (hereinafter referred to as the "contractor"), agrees as follows:

a. Compliance with Regulations: The contractor shall comply with the Regulations relative to nondiscrimination in Federally-assisted programs of the U. S. Department of Transportation, Title 49, Code of Federal Regulations, Part 21, as they may be amended from time to time, (hereinafter referred to as the Regulations), which are herein incorporated by reference and made a part of this contract.

b. Nondiscrimination: The contractor, with regard to the work performed by it during the contract, shall not discriminate on the grounds of race, color, or national origin in the selection and retention of subcontractors, including procurements of materials

"Performance and indemnity bonds may be required from the applicant of an encroachment agreement for installations to be placed within the limits of highway rights-of-way. The purpose of such bonds is to indemnify NCDOT for any damages within the highway rights-of-way caused by the installation.
Bonds are accepted in the following forms:

- *Corporate surety bond*
- *Continuing indemnity bond*
- *Certified or cashier's check*

Bonds are eligible for a release a minimum of one year from the date of satisfactory completion of the work. A written request for bond release must be submitted to NCDOT with the following encroachment information included

- *Name of encroachment Applicant (second party on the agreement)*
- *Description of the work*
- *State road number(s) of road(s) on which work was performed*
- *County where work was performed*
- *NCDOT encroachment number*
- *Date that work was satisfactorily completed" – NCDOT*

Encroachment agreement sample – Town, NYDOT

1. Applicant is responsible for any and all expenditures of labor or materials required for the planning, installation, erection, repair, maintenance and removal if ordered by the Board of Commissioners of the Town, of the above-referenced Encroachments.

2. Applicant is to be fully responsible for any and all property damage or injury or death of any person which results from any and all negligence, omission, defect in design, maintenance, or workmanship created by the Applicant, its agents or contractors relating to the Encroachment, or any cause of action arising out of the installation, erection, repair, maintenance, location or removal of said Encroachment.

3. Applicant agrees to and does hereby hold the Town, its officers, board members, and employees harmless from any and all liability arising out of such negligence, omission, defect, or other cause of action; that it will defend the Town, its officers, board members, and employees, and pay all attorney fees in any and all actions brought as a result of such; and that it will indemnify the Town, its officers, board members, and employees against any and all loss sustained by reasons of such negligence, omission, defect, or other cause of action arising out of the installation, erection, repair, maintenance, location or removal of said Encroachments.

4. All notices required herein shall be deemed given by depositing such in the United States mail, first class, and addressed to:

To Town: Town of Wake Forest Public Works Department
234 Friendship Chapel Road
Wake Forest, NC 27587

To Applicant:

_____
_____

5. In the event there is a dispute between the parties concerning the interpretation of the terms of this Agreement or their respective rights and obligations hereunder, such dispute or controversy shall be adjudged pursuant to the laws of the State of North Carolina, without regard to its choice of law provisions, and venue for any action related hereto shall be Wake County Superior Court or the United States District Court for the Eastern District of North Carolina, Western Division.

"Application for utility encroachment permits shall be made utilizing GUPS to the Department's District Utilities Engineer having supervisory responsibility for the area in which the facilities are to be installed." - Georgia DOT

"Utilities are required to give advance notice and obtain approval from the District Office for any new pipeline or anticipated change to the current design or operation of a pipeline. The permit application shall specify the applicable codes to be used. Construction permits for pipelines shall specify the class of materials being carried, transmittant, the maximum working, test, or design pressures, and the design standards for the carrier." - Delaware DOT

"The Utility shall notify the Area Engineer prior to beginning any construction activities, when work will be suspended and prior to resuming work if construction activities are not continuous. Failure to notify the Area Engineer will jeopardize payment on reimbursable work since any work performed without notification and cannot be verified may be cited and deducted from a progress or final bill. The Area Engineer will notify the State Utilities Engineer and the District Utilities Engineer of beginning and ending dates of work by the Utility. Also, failure to properly locate facilities in reference to alignment and grade for the project as established by the Department may result in having to move facilities a second time at the Utility's expense." - North Dakota DOT

"The Utility must obtain all permits and easements necessary for relocation work that occurs prior to TDOT construction. This will include obtaining all environmental construction permits or the submittal of the Environmental Agreement (Form 2011-20) if less than one (1) acre is being disturbed. The Utility is responsible for staking the ROW and should include an item for survey in their cost estimate, as well as for clearing and grubbing since these activities will occur prior to the State contractor occupying the project." - TDOT

"A Utility Construction Permit is required any time utility construction work (including excavations or openings) will disturb anything on the roadway or State right-of-way. The permit is necessary each time a facility is upgraded or rebuilt, or an installation is added (excluding services)." – Delaware DOT

Dispute/Claim Resolution

"If CDOT and Owner fail to resolve a Dispute in accordance with Article 19(b), either Party may proceed to court in accordance with C.R.S §24-4-106. The venue for all disputes shall be in state District Court for the City and County of Denver, Colorado except, if applicable for condemnation or inverse condemnation claims, which will be filed in the State District Court for the County where the real property at issue is located and may pursue any remedies that may be available to it at law or in equity." - Colorado DOT

"The Utility's proposal to cure the utility delay is not satisfactory for the completion of the project on schedule, and the Utility may be liable for damages or delay costs. The utility delay cost/damage claim dispute shall be resolved through payment or Mediation as prescribed in O.C.G.A. § 32- 6-171 and GDOT Board Rule 672-19. The Department or its Contractor shall notify the Utility in writing (by certified mail or statutory overnight delivery, return receipt

requested) that the utility is liable for such damages or delay costs. Such written correspondence shall only be sent after the Utility has completed the related utility facility relocation or adjustment work to which the damage claim is based upon and within 30 calendar days after the project contract time expires, including any project contract time extension(s) granted by the Department. Further, this letter shall also detail the claim for damages and itemize the associated costs respectively." - Georgia DOT

Schedule/Plan/Deadlines

"Work Plan: A set of documents that consists of, but is not limited to, the Utility relocation plans, cost estimates, and the GUPS Permit including the Utility Adjustment Schedule to be submitted by each utility facility owner who has facilities that are required to be relocated or adjusted to accommodate the said project construction." - Georgia DOT

"The utility owner, furnishing dates of its planned activities, prepares the work schedule. The schedule should take into consideration the schedules for various phases of the transportation project including, the expected dates for approved right of way plans, completion of right of way and easement acquisition, project advertisement, award of the transportation contract, and commencement of project construction. The utility owner is to pursue completion of the work at the earliest possible date in order to minimize interference with the transportation project construction. Planning by the utility owner should be coordinated with the transportation project schedules and be as realistic as possible." - Virginia DOT

"General - During an emergency situation, the Utility should protect the public safety by making necessary repairs to the existing facilities complying, as much as is practical, with the requirements of this Manual. The Utility will assist the Department in restoring damaged or closed transportation facilities by expediting the engineering, scheduling, and other activities required to meet the accelerated construction deadlines and for the protection of existing facilities which may include relocations and/or adjustments, whether temporary or permanent. No advanced permit approval is required. However, notification is required and an Emergency Utility Permit shall be submitted utilizing GUPS within 5 business days after the onset of the emergency for any excavation or boring within the roadbed structure, or cutting of any paved surface, or the replacement of any poles. Upon notification of an emergency Let project(s), the Utility shall submit the required Work Plan as the accelerated schedule demands." - Georgia DOT

"New Utility Installations on Projects under Construction - It shall be the responsibility of the Utility to furnish a Utility Adjustment Schedule for making a new utility installation that is compatible with project construction when highway construction is underway. Written approval of such schedule by the Contractor shall be furnished to the Department's engineer having jurisdiction over the project prior to beginning work. Upon request the Department will assist in resolving any disputes over utility adjustment schedules or in arranging for emergency access to utility facilities within a project under construction." - Georgia DOT

"Utility Plan Development Submission Deadlines - In accordance with O.C.G.A. § 32-6-171, the Department is required to set deadlines for Utilities to comply with information submittals in

order for the Department to meet its project delivery schedule. It is the District Utilities Engineer's responsibility to review each project within their jurisdiction and provide the Utilities with a deadline for each deliverable needed in accordance with the Department's Plan Development Process (PDP) as well as the guidelines provided in this Manual." - Georgia DOT

"At least two working days prior but no more than 15 working days prior to commencing excavation, the contractor shall contact ARIZONA 811, between the hours of 6:00 a.m. and 5:00 p.m., Monday through Friday, excluding holidays, for information relative to the location of buried utilities." - Arizona DOT

"If necessary, a coordination meeting will be scheduled with affected utility companies to review the Utility Statements and sequencing bar chart. Utility companies shall modify their Utility Statements based upon the coordination meeting. Final Utility Statements from the utility companies are to be submitted to DelDOT within 30 days of the meeting so that a revised DelDOT Utility Statement can be prepared." - Delaware DOT

"The proposed relocation plan, and their proposed Utility Statement to the Utilities Engineer within thirty (30) days of receipt unless a coordination meeting is requested. If a coordination meeting is scheduled, the plans should be returned within two weeks of the meeting. In either case, a later date may be agreed upon by the project manager and the utility representatives. The Utilities Engineer will verify any proposed reimbursable work." - Delaware DOT

"The utility company shall return the proposed work plan on one set of plans provided by the Department within 30 days of receipt. If a site meeting is held, the plans will be returned within two weeks of the meeting. In either case, a later date may be agreed upon by the project manager and the utility representatives." - Delaware DOT

"The Utility shall have 45 calendar days from receipt of such letter to either pay the amount of the damages or delay costs to the Department or its Contractor or request a Petition for Mediation Board Hearing as prescribed in O.C.G.A. § 32-6-171 and GDOT Board Rule 672-19. To request a Petition for Mediation the Utility shall submit the Uniform Petition for Mediation form (see GDOT's Utilities webpages) and any associated information to each Party involved in the dispute in accordance with GDOT Board Rule 672-19-.06 Mediation Board Procedures." - Georgia DOT

"The following recommended information submittal deadlines are applicable for all "1st", "2nd" and "Revised Plan Submission" requests described above: • 30 days for resurfacing projects; minor maintenance projects (drainage, shoulder work, vegetation) • 60 days for intersection improvement projects (can vary based on number of intersections involved in the project); Intelligent Transportation Systems (ITS/ATMS) projects; Signal projects; enhancement type projects (sidewalks, bike paths, etc.); passing lane projects. • 90 days for reconstruction and rehabilitation projects such as urban highway widening; widening to 4 lane divided highways; bridge projects; interchanges • 120 days for mega projects (construction estimate over $100 million dollars)" - Georgia DOT

"The deadline is subject to change based upon the Department's project schedule. It is the District Utilities Engineer's responsibility to track a project's schedule and notify the affected utilities if the deadline dates have changed. " - Georgia DOT