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AVOIDING UTILITY RELOCATIONS

NOTICE

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PREFACE

This manual, *Avoiding Utility Relocations*, was prepared for the Federal Highway Administration (FHWA) in accordance with Research Development and Technology Transfer Order DTFH61-01-P-00237, pursuant to recommendations in 2000 by the AASHTO Highway Subcommittee on Right of Way and Utilities and by the AASHTO/FHWA European Scanning Team on Right of Way and Utilities.

The purpose of the work was to develop a manual that encouraged highway designers to avoid unnecessary utility relocations in the designs for which they are responsible. This was accomplished by identifying both the value of avoiding relocations on highway construction projects, and the technologies and techniques that can be used to achieve this goal.

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EXECUTIVE SUMMARY

Background

Conflicts between underground utilities and the alignment, grade, and drainage of new and expanding streets and highways are now all too frequent in this country. The environments of the urban and sub-urban underground are a complex web of utility lines including electric, telephone, cable TV, fiber optics, traffic signals, natural gas, water, sanitary and storm sewers, and it is nearly impossible for a road project to be free of conflict. The proliferation of underground facilities has reached the point where project budgets and schedules can no longer support the multiple unplanned and unnecessary relocations typical of highway projects.

From the utility's perspective, an unexpected request, or order, to move a facility means unscheduled work and unplanned expense. Even scheduled work on a highway project that is delayed due to a change in the DOT's program or project plan may mean that supplies purchased for that job can't be used, or equipment is mobilized to the wrong location. If a facility <u>must</u> be moved, it may mean service disruption, and even higher user costs as the expenses for relocation are passed through the system. In the worst cases, the unplanned work may lead to litigation between the agency and the utility, the utility and the contractor, or the contractor and the agency. Unplanned and unnecessary utility relocations must be avoided.

The problem is that highway designers have little motivation to avoid utility relocations under the typical design processes. Designers are usually rated on how fast they get the project designed, and efforts to "design around" existing utilities to avoid relocation often involve consideration of several alternatives, including cost estimation and comparison. This extra work extends the design time and increases the design budget. The same applies when an outside design consultant is used, as the additional time spent on design alternatives is clearly extra work, and it is often difficult for the consultant to negotiate design change orders. When the designer works only with where the utilities might be, or where they ought to be, the likelihood of encountering an undocumented facility during construction is much higher.

Needs

The information from practitioners points to a needed shift in the utility-related design process. Historically, utility information has been added to the highway plans at the 60% design stage for the sole purpose of determining where the conflicts will require relocation of utilities. At 60% design, there is little that can be done to ameliorate a conflict, short of a major plan revision. A major plan revision at this late stage could significantly delay the target bid date, and would therefore need to demonstrate significant project cost or construction schedule savings to be approved.

In the past, the utility relocation might have been the sole responsibility of the utility company. Depending on the terms under which they are located in the right of way, they would have been ordered to move, within a specific time frame that supported the construction schedule. They may have been given the option to use the contractor working on the government project, but the expense would be theirs. Recent changes in the practices related to reimbursement have shifted many of those costs from the utility to the federal funding available for the project. Funds diverted from programmed projects to utility relocations on other projects thus affect the entire workload and funding allocations for a DOT.

The alternatives that surfaced in this study center on identifying the potential conflicts early in the design process – at the 30% design stage, or sooner. At that stage, the creative solutions listed in the report are feasible, and can be accommodated in the design and construction work ahead. Utilities, while a tangible part of project cost and schedule, need not be a problem or a contributor to project cost overruns and delays.

To "design around" utilities, we must know where they are. The technology exists today to verify the presence of almost any type of buried utility, and to positively determine its location, size, and composition using non-destructive excavation methods. There are professional licensed engineers, geologists, and surveyors who have specialized in the use and interpretation of these technologies, known as Subsurface Utility Engineering (SUE). These specialized consultants accept the liability for the interpretation and subsequent reliance on the results of their investigations by highway designers and contractors. There is documentation to support project savings of $4.62 for every $1 spent on SUE. The FHWA advocates the use of SUE, as well as programs for effective and continued communication, coordination and cooperation among DOT planners and designers, and the utility owners and operators within their jurisdiction.

There is a nationwide need to change current practices. This manual was prepared to identify the practices that support the collection of accurate and complete subsurface utility information and promote effective communication and coordination between highway agencies and utilities in the planning, design, and construction phases of highway projects. FHWA hopes that this manual encourages transportation professionals to look for innovative planning, design, and construction methods that avoid or minimize utility relocations.

Research

Research for this manual included:

- A mail survey asking for current practices, policies, and strategies of State and municipal highway agencies (utility divisions), and private utility companies across the county.
- Review of State DOT's published utility accommodation policy and procedure manuals.
- Investigation into state-of-the-practice technologies for locating utility facilities.
- Review of related publications and internet information sponsored by the Federal Highway Administration (FHWA), the United States Department of Transportation (USDOT), the American Association of State Highway and Transportation Officials (AASHTO), and the American Public Works Association (APWA).
- Review of other related publications and internet information from the private sector.
- Informal telephone interviews with DOT and utility personnel and professional subsurface utility engineers and locators.

Key Findings

The key findings of this manual are:

- Conflicts between utility facilities, both above and below ground, and the alignment, geometry, grade, and drainage of new and expanding highways are all too frequent.

- Conflicts with utilities are a major cause of delays to highway contractors. The inability to accurately and comprehensively identify the locations of underground utilities, and the lack of adequate communication and coordination are measurable contributors to construction problems (cost overruns, delays, change orders, redesign costs, claims).

- It is imperative to identify potential utility conflicts early in the development of highway projects and to incorporate the most efficient and cost-effective accommodation possible into the highway design. Every effort must be made to “design around” as many utilities as possible.

- Subsurface Utility Engineering (SUE) is a proven, cost-effective engineering process for accurately identifying the quality of subsurface utility information needed for highway plans, and for acquiring and managing that level of information during the development of a highway project. The efficient use of SUE information allows designers to avoid utility relocations. The use of quality levels in the SUE process allows designers to certify on the plans that a certain level of accuracy and comprehensiveness has been provided.

- Good communication and cooperation between highway agencies and utilities are essential throughout the development and construction of highway projects. It has been typical in the past to design projects without consideration of the utilities, and then to relocate conflicting utilities. Consultation with utilities early in the developmental stages may result in minor plan changes to avoid them, or even major plan changes that subsequently avoid costly, time-consuming, and unnecessary relocations

Design Alternatives:
Following is a summary list of the design changes that have been used to avoid utility relocations as reported by the agencies responding to a mail survey by Nichols Consulting Engineers:

Geometric/Alignment Changes
1. Grade
2. Alignment
3. Widen one side of highway as opposed to other
4. Offset location of centerline for short distances
5. Move ramps

Drainage/Ditch/Culvert/Inlet/Curb Changes
1. Move storm drains
2. Low head storm pipe
3. Alternative type inlets
4. Alternative storm drain (oval, etc.)

5. Ditch culverts
6. Narrow ditch widths
7. Redesign ditches from flat bottom to “V” bottom
8. Adjust flow lines
9. Ditch grade changes
10. Use paved ditches
11. Change from ditch cross section to gutter
12. Adjust manhole locations
13. Extend storm pipe runs to avoid ditch cuts that impact utilities
14. Concrete slabs over utilities in ditch bottom
15. Revise or eliminate portions of the drainage design
16. Install closed drainage and curbing
17. Use rip-rap on ditches
18. Add curb and gutter
19. Alternative curb and gutter

Slope/Retaining Wall/Barrier Changes and Additions

1. Barriers
2. Guard rails instead of moving poles
3. Change backslope rate
4. Add retaining walls to the design to reduce slope encroachment
5. Remove slope rounding
6. Change retaining wall types
7. Impact attenuators on above ground appurtenances

Structure/Bridge/Footing Changes

1. Move bridge bents
2. Move bridge end that would conflict with pipeline
3. Alternative foundations
4. Move bridge ends
5. Structural box modifications
6. Structure footing redesign
7. Abutment modifications to allow bridge occupancy
8. Customized foundation design

9. Move bridge pilings
10. Change bridge type
11. Use protective casings
12. Pre-bore and batter pile driving to miss utilities

Conclusions

The message from this manual is that there are many opportunities to reduce and resolve the conflicts between highway construction and the utilities located nearby. The opportunities fall into two categories: system changes and operational changes.

To take advantage of a system change, the highway agency could look at:

- planning – When does the agency look for potential conflicts between proposed road work and existing and planned utilities?
- communication – What methods are in place to assure frequent and meaningful conversation and problem solving?
- design – When are utility locations added to the plans? Is information from SUE incorporated into the design process?
- construction – What innovation is permitted in the field?
- maintenance – How are ideas from maintenance staff incorporated into future designs?

To take advantage of operational changes:

- Is there a set of typicals that details “non-traditional” design choices?
- Are designers rewarded for avoiding a relocation?
- Do designers keep a “catalog” of design alternatives?
- Do all members of the agency understand the value of coordination among the stakeholders, and look for opportunities to prevent problems?

This manual provides ideas in each of these areas. We hope that it is an additional resource for highway agencies and utilities, supporting their mutual commitment to the continuous improvement of services to the traveling public.

SECTION I. INTRODUCTION

The transportation and utility networks of the United States cross all social, political, and geographical boundaries to link citizens to essential services. Although these networks are operated independently, owners share the common goals of serving the population in the most economical manner, providing improved services with the lowest financial and functional impacts. In pursuit of these goals, networks have evolved into common alignments in an effort to traverse the distance between users and suppliers in the most direct path.

Conflict occurs when network owners – State and municipal transportation departments and utility service providers – compete for limited space within existing alignments. Frequently, they construct, alter, repair, or replace facilities without regard to the impact to the others' facilities, operations, and budgets. Regardless of which network incurs the initial cost of resolving these conflicts, it is the taxpayer or the ratepayer, who are one and the same, who ultimately bears the financial burden.

Conflicts between the utility facilities, both above and below ground, and the alignment, geometry, grade, and drainage of new and expanding highways are now all too frequent. This chronic problem makes it imperative to identify potential conflicts, and incorporate the most efficient and cost-effective accommodation possible into the highway design.

This manual describes the problems common to highway designers and utility owners, the tools available to locate utilities, and the mitigation measures that have been implemented to avoid relocation. It describes successful processes being used in the planning, design, and construction phases of highway projects that support coordination and reduce conflict among owners. We hope that it encourages transportation professionals to look for innovative designs and construction methods that avoid or minimize a utility conflict.

SECTION II. HISTORICAL FRAMEWORK

II.1 USE OF RIGHT-OF-WAY FOR UTILITIES

Utility owners and operators (utilities) have been constructing, operating, and maintaining utility facilities within and adjacent to the public right-of-way (ROW) of streets and highways since the late 1800s. Beginning with the urban distribution of basic municipal facilities (water, sewer and power), technology and demand have evolved to include natural gas, communications, and cable television facilities as well, within almost every local street in the country. As growth expanded, and continues to expand, transmission of utility services between urban cities and towns, and to outlying rural areas now routinely involves utilities in the public ROW.

For the utility company, dealing with a single entity such as a municipality or State Department of Transportation (DOT) can be more efficient than dealing with a myriad of private property owners. Property rights (ROW or easement), frontage to service customers, and access for facility maintenance are coincidental with the street or highway, potentially reducing the utilities required project investment in both time and money. As savings realized by the utility may reduce the end cost to the customer, it is generally considered in the public's best interest to allow utilities to occupy right of way, and utilities have been given some level of ROW privilege in all states.

Utilities, whether occupying the ROW by permit, easement or other property right, are responsible for the operation and maintenance of their particular facilities and not the public road which they occupy (except for damage to the road caused by the utility). The governing agencies, having the responsibility to maintain the rights-of-way of streets and highways to preserve the integrity, operational safety, and function of the transportation facility, are thus charged with the regulation of the activities of utilities within the public ROW.

II.2 PROBLEMS

More than 90 percent of the highways currently in use in the United States were built prior to 1950 (Highway Utility Guide, FHWA, June 1993). Many of these roads have insufficient ROW for the expansion needed to satisfy the tremendous growth of traffic and the proliferation of basic and increasingly sophisticated utility services in this country. Connectivity through buried fiber optic cables is being viewed as a necessity to moving large files and amounts of data around the country. Each utility company has its own network and is laying cable to expand the network as fast as possible. The underground environment has become increasingly congested as more and more utilities compete for limited space within and adjacent to the ROW.

As demand for the finite space in existing ROW increases, the difficulty and cost of adding new utility facilities and relocating existing utility facilities also increases. Just as significant is how utility service interruptions may add to public discontent with overall highway construction. It is therefore essential for planners, designers, and builders of street and highway projects to avoid unnecessary utility relocations. The first step in this process is to recognize the problems facing highway agencies and utility owners in resolving utility conflicts and avoiding utility relocations.

II.2.1 Property Interest

The premise of utility relocation is that the utility bears the financial burden unless they have a legal property interest (fee title, easement, prescriptive right, long term lease) in the land their facilities occupy that is preemptive to the ROW interest of the highway. **Fee title** interest is when the utility actually owns the land, which is typically associated with utility service centers, base of operations, or plant generating stations. Along active and proposed highway corridors, the most common form of property interests are easements. **Easements** are typically located adjacent to existing ROW, or are within an area proposed for new ROW, and are granted to the utility by the property owner. Prescriptive rights and long term leases are the least common forms of property interest. When utility relocation is involved, the utility must normally provide the burden of proof to the agency regarding its property interest.

If a utility has a proven **property right**, then the agency must reimburse the utility for the cost of any relocation, or other accommodation required as a result of the road project. The utility would, however, be required to release their property interest to the State upon relocation. The State, since it would pay, puts a priority on avoiding relocation and acquiring additional ROW to accommodate the utility in order to keep its project costs down.

When the utility facilities occupy the ROW of existing streets and highways, it is usually under a **permit or franchise agreement** with the governing agency. This gives the State or municipality the power to force relocation, with the cost of relocation, including any private easement acquisition, borne by the utility. In this case, the agency, although cognizant of relocation impacts and costs, is not as concerned with avoidance strategies as they would be if reimbursing. Consequently, there is often a lack of project coordination between the agency and the affected utilities, resulting in unnecessary relocations or undiscovered conflicts, the burden of which, although generally placed on the utility, inevitably impacts the project cost and schedule. Just obtaining required easements on private property is a costly and time-consuming exercise for the utility. Even if the utility has the power of eminent domain, it is not as comprehensive as the State's. If the utility is not informed of the relocation early enough in the process, easement acquisition alone can cause delay and, when combined with the cost of the actual relocation, can have a significant financial impact to the utility and its customers.

In the case of permits or franchise agreements, the costs of relocations can be reimbursable, depending on the laws of the given State. According to the Code of Federal Regulations, title 23, Federal funds are available for all phases of utility relocation on Federal aid projects, regardless of the utilities' property interest. The State, however, must pay for the cost of relocation from its own funds and be the entity to be reimbursed with Federal funds. It is, therefore, up to the States to pass legislation to include utility relocation reimbursement for their highway projects.

II.2.2 Quality of Records

Probably the most frustrating problem the designer encounters is knowing that there are utilities in the area and not being able to locate them. Unless existing utilities are "positively located" (pot-holed), or "designated" by surface geophysical methods, the highway designer must rely on utility records and as-built plans to determine the location of existing utilities within the project corridor. The utility owners must also rely on these same records, both their own and those of other utilities and agencies, to provide the highway designer with the location of their facilities or to perform facility maintenance or expansion operations. There are many different types of records, both public and private, contained on as many different formats (paper, mylar, maps, books, electronic, etc.), containing diverse types of detail (location, depth, material, size, slope, etc.). The main difference among these records is quality. Combining data collected from various record sources usually results in all information being portrayed the same; at the lowest common denominator of quality. The lack of a common platform or shared database on which to collect, report, and disseminate records also makes the search for records time-consuming and often incomplete.

II.2.3 Readability of Plans Sent to Utilities

Wisconsin DOT, in a memorandum published in the "WisDOT Guide To Utility Coordination," reports receiving numerous complaints from utility companies that the plans that are being sent by the DOT are of poor quality and it is difficult for them to determine if their existing facilities are in conflict with the proposed construction. The main reason stated for this is the reduced plan size (11"x17") typical of most DOTs. If the utility locations are hard to read on the original large plan sheets, they are virtually impossible to see when the plans are reduced. Another reason stated was poor reproduction quality. Existing facilities which are screened do not show up well when the printed copy is lighter than it should be due to low toner or an improper setting.

Solutions to this problem include providing the utility with special plans that contain enhanced graphical resolution of existing utilities, providing the utility with large size plan sheets, and providing the utility with the electronic plan file.

II.2.4 Reliance on Institutional Memory

There is a crisis in the highway industry that will be difficult to solve. The institutional memory is being lost. Through reduced budgets and a general aging of the staff members in the agencies, the "old guard" is retiring. Over the past few decades, hiring freezes were imposed on agencies and these freezes, in conjunction with normal retirements, have created a void between the senior experienced people and the new entry-level personnel. There are no mid-level people who would be the heirs to valuable planning and design practices, which was in the memory of the senior individuals.

II.2.5 Communication and Coordination

Lack of effective communication and coordination between the agency (DOT or municipality), and utility owner/operators is a recognized problem. Every agency has some form of long-range transportation master plan based on the projected needs of future growth. Typically these master plans are distributed among government agencies and discussed at public meetings. Limited staffing makes it impossible for utility companies to attend all the public meetings for projects within their service territories. The utilities are not being routinely provided with master plans and meeting agendas so that they can determine which projects are most important and then allocate the necessary resources for attending the important meetings. Furthermore, poor advance planning can result in multiple relocations of the same facilities due to all phases of a highway expansion not being identified on the master plan.

Effective January 1980, the Florida Department of Transportation (FDOT) established a policy for adequate and effective liaison practices between the department and other entities such as local governments and utilities. In spite of the existence of this policy, a 1996 study by the State of Florida's Office of Program Policy and Government Accountability (Report 95-30), identified poor communication and coordination between FDOT staff and other entities as the second major factor contributing to FDOT construction project cost overruns and delays. About 30% of the study cases involved coordination problems with utilities, most often resulting in extra work to locate and move utility lines impacted by the projects. A 1998 follow-up report (Report 98-24) indicates that FDOT should continue improving its efforts to coordinate with third parties to identify existing utilities and incorporate design alternatives as plans are developed to minimize cost overruns and delays due to making design changes and unplanned utility relocations during construction.

Wisconsin has a State law that was enacted to prescribe minimum utility coordination requirements in order to prevent utility relocations from delaying highway projects [Sec. 84.063, Wis. Stats. Utility Facility relocations and related Administrative Rule Trans 220]. This law, among other things, requires the Wisconsin Department of Transportation (WisDOT) to provide utility companies with a notice of proposed highway improvements and preliminary plans as early in the development of highway projects as possible. Within a reasonable time, usually about 60 days, utilities are to respond to the notice and provide a description of facilities in the vicinity of the improvements, including specific reasons or needs for those facilities to remain in place or be relocated. After each utility responds to the notice, WisDOT must mail each utility at least one set of preliminary plans. These plans must show all existing utility facilities known to WisDOT in areas where they will conflict with the improvements. More details and other legislative requirements may be found under Trans 220 at: http://www.legis.state.wi.us/rsb/code/trans/trans.html.

FDOT and WisDOT are certainly not alone, and despite the lack of similar studies in other states there is enough personal experience in the state highway design departments and the construction and utility communities across the country to verify that poor communication and coordination is a measurable contributor to construction problems.

The FHWA has developed and distributed a video entitled *"CCC: Making the Effort Work!"* This 19-minute video is based on the research and recommendations contained in AASHTO Utility Guidelines and Best Practices. It is designed to inform highway agencies and utilities of actions they can take toward avoiding construction delays and reducing or eliminating unnecessary project costs, and to motivate them to work in partnership with each other toward this common goal. Information for obtaining copies of this video can be found on the FHWA web site at: http://www.fhwa.dot.gov/programadmin/utility.html.

II.2.6 Technology to Locate Utilities

Although many geophysical methods currently exist to designate buried utilities successfully, there is no one piece of equipment capable of detecting all types of utilities in a given location, and many of the methods are further constrained by soil conditions, depth of burial and proximity to other utilities. The current technology thus makes it necessary to have a variety of equipment on hand and the trained staff to use it, economically limiting the in-house capabilities of any DOT or utility. The use of a Subsurface Utility Engineering (SUE) provider becomes the most economical solution as they specialize in the equipment and training necessary for all project conditions. The technology is at hand for refinement of current designating devices for increased accuracy and a broader range of material detection, under a variety of soil conditions, under a variety of installations. As the technology increases however, so does the level of training required to utilize the equipment and interpret the results, therefore it is likely that SUE professionals will continue to remain the best choice for application of the designating technology of the near future.

II.2.7 Abandoned Facilities

Abandoned facilities represent out of service utilities that have been abandoned in place. Abandoned facilities are generally of unknown origin which is attributed to either a lack of records indicating their presence, or the original owner being out of business or otherwise unavailable to participate in the locating effort. Abandoned facilities may sometimes still contain product, and when found, create a potentially hazardous, definitely precarious situation to deal with. Encountering an abandoned facility during construction can mean a major delay to identify, remove, or seal the facility. Abandoned facilities, existing in close proximity to active facilities, can be marked as active and vice-versa leaving the active facility vulnerable to potential damage. Abandoned facilities must be identified in the design stage so that ample time may be allocated for discovery of the ownership and contents of the facility. Unless there are surface features (picked up on topographic survey) to indicate their presence, abandoned facilities are not typically discovered in the design stage unless a SUE investigation is performed as part of the project mapping.

II.2.8 Joint Use Trench Liability

The issue of joint use (common) utility trenches involves the sharing of a trench by two or more utilities. In a common trench application, different utilities are separated vertically according to the affected utility standards, with multiple lines of the same utility separated horizontally on the same vertical level. The two most frequent examples of common trenches include gas / water, and electric / telephone / cable TV. Municipal and private utilities are never in a common trench with each other.

Common trenches make effective use of space where ROW is limited and are therefore utilized often as a design option. The designer, whether employed by the highway agency or the utility, should be cognizant of the following problems associated with the use of joint trenches:

- Typically, the facilities installed in common are owned and operated by different companies. Since these companies perform independent operation, maintenance and repair activities, additional risk and liability to both parties is assumed in protection of the other’s facilities during these activities. The utility companies should seek legal counsel and negotiate an agreement between them regarding this liability. In any case, the highway agency should require a hold harmless agreement in favor of the agency for any joint installations mandated by the highway project.

- Positive location of the lower utility by either geophysical methods or by potholing can be difficult. It is important that as-built drawings of each respective utility show the other's facilities in common trench for future identification.

- The most cited problem with common trenches is improper field installations resulting in less than minimum clearances between facilities. This compounds the risk and liability issue. The designer must insure that the project PS&E specify the proper installation, and that the construction inspection enforces compliance by the constructors. The more frequently that the trenches are properly installed, the more willing utilities will be to utilize the option.

II.3 FINANCIAL IMPACTS

II.3.1 Cost for Relocation

Utility relocation, as required for highway construction and rehabilitation, is inherently a costly item. As previously stated, relocation costs can be borne by either the utility or the highway agency, depending on the utility's property interest and the State's utility accommodation laws. In either case, the cost is ultimately borne by either a ratepayer or a taxpayer, who are one and the same person, so to truly serve the public, the agency should attempt to avoid relocations whenever possible, whether or not it is reimbursable. Since 1983, New Jersey DOT has been reimbursing for all public utility relocations (utilities that are regulated by the public utilities commission), as well as reimbursing private utilities with property interests. The NJDOT utility department estimates utility reimbursement at approximately 10 percent of the State's annual highway budget, with DOT personnel dedicated to coordinating with utility companies comprising approximately 5 percent of the highway design budget.

The costs of utility relocation increase significantly when not planned for well in advance, especially if discovered after construction begins. The utility company must have time to prepare construction drawings, obtain the required materials for the relocation, and mobilize its forces for traffic control and construction. Most often, the utility is required to relocate prior to mobilization of the highway contractor and this can't occur if the conflict is unknown to project designers. Once the highway contractor is mobilized, any delay to the contract schedule, through no fault of the contractor, constitutes a contract change order claim. In addition, work that the contractor may do involving the actual relocation would also be a change order claim, to be paid at the contractor's cost plus profit and overhead. If identified during design, the relocation could have been included in the bid price and schedule, or possibly even avoided.

II.3.2 User Costs

User costs are the great unknown in calculating costs of a highway project, both on a first cost basis and on a life-cycle cost basis. What are the fuel costs involved with congestion caused by lane closures? What costs are incurred by businesses in the form of lost revenue when access to their businesses are impeded by rehabilitation activities? What are the costs incurred by ratepayers as a result of temporary loss of service and unnecessary utility relocation? What are the costs to the State when public opinion opposes frequent highway construction? Although these costs are difficult to quantify, the fact is that they are real.

One of the drivers for avoiding utility relocations is the reduction of user costs due to delay. A common practice is for State agencies to require utilities to relocate prior to the commencement of highway construction. The traveling public sees lane closures and congestion during the relocation work and then suffers again through the actual highway construction. The public does not understand the process. They want a maximum service facility with a minimum of disruption. The pressure to reduce or eliminate such delays in congested corridors is growing. Agencies such as Florida Department of Transportation now require a permitted Maintenance of Traffic (MOT) for highway utility work to minimize traffic disruption. NJDOT schedules the utility work to occur either using the highway contractors own forces, or at least in conjunction with the highway contractors traffic control operations.

SECTION III. SYNTHESIS OF CURRENT PRACTICES

Government agencies have been developing systematic approaches to managing utility conflicts within highway construction projects since the 1970s. Historically, however, most of this effort has been focused on the damage prevention component of the problem and not on the avoidance of utility relocations. In the last decade, the United States Department of Transportation (USDOT), the Federal Highway Administration (FHWA), and American Association of State Highway and Transportation Officials (AASHTO) have played a major role in promoting practices that reduce and avoid utility conflicts and relocations in highway construction projects. In developing DOT utility accommodation policy and procedure documents, State agencies have adopted these practices, as well as incorporating new ones based on experience on projects in their own State. The current practices of most states place emphasis on communication and coordination with utility owners supplemented by the collection and distribution of accurate utility location information, in all phases of project development (planning, design, and construction).

III.1 ONE-CALL SYSTEMS

One-call systems represent the first nationwide concerted effort to address utility damage prevention issues. A one-call system provides a single statewide toll free “call before you dig” phone number that anyone (contractor or individual) planning to excavate must contact prior (24 to 48 hours) to performing the excavation. The one-call system provider is responsible to notify the affected utilities (subscribers) of the scheduled excavation activity, who, in turn must respond to mark the horizontal location of their facilities at the site before the excavator begins to dig. It is mandatory for utility owners/operators to participate in the one call system for the State(s) within their service territory. Current state-of-the-practice for one-call systems can be found in “Common Ground, Study of One-Call Systems and Damage Prevention Best Practices (August 1999)” published by the USDOT, in conjunction with the Office of Pipeline Safety.

Use of the one-call system can reduce or prevent damage to existing utilities during construction, thereby reducing project cost. The discovery of a utility conflict at the construction stage doesn’t, however, reduce the impacts to the project resulting from an unplanned utility relocation or design revision to avoid the relocation. Often, such impacts are attributed to insufficient or poor quality utility location information available to the project designers and it would seem logical to utilize the one-call system to obtain the utility information for project design purposes as well as for construction. This is not the case, however, and although the one call system is an effective damage prevention tool, it is not an accepted means of obtaining design level information. In fact, in many areas this is discouraged or even prohibited. This can be attributed to inherent one-call system errors (no depth information, tolerance, ignorance of abandoned facilities, short response / turnaround time, limited education and training of employees, availability of equipment), but the primary reason against using the one-call system for design is the lack of acceptance of liability.

Engineers accept a certain liability for the accuracy of data contained on their plans. When this data is obtained from sources not under the control of the Engineer, such as utility records and as-built plans, responsibility / liability disclaimers are often used to protect the Engineer from a third party relying on such information. In the case of the one-call system, individual utilities are required to mark the approximate location (the accepted tolerance is two feet on either side of the mark) of their facilities for an immediate (2 days maximum) excavation. If the utility is hit outside the tolerance of the marks, the utility would clearly be responsible. If the same marks had been referenced by survey to the construction plan and used for design and the utility was hit during construction, the responsibility is less clear. Since the original marks naturally fade with time and leave no permanent field record, it would not be possible to determine if the marks were in error or if the survey was in error.

Although the one-call system markings are not being used for design purposes, the one-call subscribers (utilities) are typically contacted on an individual basis by agency designers and required to verify their facilities on agency design plans. The means, methods, and liability for locating one's own facilities during this process is assumed by the individual utility. The DOT project designer must evaluate the need for additional subsurface investigation to either supplement or supplant the utilities' effort, or to locate suspected abandoned facilities. In the recent past, such additional investigation was a difficult and expensive task because of the limited number of private firms with the required expertise and equipment willing to assume the liability for locating. As demand for accurate and complete subsurface information continues to increase throughout the country, more and more firms are becoming qualified to perform the service. The professionals at the helm of these firms are setting standards for the industry and their services are now recognized as a new branch of Engineering called Subsurface Utility Engineering (SUE).

III.2 SUBSURFACE UTILITY ENGINEERING (SUE)

The greatest potential for avoiding utility relocations requires collection of high quality location data very early in the design process, and preferably in the planning stage. SUE holds the key to obtaining and delivering this information to planners and designers. SUE is becoming more widely used and is now accepted and promoted by engineering organizations and Federal and State agencies as a means of reducing overall project costs and liabilities. The FHWA has been involved in promoting the use of SUE because of the waste involved in unanticipated utility conflicts involving Federal dollars. AASHTO has also recognized SUE as a best practice and the American Society of Civil Engineers (ASCE) Standards Committee has developed standard guidelines for the collection and depiction of existing subsurface utility data.

The following description of SUE was taken from the Washington State Department of Transportation's Technology Transfer Newsletter and was written by Jim Anspach, a leader in the field.

What Is Subsurface Utility Engineering?

SUE is a relatively new interdisciplinary approach to managing the risks that existing underground utilities create on projects involving excavation. Many of these risks are a direct result of inaccurate, incomplete, or imprecise information on the location or existence of existing utilities. Just as important are the timing and distribution of this utility information. SUE utilizes new and existing technology to collect and manage utility data, and transmits this data to the right parties, at the right times, in order to decrease project risks.

A pending ASCE standard titled *Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data* defines SUE as: "A branch of engineering practice that involves managing certain risks associated with: utility mapping at appropriate quality levels, utility coordination, utility relocation design and coordination, utility condition assessment, communication of utility data to concerned parties, utility relocation cost estimates, implementation of utility accommodation policies, and utility design."

An engineer has many sources of information on existing utilities. Utility owner records, public records, private records, interviews with knowledgeable sources, visual site indications, historical books and newspaper archives, subsurface geophysical information, test holes, and Geographic Information System (GIS) systems are some examples.

How Do These Records Differ?

There is one obvious difference between these records: Quality! Different types of records have different quality. Some records have very high quality, and tell us everything we need to know about a particular utility at a known point, location, depth, backfill type, and utility composition. Other records may have a very low quality, and tell us next to nothing about the utility, other than its potential presence somewhere in the general area.

Until recently, there was no mechanism for engineers or surveyors to differentiate these differences in quality on design or construction plans, or in GIS databases. All utility information was depicted as being the same. The end result of low quality information being portrayed the same as high quality information resulted in all the information sinking to the lowest common denominator of quality, in other words, untrustworthy information.

Engineers and surveyors recognize this and completely disclaim responsibility for utility information that they depict on documents. They attempt to push liability to the utility owner or the constructor. Some court rulings uphold these disclaimers. Others do not. In a Commonwealth of Pennsylvania ruling (PennDOT v. I.A. Catalso), the owner of the construction plans (PennDOT) was found to be responsible for any costs associated with poor or missing utility information on the plans. This prompted the following statement from William D. Pickering, P.E., PennDOT State Utilities Engineer, on a 1995 FHWA film: “In Pennsylvania, the project owner can be held legally responsible for the accuracy of the information on the bid documents. Consequently, we want a competent professional to obtain that information for us.”

Usually, the finger of blame points everywhere for problems associated with poor utility information and only the lawyer's profit. A recent Indiana (Lafayette) court case assessed damages at 30 percent, 30 percent, and 40 percent, respectively to the city, the engineer, and the contractor.

How Can Responsibility Be Better Defined?

One of the advantages of applying SUE to a project is that responsibility for wrong or missing utility data on plans is better defined. The SUE provider becomes individually and corporately responsible for negligent errors or omissions of the deliverables and no longer disclaims utility information, but instead, claims responsibility for it – within certain guidelines. These guidelines involve defining and then obtaining and depicting the "quality level" of utility information. In other words, if the engineer can verify that a particular utility depiction on the plans is very accurate, why not say so, rather than disclaim the good information along with the bad? By taking responsibility for data, contractor bids are lowered and there is certainly a better incentive to get right information on the plans.

The ASCE recognizes that national standards for these quality levels need to be developed and promoted. They have, therefore, formed a national consensus standards activity to draft such standards. Once in place, these standards may influence how the insurance industry and the courts view utility data liability. Membership of the committee includes people from engineering, construction, insurance, utility owners, academia, Federal agencies, the military, labor unions, equipment manufacturers, and providers of SUE.

What Are Utility Quality Levels?

It would be quite easy to develop literally hundreds of different quality levels if one were so inclined. However, such a large number would be unwieldy and, therefore, probably not effective. In developing quality levels, a natural grouping emerged that addressed how data was collected and how that data could be endorsed by a licensed professional.

Quality Level D (QL D) utility data is that information that is collected and depicted on documents that comes solely from utility owner records, or conversations, or indirect visual indications. It is the lowest quality level and everyone should be very careful when using it for any purpose. The only aspect the engineer can be held accountable for is investigating appropriate sources of information and interpreting the records as best as can be done. It has a good application for project planning / route selection, where the planner needs to get an overall "feel" for the utility congestion. An example of its use and pitfalls is as follows: A water record from 1960 shows the water line 2 feet off the edge of the road, with one valve on the main. The road in 1960 was two narrow lanes; now it is two wider lanes with a turn lane. The engineer plots the water line 2 feet off the edge of the road, but is not known whether (a) the edge of the road is at the same place now as in 1960, (b) the water line record was correct as far as its geometry, (c) the water line is still in service or abandoned, or (d) the water line underwent changes in conjunction with road improvements or other events.

Quality Level C (QL C) utility data is better and entails the use of visible utility features. It addresses the problem of where the old road edge might be by using the water valve as a survey point. All visible utility structures that indicate a utility below the surface are surveyed to project control and placed on the plans at the right positions. Then, the utility record's geometry can be used to place it on the plans. The water line that would have been plotted 2 feet off the edge of the road is now plotted through the surveyed water valve. If the water valve is 6 feet inside the turn lane, then the water line is plotted parallel to the road (following the record geometry) but 6 feet inside the turn lane. Of course, if the water valve cannot be found, this utility can only be plotted to Quality Level D standards. Quality Level C data still does not address utilities for which there are no records, utilities for which the records are wrong or incomplete or not updated, or utilities which have no visible features that can be surveyed. The survey of the visible utility feature is endorsed by a licensed professional. Liability revolves around the appropriate utility records search, the survey, and the best interpretation of the records information.

Quality Level B (QL B) utility data provides a significant upgrade in quality from QL C data. It involves the use of surface geophysics to identify, interpret and field-mark underground utilities, combined with a survey of the field markings, and subsequent reduction onto plans or into the digital database. There are many different types of surface geophysics that will work under certain conditions to identify underground utilities. The key to liability here is that the appropriate methods be used. Appropriateness of method is part of the professional geophysicist or competent engineer's role, along with interpretation of the data, and education of the client for budgetary purposes. The key is to pick those techniques that, given the environmental and site conditions, will give the educated client the best "bang for the buck" in identifying the most, or the most critical, utilities for the project mission. Not all utilities may be found through surface geophysics.

After utilities' approximate locations are marked on the ground surface, the engineer / surveyor references them to project control and reduces them onto plans or into the database. Other information might be interpreted from the surface geophysics, such as approximate depth and utility type. Utilities for which records exist, but which could not be found through the surface geophysics, are depicted at a lower quality level.

In the water record example, if the water line had bends in it that the records did not reflect, the surface geophysics would detect them. If the valve were paved over, the surface geophysics would detect it; survey would place it on the plans correctly. If the water line was abandoned and in poor condition, the surface geophysics might detect the new waterline, and give clues to the condition of the abandoned one.

Liability for Quality Level B data is generally confined to surface geophysics method selection, education of the client, correct interpretation of the surface geophysics, correct marking of the utility on the ground surface, survey of those markings, depiction on the plans or in the database, and evaluation of all appropriate records to see if utilities must be depicted at a lower quality level. The appropriate professional affixes his or her stamp on the deliverables;

insurance covers all aspects of the end work deliverables. QL B data is most useful in the preliminary design stage of projects.

Quality Level A (QL A) data is the highest quality. No matter how well the surface geophysics are applied and interpreted precise information on elevation, size, material type, condition, configuration, and so forth of the utility cannot be verified without exposure. So QL A data is that data that is gathered, surveyed, and depicted through excavation or exposure of the utility. It takes all interpretation out of the utility information at that point. In our water line example, the exact horizontal location, depth, condition, and other data at the point where it is needed is gathered.

New excavation technologies such as air / vacuum methods protect the utility from damage during exposure, limit the work zone, and reduce costs. Quality Level A measurement data is endorsed by the licensed professional.

What Are the Advantages of Using Quality Levels?

Instead of all utilities depicted the same on a document, those utilities for which better data are available can be portrayed in such a manner that designers and constructors can minimize their impacts. The subsurface utility engineer is responsible for depicting the utilities at the correct quality level, and following the established industry procedures for collecting and interpreting that data. If the engineer makes a negligent error or omission, he or she may become responsible for the resultant problems with design or construction.

Being able to obtain higher quality utility information results in project savings through better design and construction. The FHWA has performed widespread studies that show average savings in excess of 462 percent of every $1 spent in upgrading utility information to its highest necessary quality. Project owners and utility owners can select the amount of risk they want to underwrite on a project by selecting the quality level of utility information that they procure, or by requiring the project engineer to provide it to them.

From “Subsurface Utility Engineering in Washington State,” *Washington State Technology Transfer Issue 71*, Summer 2001.

III.3 ELECTRONIC DOCUMENT DELIVERY

With the widespread use of computer-aided drafting and design (CADD) systems, and Geographical Information Systems (GIS), information collected by SUE providers can be easily shared with project designers. These systems also make it possible for utilities to keep more detailed and accurate records of their facilities and make this information available to other agencies. Highway agencies and utility companies across the country have invested heavily in state-of-the-practice electronic information technology. Base mapping as well as project specific data is now almost universally digitized or created in some type of CADD format. The coordination issue now becomes how to share this information. Proprietary rights and security protocol often prevent open access to data bases maintained by DOTs and utilities. Open access would also place the burden on the utility or agency as the case may be, to navigate the other’s database to find the required information, all the while having access to unrelated proprietary information. The solution may be to electronically transfer data base information to the necessary users.

Electronic Document Delivery (EDD) is the use of electronic files to communicate highway project design information and status over the Internet to affected utility companies. Hypertext Transfer Protocol (HTTP) is how a standard web browser transfers files from remote web servers to PC users. Transferring files using e-mail is also a common practice. HTTP and e-mail, however, do not provide the fast and efficient transfer of large files as required by many of today’s business internet users and subsequently, a growing number of companies are using File Transfer Protocol (FTP). FTP is being used because of its capability to transfer files as large as 20mB. Other advantages of FTP include the ability to resume transferring after interruptions and the availability of various security and file management software support applications.

Electronic Document Delivery using an FTP site is currently being used by the Georgia Department of Transportation (GDOT). The following information was obtained from the GDOT Utility web site http://www.dot.state.ga.us/operations/utilities/.

The District Utilities Office (DUO) of the GDOT is responsible for initiating and coordinating the EDD process for a given project, consisting of various EDD submissions. Each submission contains a higher percentage of completed highway design information and requires that a higher percentage of utility information be provided to the DUO prior to the next submission. An example is shown below for the first submission:

1st submission (identify existing utility facilities): the DUO transmits conceptual project electronic reference files (preliminary alignment plans and general project information) and blank utility files on the FTP server site. The utility companies are notified by mail or e-mail that preliminary project information is available on the site and of the time frame in which the utility must respond. The utility researches its records and places its existing facilities in the blank electronic file, sends it back to the FTP server within the allotted time period and notifies the DUO of such.

Coordination continues with the 2nd (identify utility relocations), and 3rd (utility review) submissions until completion of the highway and utility design which is represented by the 4th submission (final plans).

In addition to FTP sites, other Electronic Document Delivery and Web enabled Document Management systems currently exist to support file transfers and updates with minimal intervention. One such system is Bentley's ProjectWise (http://www.bentley.com) which provides a common platform for the management of content created by MicroStation and AutoCAD files as well as other business file formats such as Microsoft Office XP. Another is the peer-to-peer (P2P) method for project sharing at the workgroup level. Groove Networks, Inc. (http://www.groove.net) offers a P2P computing platform for secure business collaboration across multiple organizational and technological boundaries. Groove and other platforms are utilizing an Extensible Markup Language (XML) which deals with defining a common language to describe objects as they exist in disparate systems. While simple file translations are currently possible, XML offers the promise of total data fidelity between different systems so that data will never have to be entered or edited more than once. Desktop applications such as Microsoft Office and AutoCad, among others, now support XML data. In 1999, Autodesk initiated LandXML which provides a specialized XML format for land development professionals (http://www.landxml.com).

III.4 COMMUNICATION AND COORDINATION MEETINGS

Many jurisdictions have adopted a proactive approach to utility coordination that involves regular coordination meetings among utilities and the DOT staff, both on short and long term work plans. The main objectives of meetings and the justification for the dedication of necessary staffing is to:

- Recognize the shared goals of the stakeholders and act as a team to accomplish those goals.
- Identify early, proposed highway projects that affect existing utility facilities to allow highway planners to explore highway alignment alternatives to avoid major utility relocations prior to project design.
- Identify design alternatives to minimize utility impact and relocations on highway projects already in design progress.
- Coordinate the construction schedule of unavoidable utility work with the highway construction schedule to reduce the disruptions to the public and prevent conflicts between contractors. This may include the highway contractor performing some or all of the relocations.
- Refine the coordination process for continued efficient communication.

The operating principles that support successful communication are summarized below:

- Monthly, short meetings are better than quarterly, long meetings.
- Hold the meetings in a convenient location; make sure the accommodations are suitable for the purpose of the meeting.
- The people who attend should have decision-making authority.
- The same people should attend every meeting. If this is not possible, the person coming as a substitute should have the authority and the background information that the primary participant has.
- Use good meeting management skills, or include a facilitator to keep the meeting focused on the desired results.
- There should be an agenda jointly developed and shared before the meeting.
- Try to share materials/handouts for review before the meeting to save time.

- There is mutual commitment to start and end on time.
- The group should agree on a decision-making process, e.g. consensus, majority vote, etc.
- There should be a record/minutes of the meeting. Actions should be verified before the meeting ends; the record should be shared with all stakeholders.
- Someone should have responsibility for follow up, to make sure that agreed upon actions are completed by the date selected.
- Group members should share contact information (telephone, cellular, fax, e-mail).
- Establish rotating or shared leadership of the meetings.
- Periodically, assess the effectiveness of these meetings, either verbally or with a written survey. Discuss problems and take corrective action.
- Use a common base map (GIS or CADD).
- Use all of the available technology tools to share information between meetings – web sites, electronic bulletin boards, established groups for e-mail, on-line or print newsletters.

III.5 REGULATIONS

Most State DOTs have already developed, or are currently developing, Utility Accommodation Policy and Procedure Manuals. These manuals deal with all aspects of utility accommodation within the public ROW, including planning, design, permitting, construction, maintenance, ownership, relocation, and reimbursement. Links to various DOT utility department web sites can be found on the FHWA web site, Office of Program Administration, Utilities Program http://www.fhwa.dot.gov/programadmin/utility.html. Federal utility regulations are contained in the Code of Federal Regulations (23 CFR Part 645). Federal guidelines can be found in the current edition of the FHWA publication "Program Guide: Utility Relocation, Adjustments, and Accommodation on Federal-Aid Highway Projects."

III.6 AGENCY SURVEY

The policies and practices of most states are continuing to evolve as the value of avoiding utility relocations becomes more evident. In order to evaluate how the State agencies are utilizing the various current practices, Nichols Consulting Engineers (NCE), on behalf of the FHWA, conducted a survey of State agencies around the country. The survey questionnaire, as well as a summary of the responses in a spreadsheet form, can be found in Appendix A.

Surveys were sent to more than sixty (60) agency utility coordinators and other State Department of Transportation personnel responsible for utility issues. Private sector representatives from universities, utilities, consulting firms, and SUE providers were also contacted. Both the agency and private sector contact lists were provided by the FHWA.

There were 44 responses from 37 State agencies. In some states, more than one district responded. There were six responses from the private sector and one each from a county and a city. The following evaluation of survey responses is based on analysis of the State responses. Although the other information provided was useful and informative, the survey was geared to capture aspects of utility issues as they relate to State and Federal highway construction. Following are the questions of the survey and a brief analysis of the responses.

1. **Does your agency currently use the Subsurface Utility Engineering (SUE) process, as defined by the FHWA, to obtain information about underground utilities?**

Of the 44 agencies that responded, approximately 70 percent said they used SUE. About 40 percent as a standard practice, 20 percent on occasion, and the other 20 percent had conducted a trial project, pilot projects, or were just implementing SUE contracts. Notable Response: “My district is currently using SUE to some extent on each and every project within our district work program,” Florida Department of Transportation District 2.

2. **If so, do your in-house designers and/or design consultants use the SUE information in the design of highway projects to avoid or minimize utility relocations?**

Almost all agencies used their SUE data to provide designers with information that would help avoid relocations. Some admitted that the information may not get to the designers soon enough to alter the design but they would know for sure whether or not the utility had to be relocated. Notable Response: “Yes, our designers have been instructed to design around utilities whenever possible,” Montana Department of Transportation.

3. **If not, do your in-house designers and/or design consultants use any other sources of underground utility information in the design of highway projects to avoid or minimize utility relocations?**

Agencies who did not use SUE relied on historic data, one-call locates, and utility as-built plans to acquire utility information for design. Notable Responses: “We place this responsibility upon the owner of the utility. We send plans to them of our surveyed data and they are required to mark up any corrections and or confirm the accuracy” New Hampshire Department of Transportation. “Other sources of information (besides SUE) are generally not reliable enough to allow one to confidently re-design around utility conflicts,” Colorado Department of Transportation.

4. **At what point in the development of highway projects does your agency notify utilities of upcoming projects that may have utility conflicts?**

The design process was broken into the 30 percent, 60 percent and 90 percent design completion. The scoping plans that include topography and ROW are at 0 percent design and at 90 percent design, cost estimates are being prepared and the design is pretty much set.

About 70 percent of the responders said that they got utility information into the design process before the 30 percent design stage and many started coordination well before that. “Got utility information” means it was solicited from utilities, acquired through the one-call system, taken from as-built plans, obtained through SUE, etc. Notable Response: “Upon initiation of the design process, the Houston district began an electronic distribution of our project award schedule on a monthly basis. Per Houston district policy, designers are required to communicate and coordinate with the utility entities themselves," Texas Department of Transportation, Houston District.

5. **What other coordination activities does your agency engage in with utilities affected by proposed highway construction?**

After initial contact most agencies said they continued regular, often monthly meetings through the rest of the design phase and through construction. Other agencies conduct utility field inspections to evaluate the accuracy of the plan data. Notable Response: "Michigan Department of Transportation (MDOT) includes some utility work in construction contracts." The MDOT contractor is responsible for utility work, thus minimizing potential conflict and delays.

6. **Who in your organization determines whether to relocate conflicting utilities or to design around them?**

In about half the cases, responders indicated this is a cooperative decision between the design engineer and the utility coordinator, with utilities and contractors involved along the way. In about 40 percent of the cases, it is the ultimately at the discretion of the design engineer. Notable Response: "Joint Effort, utility coordinator, designer and utility representative. Usually a mutual cost-driven solution," Wisconsin Department of Transportation.

7. **What are the factors that might contribute to the design being revised as opposed to the utility being relocated?**

Half the respondents cited a combination of cost, schedule delay, and safety as factors to determine whether a utility should be relocated. After this combination of factors, about 35 percent said cost was the driving factor with schedule following at 10 percent. Notable Response: "Path of least resistance = move the utilities, NOT re-do the design," Texas Department of Transportation.

8. **Are Life-cycle Cost (LCC) considerations or other economic models used to evaluate relocation re-design issues?**

About 70 percent of the agencies said LCC were not used in evaluating the relocation vs. re-design with 28 percent saying they did evaluate them. Notable Response: “All cost comparisons are based upon current dollars,” Illinois Department of Transportation.

9. **What types of design changes have been made by your designers in order to avoid or minimize the need to relocate utilities?**

There was a big response to this question with about 58 different strategies suggested. These are discussed in detail in Section V. The gist is that the earlier the designer gets good / accurate information, the greater the range of strategies available. If the location of utilities is known prior to the start of the design, bridges and alignments can be moved. At 30 percent on, there are fewer options for re-design. Notable Response: “We look at every avenue to minimize the need to relocate utilities,” Connecticut Department of Transportation.

10. **During the design process, are there design practices that are implemented during the preliminary design stage to lessen the possibility of a utility conflict? If so, can you name some of these design practices?**

Approximately 90 percent of the agencies cited practices that they used. About half of these involved good coordination procedures and the other half involved using locate/designate/SUE procedures to get accurate data. Some indicated cost/benefit procedures drove some of the design decisions. Notable Response: “Each utility owner is required to develop a utility work schedule that identifies their utility within our proposed project and provides a disposition of what is going to happen to that facility during construction, i.e., locate, protect, relocate, adjust,” Florida Department of Transportation.

11. **If a utility conflict cannot be avoided and the utility needs to be relocated, do you have any methods in place to help minimize the cost of relocation?**

Twenty percent of respondents indicated concerns for both the taxpayer and the utility ratepayer and cited good coordination and a cooperative spirit to realize cost savings. Sixteen percent advocated including the relocation work in the highway contract. Another 20 percent responded with “no”, or said the burden lay entirely on the utility. The remainder of respondents cited a variety of responses. In about 10 percent of cases, State law forces the utility to pay relocation costs in most circumstances so the agency indicated limited incentive to search for savings. Notable Response: “Communication, cooperation, trust and good working relationship allow alternative solutions to be investigated,” Kansas Department of Transportation.

12. **Does your agency have any requirements concerning the placement of new utilities to help avoid future conflicts?**

There were a wide variety of responses to this question. About 20 percent indicated a preference for utilities locating as close to the ROW line as possible. Thirteen percent indicated they looked at each case with the future in mind. Seventeen percent each said the permit process drove the location decision or it was handled by the agency Utility Accommodation Policy. Seven percent preferred that utilities relocated outside the ROW. Notable Response: “We buy the minimum amount of ROW to keep costs down, therefore, the chances of hitting utilities in the future are pretty good,” Ohio Department of Transportation.

13. **Does your agency have any policies or other strategies concerning utilities that may be pertinent to this study?**

Twelve percent recommended starting to work with utilities as early as possible. Fifteen percent referenced their Utility Accommodation Policy and several provided websites where the policy can be accessed. More than half had no response to this question. Notable Response: “Continual training of new highway designers on the importance and value of good utility coordination,” Wisconsin Department of Transportation.

14. Does your agency have any policies on shared databases?

About 15 percent of agencies indicated that they did have database sharing policies of some kind. These were primarily related to sharing of CADD files. This could be done on a case by case basis or under agency policy. Seventy percent indicated no policy was in force. Notable Response: "Started on GIS program which will use highway inventories, USGS Quad maps (1:24,000 scale), and these will be available in the future to the public on a web site," North Dakota Department of Transportation.

15. Does your agency do anything else other than the items previously mentioned to avoid or minimize the need to relocate utilities to accommodate highway construction?

There were few responses to this question but those that did provided some valuable input. Agencies suggested getting utilities to provide accurate as-built plans, place utilities in a separate corridor when ROW is available, provide utilities with future project information, and establishing a final scoping report that has a section to address utility concerns. Notable Response: "Just continually emphasizing coordination, communication, and cooperation," Texas Department of Transportation.

III.7 AASHTO BEST PRACTICES

The AASHTO Highway Subcommittee for ROW and Utilities recently completed the assembly of guidelines and best practices for ROW and utilities. The utilities guidelines and best practices were put together by a subgroup consisting of representatives from the Montana, California, Colorado, and Pennsylvania Department of Transportations and from the FHWA's Office of Program Administration. All State Departments of Transportation had the opportunity to provide input, and many took advantage of this opportunity.

The utilities guidelines and best practices have been submitted to the AASHTO Standing Committee on Highways. It is not certain yet what use will be made of them. A summary of these guidelines and best practices is contained in Appendix C.

III.8 MUNICIPAL VS. STATE ISSUES

The underground environment of urban city and county streets is typically more crowded than State Highways, requiring a higher level of utility coordination. On the other hand, municipal projects are generally planned and implemented in much shorter time frames than State projects, making it more difficult to obtain advance utility coordination. In addition, many utility companies have service territories that cover many municipal jurisdictions, requiring the utility to keep in contact with many different people and monitor a tremendous amount of project planning and design information with limited staff. The consensus from the utility community is that the municipalities are not providing the same level of advance planning information and are not as sensitive to the issues affecting the utilities operations and budgets, as are the States.

III.9 UTILITY PERSPECTIVES

Based both on the responses to the written NCE Agency Survey by private utilities and other informal telephone inquiries to utilities performed by NCE, the following is a list of general comments from the utility community regarding utility relocation:

- The utility should be recognized as a “stakeholder” in the highway project.
- State agencies should provide more reimbursement for utility relocation work.
- Utility reimbursement should be based on their performance to relocate their facilities within an agreed upon schedule.
- Utility reimbursement and performance should be studied as to the benefits to the overall project. This should include team building, improved coordination and communications, and impact on construction cost and schedule. Currently, some utilities keep track of their “negotiated savings” which are the savings to the utility resulting from negotiation of highway design alternatives or re-design vs. utility relocation. Project savings statistics such as these will aid the national effort to avoid utility relocation.

- The State Utility Office should hold the State highway designer(s) more responsible for addressing utility conflicts and suggesting resolutions. Unnecessary relocations must be avoided, and when they occur due to lack of communication or coordination by the State or municipality, the designer should somehow be held accountable, thus providing an incentive for identifying conflicts and exploring alternatives early in the design process.

- State DOTs have set standards for placement of facilities in the ROW. Many of these standards, such as increased bury depth, have been implemented to accommodate future highway maintenance (such as installation of signs or other minor excavation or drilling) or expansion without disturbing the utilities. Utilities complain that some of these requirements increase installation and maintenance cost.

- Improve notification to utilities as to when projects are funded and scheduled for bid. This will aid utilities in budgeting and scheduling relocation work on a timely basis. The State should be responsible for initial contact on funded projects at the 0 percent design stage.

- It is difficult to obtain permits for parallel utility encroachment in many existing ROW. This has caused the utility to obtain private easements adjacent to the ROW.

- Utilities are required to provide the location of their facilities at their own expense. Agencies have the authority to retain SUE consultants to perform the same work. Utilities should be paid to provide this service as are the consultants.

- Utilities prefer to receive electronic plan information for locating and design, however, states are not always using compatible software. The State should be responsible to set up compatible electronic plan transfer system.

- Municipalities should be held to the same standards and level of coordination and communication as implemented by the State.

SECTION IV. LOCATION TECHNOLOGY
SITE CHARACTERIZATION AND UTILITY LOCATING

Highway construction projects require a significant amount of planning and design before the actual construction work can begin. An important part of the planning and early design information gathered for a project includes subsurface site characterizations, such as various geologic and environmental studies. Just as important, however, is site characterization of subsurface utilities, which is often overlooked, or is not considered until actual construction begins. When utilities are finally considered, too much emphasis may be placed on old site diagrams or as-built diagrams that may not be reliable. For this reason, it is highly probable that undocumented or unknown utilities will be encountered when construction begins, resulting in possible project delays and cost overruns.

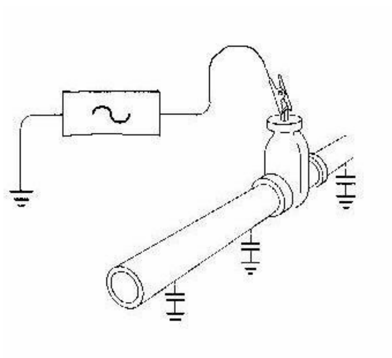
To avoid these delays, the planning and early design phases should include site characterizations of subsurface utilities. While not all utilities are detectable, utility-locating surveys will significantly reduce the uncertainty typically associated with these projects. Following is a discussion of the methodology of utility locating surveys, the recommended procedures that should be followed when planning and conducting a utility locating survey, and the limitations associated with utility locating surveys.

IV.1 METHODOLOGY

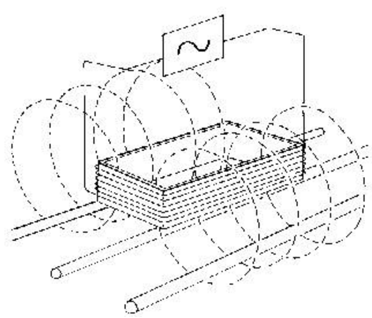
IV.1.1 Electromagnetic Line Location (EMLL)

Theory

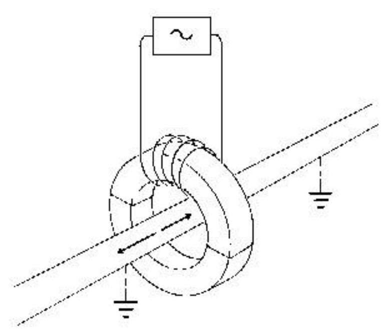
EMLL techniques are used to locate the electromagnetic field resulting from alternating electric current (a.c.) flowing along a conducting metallic line. The magnetic field forms a cylindrical shape around the conductor and is called the "signal." These signals can arise from currents that are naturally present in many conductors (known as passive signals) or currents applied to a line with a transmitter designed to produce an a.c. current of known frequency (known as active signals). The most common passive signals are generated by live 50-60-Hertz (Hz) power cables, power system return currents and long wave radio transmissions flowing along the convenient paths of lower resistance provided by metal pipes and cable sheaths. Active signals can be introduced by physically connecting a transmitter to the line at an accessible point and completing the circuit by a connection to ground. The conducted signal will usually then travel along the line and will be detectable over a distance dependent upon the type and size of the line, the type of joint, and the surrounding soil conditions. This is referred to as electromagnetic conduction (EMC). Alternatively, an active signal can be introduced onto a line through electromagnetic induction (EMI). This involves transmitting a high frequency a.c. current through the air to create a primary electromagnetic field in the space surrounding an underground line, which then induces a secondary magnetic field signal onto the line which is detectable by a receiver. Metallic pipes can be located using the induction mode by either placing the transmitter on the ground above or in close proximity to the utility, or by means of placing an induction clamp around the line. An induction clamp can only be used at accessible portions of the utility lines in vaults or breaker boxes. Nonmetallic pipes can be located using EMI by placing a Sonde inside of the pipe. The Sonde transmits a controlled frequency electromagnetic field that is then detected at the surface by a receiver above the transmitter.



Active Signal
Direct Connection



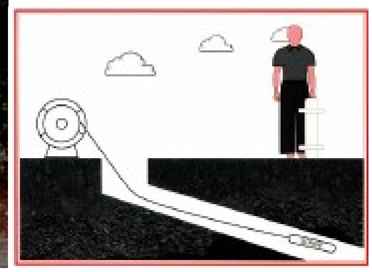
Active Signal
Surface Induction



Active Signal
Induction Clamp

(Source: www.radiodetection.com/theorybook)

The detection of underground utilities is dependent upon the composition and construction of the line of interest. Utilities detectable with standard line location techniques include most continuously connected metal pipes, cables/wires or non-metallic utilities equipped with tracer wires. These generally include water, electric, natural gas, petroleum, telephone, cable TV, and other conduits related to facility operations. If there are no passive currents present, then these utilities must be exposed at the surface or in accessible utility vaults in order to have an active signal placed on them. Utilities that require additional EMLL techniques include those made of non-electrically conductive materials such as polyvinyl chloride (PVC), fiberglass, vitrified clay, and metal pipes with insulated connections. Generally, a steel fish tape or transmitting Sonde has to be placed into the pipe before these utilities can be detected.



Metallic Pipe - Direct Connection and Surface Induction (Source:www.subsurfacesurveys.com)

Non-Metallic Pipe – Sonde (Source: www.utiliscope.com)

Buried objects can also be detected, without direct contact, by using the induction mode. This is used to detect buried metal utilities and near surface metal objects such as rebar, manhole covers, USTs, and various metallic debris. The induction mode is used by holding the transmitter-receiver unit above the ground and continuously scanning the surface. The unit utilizes two orthogonal coils that are separated by a specified distance. One of the coils transmits an electromagnetic signal (primary magnetic field) which in turn produces a secondary magnetic field about the subsurface metal object. Since the receiver coil is orthogonal to the transmitter coil, it is unaffected by the primary field. Therefore, the secondary magnetic fields produced by buried metal object will generate an audible response from the unit. The peak of this response indicates when the unit is directly over the metal object.

Equipment

The equipment used for EMLL surveys varies and is made by several different manufacturers. A few representative EMLL instruments are listed below:

- Radiodetection RD-400 and 500
- Metrotech 800 series pipe and cable locators
- Dynatel 2250 digital cable locator

- Fisher TW-6 inductive pipe and cable locator
- Schonstedt MAC 57 Bx pipe and cable locator

Radiodetection RD400 & RD500

(Source: www.radiodetection.com)

Schonstedt MAC 57 Bx

(Source: www.schonstedt.com)

Fisher TW-6

(Source: www.fisherlab.com)

Metrotech 810 and 850

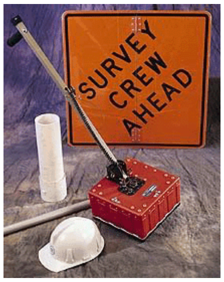
(Source: www.utiliscope.com/metrotech.html)

It should be noted that there are additional manufacturers and equipment that have not been mentioned. All of the instrumentation listed above specialize in the detection of utilities (pipes and cables) using both the EMC and EMI techniques. The Fisher TW-6 and Schonstedt MAC 57 Bx can also be used as a near surface ferrous metal detector.

IV.1.2 Ground Penetrating Radar (GPR)

Theory

GPR is a method that provides a continuous, high resolution cross-section depicting variations in the electrical properties of the shallow subsurface. The method is particularly sensitive to variations in electrical conductivity and electrical permittivity (the ability of a material to hold a charge when an electrical field is applied). The system operates by repeatedly radiating an electromagnetic pulse into the ground from a transducer (antenna). The antenna is hand drawn or towed by a vehicle as it is moved along a traverse. When the radar signal encounters an interface representing a change in permittivity (resulting in what is known as an impedance contrast) some of the electromagnetic energy is reflected back to the surface. Notably, when the signal encounters a metal object, virtually all of the incident energy is reflected. The reflected signals are received by the transducer and are printed in cross-section form (time-depth) on a graphical recorder. The resulting records can provide information regarding the location of underground metallic and non-metallic utilities, as well as backfill material that may indicate a utility trench. Generally speaking, electrically conductive materials such as clay soils can limit radar performance by reducing the depth of signal penetration.



Hand-operated GPR units

(Sources: www.subsurfacesurveys.com, www.radiodetection.com, www.geomodel.com)

Vehicle-operated GPR units

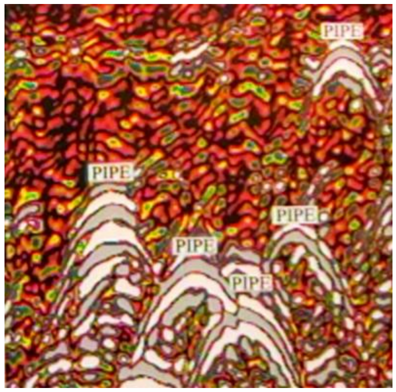
(Sources: www.technos-inc.com/Surface.html, www.geomodel.com)

Equipment

Both conventional and highway specific GPR systems are used to locate utilities. The most widely used conventional systems are the:

- Geophysical Survey Systems, Inc. (GSSI) SIR-2000,
- Sensors and Software pulseEKKO,
- Mala Geoscience RAMAC X3M.

These GPR systems comprise a computer processor and one or two antennae. Each system can be equipped with antennae that range from 100 to over 1,200 megahertz (MHz), depending on the objective of the survey and the desired depth of detection. The frequency range of 200 to 400 MHz is typically used for utility investigations. This frequency range generally provides high-resolution data within the depth range that utilities are buried (1 to 6 feet). The results are printed in cross-section form that shows a vertical 2-D slice (image) into the ground. The location of utilities can then be interpreted from these records in the field.



SIR-2000 control unit
(Source: www.geophysical.com)

GPR display
(Source: www.geomodel.com)

Recently, advanced GPR systems have been designed to evaluate the condition of new and existing transportation infrastructure, including both pavement and utility studies. Two of these are the HIGHWAY SCAN by GSSI, and the CART Imaging System by Witten Technologies, Inc. The HIGHWAY SCAN is best suited for rapid assessment of pavement layer thickness and structural evaluation. It can also be used to image near surface utilities. The CART Imaging System is a multi-channel GPR that provides a 3-D image of buried objects and utilities. Depending on soil conditions, the CART system can image the subsurface at depths greater than 10 feet. Both the HIGHWAY SCAN and CART system are designed to be towed behind a vehicle.

IV.2 PROCEDURES

A thorough set of procedures should be established to increase the probability that every detectable utility is located. These procedures should include reviewing all available utility maps and site conditions, inspecting the site for evidence of utilities, locating all detectable utilities, surveying the area for undocumented or unknown utilities, marking the detected location of the utilities on the ground, producing a site diagram, and documenting the findings in a written report.

IV.2.1 Pre-Planning

Utility Maps

Prior to starting a utility locating survey, an effort should be made to review all information possible related to utilities in the area. The search may provide beneficial information regarding the possible routing of specific utilities, including those that may not be evidenced by vault lids, valves, or above ground piping. Any information that can be reviewed prior to the utility locating survey can be used to increase success in locating all detectable utilities in a given area. Utility sources available for review include old project plans, as-built utility plans, and maintenance and repair records.

Project plans are created to show how a builder intends to develop a site. These plans may be helpful in determining what utilities may be in the area. It should be noted, however, that initial project plans may not be indicative of the final routing of utilities. In some cases, the routing of utilities are changed during construction. Final utility routing is usually shown on as-built utility plans. As-built maps are completed after a site has been developed and the utilities have been installed. These maps are important in determining the general location of a specific utility and where valve boxes, vaults, and above ground piping may be located. Maintenance and repair records indicate if new sections of pipe have been installed or if certain utilities have been abandoned in place or removed. In some cases, plastic or nonmetallic piping is used to repair a section of metal pipe. Determining this, without previous knowledge of the repair, can be difficult while conducting a utility locating survey.

Site Conditions

If utility maps are not available, knowledge of above ground structures and buildings can assist in assuming how complex a site may be regarding underground utilities. Generally, the complexity of a site is associated with the number of buildings that are in a given area. As the number of adjacent buildings increases, so will the number of utilities (laterals) that trend from those buildings. Also, the type of facility that those buildings represent can have a large impact on how many utilities may be in a given area. For example, numerous utilities generally trend off site from communication facilities, electric substations, communication/cable repeater stations, and oil refineries. In contrast, a limited amount of utilities will typically be associated with residential structures.

IV.2.2 Site Reconnaissance

After reviewing available utility maps, or the one created for the project, an initial site reconnaissance should be performed to confirm what was shown on the maps, and to visually inspect for additional utility vaults, valves, meter boxes, man-way covers, clean-outs, etc. that may be associated with adjacent facilities. After noting the location of these features, all utility vaults, meter boxes, man-way covers, and clean-outs should be opened to determine the utility's construction materials, and if it is accessible. This will indicate whether the pipe can be located by EMC, EMI, or by GPR.

IV.2.3 Known Utilities

Based on the information obtained during site reconnaissance, all known utilities should be traced with the EMLL equipment using the conductive, passive, and inductive procedures. If these procedures are not successful, then GPR can be used as a final method to possibly determine the location of the utility in questions.

Conductive

The conductive procedure should be used on all metal pipes (typically water, some natural gas, and other facility pipes) that are accessible either above ground or in vaults or meter boxes. This is done by applying a current directly to a line with a transmitter and tracing the utility by marking the point on the ground where the strongest signal is received. Utilities usually can be traced for relatively long distances using this technique. It should be noted, however, that the conducted signal can also couple to other nearby utilities. In this case, it is generally useful to continue tracing all utilities that carry the input signal.

Passive

The passive procedure can be used to locate known utilities that carry a 60 Hz signal. These include electric lines, and electrically grounded utilities such as water and gas. This procedure can also detect utilities that re-radiate very low frequency (VLF) radio signals, such as telephone and some metal lines. The passive procedure is done by systematically scanning the area immediately around the utility vault or meter box with the receiver set to 60 Hz or Radio mode. It is not necessary to direct connect a transmitted signal to the line. The peaked response indicates the location of the utility. Once the target line is detected, it can be traced through the site with relative ease.

Inductive

The inductive procedure can be used to detect known utilities without applying a current directly to a line. This can be done by placing the transmitter on the ground directly over the suspected utility. The transmitter will induce a signal onto the metal line that can then be traced using a receiver. The inductive mode can also be used to locate nonmetallic sewer and storm drain lines. This is done by inserting a transmitting Sonde into the line with a fiberglass probe and locating its projected position on the ground surface. Once the position is marked, the transmitter can be pushed in further and remarked. Typically, the Sonde is pushed to points located every 5 to 20 feet apart, until the location of the respective pipe has been determined.

Known utilities, constructed of ferrous metal, can also be located by handheld metal detectors. The handheld instrumentation indicates the presence of the metal utility by emitting a peaked audible tone. Based on this tone, the location of the utility can be determined and marked on the ground. This technique can also be used to detect man-way covers or vault lids that have been paved over, as well as buried, near-surface metallic debris.

GPR

If the location of a particular utility cannot be determined by the conduction, passive, or induction procedures, GPR can be used in an effort to determine their locations. This is done by obtaining GPR data over the approximate location of the known utility along traverses that are positioned perpendicular to the suspected trend of the pipe. The trend of the pipe can usually be approximated based on the location of vaults, man-way covers, and valves. If the targeted utility is buried within the detection capabilities of the GPR, then the utility will produce a reflection pattern on the printed cross-section. Based on the location of the reflection patterns obtained along many adjacent profiles, the interpreted location of the utility can then be determined.

IV.2.4 Undocumented Utilities

Undocumented utilities are utilities that are not shown on any site diagrams, and in most cases, they were installed without any record of their location. In order to survey an area for undocumented utilities, the EMI, passive, and GPR techniques should be used to systematically scan throughout the site. These surveys should be performed along traverses oriented both perpendicular and parallel to the street or survey area. The traverses should be spaced approximately 5 to 20 feet apart as required, depending upon the size of the site and the specific objective of the utility locating survey. After the unknown or undifferentiated utilities have been marked on the ground, invasive techniques (pot-holing, excavating, etc.) can be performed to determine what type of utility it is.

IV.2.5 Recording Detected Utilities

To ensure that additional costs are not incurred during future work at a respective site, steps should be taken to mark and document the location of all detected utilities adequately. This can be accomplished by marking the location of the detected utilities on the ground, and by surveying their locations and creating a site plan.

Typically, the location of detected utilities is marked on the ground using spray paint that follows a standard color code. The code is established by the American Public Works Association (APWA) and uses white and pink for various area markings and red, yellow, orange, blue, purple, and green for various utility designations. The color code assignments are as follows:

- White: proposed excavation
- Pink: temporary survey marking
- Red: electric power lines, cables, conduit and lighting cables
- Yellow: gas, oil, steam, petroleum or gaseous materials
- Orange: communication, alarm or signal lines, cables or conduits
- Blue: potable water

- Purple: reclaimed water, irrigation and slurry lines
- Green: sewer and drain lines

Paint offers a temporary means of marking utilities. Depending on site conditions, stakes, lath, and survey brush flags can be used to provide a more visual and longer lasting way to mark utility alignments. In addition to the field marks, the location of all detected utilities should be documented on a field drafted site diagram, and surveyed by licensed surveyors. The surveyed locations of the detected utilities can then be used to create an AutoCAD formatted site plan.

IV.2.6 Reporting

Additional documentation can be provided in a written report. Reports are used to provide detailed information regarding site conditions, the methodology and equipment used, limitations associated with the equipment, any physical limitation encountered on site, and the interpretations regarding the location of utilities and other subsurface features. The report also includes a drafted utility diagram, generated in AutoCAD format, showing the locations of all detected utilities and subsurface features.

IV.3 LIMITATIONS

There are inherent limitations associated with utility locating surveys that may not allow for the detection of all subsurface utilities of interest. These are represented by both equipment limitations unique to the EMLL and GPR techniques, and physical limitations associated with the survey area. Limitations unique to the EMLL and GPR techniques are directly related to the specific utility in question, and to the proximity of those utilities to other subsurface features or utilities. Physical limitations include access into known utility vaults, as well as site access over a suspected utility.

IV.3.1 Equipment Limitations

Electromagnetic Line Locating Techniques (Conduction)

The successful detection of underground utilities is dependent primarily upon the composition and construction of the line of interest, and depth of burial. When using the EMLL techniques in the conduction mode, the utilities must be exposed at the surface or in accessible utility vaults close to the survey area. Utilities detectable with this technique include most continuously connected metal pipes, cables/wires or non-metallic utilities with tracer wires. Such utilities generally include water, electric, natural gas, telephone, and other conduits related to facility operations. Utilities that may not be detectable using these techniques include certain abandoned utilities, utilities not exposed at the ground surface, or those made of non-electrically conductive materials such as PVC, fiberglass, vitrified clay, and metal pipes with insulating joints. Pipes generally deeper than about five feet may not be detected.

The detection of underground utilities using the conduction mode is also dependent upon the proximity of those utilities to other subsurface utilities and/or above ground cultural objects. Nearby buried utilities can mask or distort signals associated with the utility in questions. For example, if several utilities are buried in a common trench or in close proximity to one another, the signal applied to one utility can couple to the adjacent utility. This can lead to an error in the marked position of the utility in question, or to delineating the wrong utility altogether. In addition, when coupling of nearby utilities takes place, shallow utilities will generally produce a stronger response than adjacent deeper utilities. Therefore, shallow utilities buried over deeper utilities will generally mask effects from the deeper utilities. Besides buried utilities, above ground metal objects can also be affected by coupling of the conducted signal. These objects include rebar in concrete, railroad spurs, and above ground pipe alignments. Typically, subsurface utilities located beneath or in close proximity to these features are difficult to accurately detect or delineate.

Electromagnetic Line Locating Techniques (Passive)

The ability to detect passive signals associated with 60 Hz electric lines is dependent upon the current flowing through the line. The passive signal strength has nothing to do with voltage. It is the current flowing through the line that produces the magnetic field, which in turn is detected by the locator. If an electric line is energized at high voltage, but the load is switched off, there is nowhere for current to flow. Without current flow, there will be no detectable power signal. This results in a line that will not be detected by the locating equipment, but still remains very dangerous if contacted by an excavator, auger, or metal pile.

Metal Detection Techniques (Induction)

The detection of buried metal utilities, using the handheld induction technique, is dependent upon the size of the utility, its depth of burial, and its proximity to above ground metal objects. As the size or diameter of the buried metal utility decreases, the depth at which it can be detected also decreases. For example, a relatively large utility such as a corrugated steel drain line, can be detected at depths of 3 to 4 feet. However, a smaller utility, such as an electric line associated with street lights, may be detected only at depths of 1 to 2 feet. In addition, the ability to detect a buried metal utility is also based on its proximity to above ground metal objects or structure. Cultural features such as chain link fences, buildings, debris, railroad spurs, guard rails, other utilities, etc. may produce a response that can mask effects from the nearby buried metal utility.

GPR

Utilities detectable with the GPR technique include both metallic and nonmetallic pipes. The ability to detect these pipes is dependent on site specific conditions. These conditions include depth of burial, the size or diameter of the utility, the condition of the utility in question, the type of backfill material associated with the utility, and the surface conditions over the utility. Typically, the GPR depth of detection will be reduced as the clay content in the subsurface increases. Therefore, it is possible that utilities, buried greater than 2 to 4 feet, may not be detectable by the GPR technique.

IV.3.2 Physical Limitations

Utility Vault Access

Utility vaults are typically associated with many utility alignments. These vaults range in size from small circular caps and man-way covers to large rectangular steel plates. The purpose of utility vaults is to allow access to valves, meters, pipe junctions, or other features associated with the respective utility. Utility vaults may also provide access into the interior of a utility such as sanitary sewer or storm drain. As mentioned above, many utility locating techniques require that an exterior or interior portion of a utility be accessible so a signal can be applied by either direct connecting to it or inserting a signal-emitting device (Sonde). In many cases, this can only be accomplished through a utility vault. If a utility vault cannot be accessed, the utility of interest may not be detectable.

There are limitations associated with access into these utility vaults. These include limitations associated with the removal of the vault lids, and those associated with the vaults after they have been opened. Limitations associated with the removal of vault lids include physical obstructions on the surface, and denied permission by the respective utility owner to open the vault. Often, physical obstructions are encountered over a vault that has to be accessed. These obstructions can include parked vehicles, immovable trash bins or trailers, or vault lids that have rusted shut. In addition to physical obstructions, some private utility companies require that permission be obtained before a vault can be opened and accessed. Typically, these vaults are locked and must be opened by respective company personnel. These limitations can easily be avoided by conducting site walks and preplanning the utility survey.
Limitations associated with utility vaults after they have been opened include confined space entry, and physical obstructions to the accessibility of the vault. Most utility vaults, by definition, are considered a confined space. Therefore, these vaults should not be entered unless the proper permitting and health and safety procedures, including monitoring and ventilation, have been secured and implemented. To avoid physical entry into a utility vault, extensions can be used to direct connect the line locating instrument to the utility within the vault. It should be noted, however, that a utility may be too deep to reach with an extension. As a result, the utility is also probably too deep to be detected by the above mentioned line locating techniques.

Other physical obstructions to the accessibility of the interior of a vault include water and soil or debris. In some cases, vaults that are not properly sealed from the elements will fill with rain water. Other older vaults and smaller clean-outs can be filled with soil or debris. In these cases, the water, soil, and/or debris must be removed so that extensions and/or Sondes can be used to locate the respective utilities.

Site Access

Site access is very important to the ability and accuracy of locating utilities. Accurate and efficient delineation of a utility requires as many readings along the utility alignment as possible. This is especially true when a utility makes several bends or has not been installed in a straight line. When surface access over a utility has been limited due to thick vegetation, above ground objects, buildings, or parked vehicles, the location of the utility in those areas generally cannot be determined or confirmed. If these areas cannot be accessed eventually, the location of the utility can only be inferred. This uncertainty may create additional delays when construction projects finally begin.

TARGET		METHOD
Irrigation		
Metal Irrigation Line	Access to Pipe	EMC
	No Access	EMI, MD, GPR
Nonmetallic Irrigation Line		GPR
Domestic Water		
Metallic	Access to Pipe	EMC
	No Access	EMI, MD, GPR
Nonmetallic with Tracer Wire		EMC, GPR
Nonmetallic without Tracer Wire		GPR
Fire Suppression		
Metallic	Access to Pipe	EMC
	No Access	EMI, MD, GPR
Nonmetallic		GPR
Natural Gas		
Metallic	Access to Pipe	EMC
	No Access	EMI, MD, GPR, PASSIVE
Nonmetallic with Tracer Wire		EMC, GPR
Nonmetallic without Tracer Wire		GPR
Petroleum		ALL
Electric		EMI, PASSIVE, GPR
Street Signal		EMI, PASSIVE, GPR, MD
Fire Alarm		EMI, GPR
Sanitary Sewer		EMI (Sonde), GPR

Storm Drain	EMI (Sonde), GPR
Drainage Culverts	MD, GPR
Underground Storage Tanks	MD, GPR
Septic Tanks	GPR

LEGEND: EMI – Electromagnetic Induction
EMC – Electromagnetic Conduction
MD – Metal Detection
GPR – Ground Penetrating Radar

IV.4 COST / BENEFITS ASSOCIATED WITH USING SUE

The concepts and practice of SUE have been developed and refined over many years, but basically were systematically put into professional practice in the 1980s. Several states have programs whereby the State DOT contracts with SUE providers to map utilities on their projects. Several studies have shown large cost benefits due to using SUE on individual projects. Most practitioners (State utility coordinators, utility personnel, and SUE providers) feel that although there is still a lot of room for improvement in dealing with utility issues efficiently, significant benefits are currently being realized.

The FHWA commissioned Purdue University to study the effectiveness of SUE as a means of reducing cost and delays on highway projects. The result and recommendations of the Purdue study titled "Cost Savings on Highway Projects Utilizing Subsurface Utility Engineering," are presented below:

SUE is the convergence of new site characterization and data processing technologies that allows for the cost-effective collection, depiction, and management of existing utility information. These technologies encompass surface geophysics, surveying techniques, mapping techniques, AutoCAD/GIS systems, etc. Rather than disclaiming responsibility for existing utility information, subsurface utility engineers certify utility information in accordance with a standard classification scheme (utility quality levels) that allows for a clearer allocation of risk between the project owner, project engineer, utility owner, and constructor.

Previous studies and statements of cost savings were performed by various State DOTs, providers of SUE services, and the FHWA. Commissioning Purdue University to conduct this study allowed for an independent and impartial review and study of cost savings.

Virginia, North Carolina, and Ohio were initially selected to be part of this study. Texas was added because of their rapidly growing SUE program. These four states had a total of 71 projects studied in detail. These projects were selected randomly from a list of projects that utilized SUE. They involved a mixture of Interstate, arterial, and collector roads in urban, suburban, and rural settings. DOT project manager and engineers, utility owners, constructors, designers, and subsurface utility engineers were interviewed.

Wyoming, Puerto Rico, and Oregon were given seed money from the FHWA to try SUE on a select project. These projects are also included in the study (see Appendices), although data from these projects are extremely limited. Finally, several other states have studied their own projects or programs and have supplied information for this study. Overall, approximately one hundred projects were evaluated in some level of detail in order to accomplish the FHWA study mission.

A savings of $4.62 for every $1.00 spent on SUE was quantified from a total of 71 projects. These projects had a combined construction value in excess of $1 billion. The costs of obtaining Quality Level “B” (QL B) and Quality Level “A” (QL A) data on these 71 projects were less than 0.5 percent of the total construction costs, and it resulted in a construction savings of 1.9 percent over traditional Quality Level C (QL C) and/or Quality Level D (QL D) data. Qualitative savings were non-measurable, but it is clear that those savings are also significant and may be many times more valuable than the quantifiable savings.

The figure $4.62 is somewhat less than the $7.00 to $1.00 (Previous Virginia DOT study), $18.00 to $1.00 (previous Maryland DOT study), and $10.00 to $1.00 (Society of American Value Engineers) returns on investment that were previously reported in the literature.

However, the quantity of studied projects is much higher; the projects are more random in nature; and no qualitative costs were included in the total. Indeed, one individual project had a \$206.00 to \$1.00 return on investment (North Carolina DOT). Only 3 of 71 projects had a negative return on investment.

The simple conclusion of this study is that SUE is a viable technologic practice that reduces project costs related to the risks associated with existing subsurface utilities and, when used in a systematic manner, will result in significant quantifiable and qualitative benefits. Using the SUE savings factor data from this study and a national expenditure in 1998, of \$51 billion for highway construction that was provided by the FHWA, the use of SUE in a systemic manner should result in a minimum national savings of approximately \$1 billion per year, (Executive Summary from “Cost Savings on Highway Projects Utilizing Subsurface Utility Engineering”).

SECTION V.
DESIGN STRATEGIES AND ALTERNATIVES FOR AVOIDING UTILITY RELOCATIONS

Different stages in the development of a highway project offer different opportunities for making decisions that can help avoid utility relocations. These stages are planning, design, and construction. The planning stage is started years ahead of actual construction and typically begins with the feasibility analysis of a project identified on a State's transportation master plan. The planning stage can last several years and generally ends with approval of a preliminary ROW map and authorization to begin topographic and utility surveys for design. The design stage, consisting of plans, specifications, and estimates (PS&E), is commonly broken into percentage completion such as 30 percent, 60 percent, and 90 percent. As the various design milestones are reached, the options available for avoiding relocations become fewer. Once the PS&E reach 100 percent, it is assumed that all project information is complete, and the project is competitively bid for construction. Prior to beginning construction, the successful contractor is responsible to notify the local one-call provider to perform the last available utility verification before construction begins. The one-call system is not a fail-safe, however, and without prior communication and coordination effort and utility designation / locating effort, some unknown utility could still exist within the construction corridor. This has the potential to cause project delay and cost overruns, or serious injury or death to construction workers.

This section summarizes the various strategies and alternatives reported on the agency survey conducted by NCE. There are many different strategies and the choices are dependent both on the type of utility conflict and the timing of conflict discovery (planning, design, or construction stage).

V.1 PLANNING STRATEGIES

The most important planning strategy for avoiding of utility relocations on highway projects is to provide all affected utilities, both public and private, with advance notification of the proposed project. This occurs through the distribution of highway master plans, project preliminary design plans, and the regular communication among agencies and utilities.

Meetings. Many of the agencies surveyed for this manual send out annual and even quarterly updates of their 5- or 6-year plans to all the utilities within their jurisdiction. This gives the utility the opportunity to program upgrades or expansions to their facilities located within the proposed construction corridor in conjunction with the highway project, and to identify potential conflicts with existing major utilities. The discovery of a major utility conflict (large diameter interceptor or transmission mains, interstate electric lines or fiber optic cables) having a substantial economic impact to the project allows alternate highway routes to be explored prior to proceeding with preliminary design. Conflicts with minor utilities (small diameter distribution mains and service laterals) are expected, and would not generally alter a proposed highway route in the conceptual stage.

Regularly scheduled meetings are one means of coordinating the planning effort. However, one of the pitfalls of this practice is that there are often too many meetings within a given jurisdiction for a utility company to attend. The most effective method is for the State or municipality to distribute information regarding the master plan and other project issues so the utility can determine the most important projects, then dedicate the necessary staff for meetings and coordination. As individual project development progresses, and approval to proceed with design is obtained, project specific meetings between design staff from the agency and the utility should be implemented.

Utility Coordinating Councils. Many States have formed Utility Coordinating Councils (UCC) as a forum for discussion of master plans and general utility issues. The UCC comprises representatives from utilities, governmental agencies, contractors, excavators, and support companies who meet on a regularly scheduled basis to discuss mutual problems, work programs and planning. All states are encouraged to form a UCC to aid the communication and coordination process. Examples of a variety of State UCC organizations can be found at the following web sites: North Carolina (http://greensboro.ncocc.org), New Jersey (http://njua.org), Georgia (http://www.gucc.com), Arizona (http://www.ci.phoenix.az.us), Florida (http://www.fucc.org), Oregon (http://www.oucc.net), Washington State (http://www.wucc.org).

One-Call Notification. As mentioned previously, use of the one-call system to mark utilities for planning and design purposes is not a standard practice. Liability issues aside, the data and markings provided through the one-call system meet the criteria of Level C at best. However, because of the nationwide mandate to “call before you dig,” the one-call system remains a required part of all projects’ damage prevention strategy.

Subsurface Utility Engineering. Whether the use of SUE (see Section III) is implemented in a project is up to the agency, and is evaluated case by case. Detailed utility information, if deemed necessary, should be provided to the designer with the topographic survey and no later than the 30% design stage. Although relocations may still be avoided at later phases of the design, using SUE early in the design process provides the greatest potential for eliminating problems and achieving the greatest savings related to utility conflicts. The following is taken from the FHWA’s “Program Guide: Relocations, Adjustments, and Accommodation on Federal Aid Highway Projects.”

Since 1991, The FHWA’s Office of Program Administration has been encouraging the use of SUE on Federal aid and direct Federal highway projects as an integral part of the preliminary engineering. Costs for SUE services are eligible for Federal participation.

Proper use of this cost-effective professional engineering service will eliminate many of the utility problems encountered on highway projects, including:

- *Delays to projects caused by waiting for utility relocation work to be completed so highway construction can begin;*
- *Delays to projects caused by redesign when construction cannot follow the original design due to unexpected utility conflicts;*
- *Delays to contractors during highway construction caused by cutting, damaging, or discovering utility lines that were not known to be there;*
- *Claims by contractors for delays resulting from unexpected encounters with utilities; and*
- *Deaths, injuries, property damage, and releases of product into the environment caused by cutting utility lines that were not known to be there.*

The application of SUE, by qualified providers who understand the process, makes it possible to avoid these problems. Unfortunately, some project owners and even some providers believe they understand the SUE process but actually do not and are, therefore, not realizing the maximum benefits. State agencies should no longer be relocating underground utilities unnecessarily or encountering them unexpectedly on Federal aid highway projects. The SUE *technology is readily available to virtually eliminate these wasteful activities. Federal funds should not be used to participate in any unnecessary utility costs on projects where proven technologies, such as SUE, have not been used or have not been used properly.*

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

Some States have developed other agreements and/or test programs that give the State control of the positive locating process. In general, utility owners have been responsible for performing such positive locating activities as is necessary to provide agency designers with the location of their facilities within a project corridor. The agencies frequently require the positive location more expeditiously than the utility can readily or economically provide. In these cases, the positive locating agreement gives the State the authority to retain a contractor for potholing, or to retain a SUE provider to perform the entire locating process. These agreements cover all the utilities' facilities within a given jurisdiction so that separate agreements for each project are not required. These agreements do not supplant the utility agreements / permits described in the preceding paragraph. A sample of a positive locating agreement can be found on the State of California Utilities Web Site at http://www.dot.ca.gov/hq/row/utility/.

Electronic Document Delivery. Although EDD is most important to the design and permit process of a project, it is also an effective planning tool. Highway planning data that can be electronically shared with utilities is an effective means to notify them of project status and/or meeting agendas. The State could be the party responsible for initial notifications providing an efficient means such as Project Wise, Groove, or other similar Web enabled document management systems were in place.

In support of EDD, there is great potential in also having a GIS that is accessible by all entities involved. New project data can be tracked through permit processes so that the information remains current. Appendix D contains a report developed by Texas Transportation Institute of a pilot GIS system being developed in cooperation with Texas Department of Transportation.

Cost Sharing. If a project redesign or alternate design to accommodate an existing utility would require a significant increase to the project design or construction costs, the utility is given the opportunity to pay for the increased project costs in lieu of an expensive relocation. In some cases the cost to the utility may be equal, but avoiding relocation has the advantage of no service interruptions. The DOT benefits also by not having to bear the additional project cost, or having to force the utility to relocate at their expense.

Joint Project Agreements. Many DOTs are advocating incorporation of utility work into the highway contract. Consolidating the work into a single contract improves the highway contractor's control over the utility relocation and may result in lower costs. Although the Joint Project Agreement may contain provisions for dealing with relocation of unknown utilities encountered during construction, their primary purpose is to facilitate the relocation of utilities discovered in the design process, which were incorporated into the competitive bid package.

Context Sensitive Design. Highway projects involving disturbance of existing environmentally or community sensitive corridors have brought about the concept of Context Sensitive Design. Context Sensitive Design is a design approach in which agencies work with community stakeholders to develop a transportation facility that fits within the physical setting, and preserves community values and scenic, historic, and environmental resources, while maintaining safety and mobility.

> **Example:** Overhead utilities typically include electric, telephone, cable television, and other communication lines. To preserve scenic corridors, new construction or relocation of these facilities often means going underground. Burying utility lines, although the safest and most aesthetically pleasing option, is also the most expensive. Often, undergrounding is not within the agency's available budget. The challenge then becomes how to minimize the costs associated with the relocation and to design a relocation that will avoid the costs in the future.

The Maryland State Highway Administration has gotten very creative in trying to find cost-effective solutions that will still please the citizens. In lieu of undergrounding, they have used taller poles that are spaced farther apart, consolidating them to one side of the roadway, and or disguising them somehow to look like trees. By raising and consolidating the lines, much of the clutter is outside and above the driver's and pedestrian's views.

Locate Next to ROW. Because of clear zone issues, the FHWA requires above ground utilities be relocated as close to the ROW line as possible. This minimizes the potential for vehicular impacts. Most agencies require underground utilities to also locate as close to the ROW line as possible. This location has the least probable chance of conflict with widening of the highway.

Trenchless Technology. Under certain conditions, trenchless technology can reduce the costs of relocations. Trenchless technology encompasses a variety of methods to install, replace, renew, or repair underground facilities with minimal surface disruption by minimizing the surface open trench. Some of the methods of trenchless technology are utility tunneling, pipe jacking, micro-tunneling, pipe bursting, directional drilling, auger boring, and slip-lining. Although trenchless, the application of these technologies still requires the accurate locating of existing utilities in and around the work area and is therefore not a substitute for SUE services or one-call notification. A paper on Trenchless Technologies, presented by Mr. Terry McArthur, P.E, can be found on the AASHTO web site under the Highway Subcommittee on Right of Way and Utilities, Proceedings of the 2001 AASHTO/FHWA Right of Way and Utilities Conference, Chapter 4, http://www.transportaion.org/community/right_of_way/2001_cho4so1.pdf.

Joint Trenching / Utility Corridors. Some states relegate utilities to specific corridors or easements that will prevent them from coming into conflict in the future. Reduction in relocation costs and saving critical space in the ROW can also be accomplished by combining compatible utilities into a single common trench that has to be excavated and backfilled only once. As mentioned previously in this manual, however, constructors must be held to the design specifications for installing the joint trenches if utilities are to be expected to accept the additional liability with its use.

Utility Tunnels. No longitudinal utilities were allowed on freeway ROW until 1988 when the ROW was opened up to fiber optics and wireless towers. The telecommunication act opened up highway ROWs to hundreds of communications companies which has created tremendous problems. The use of utility tunnels has been proposed to alleviate some of these problems. This would involve constructing large diameter pipes or box culverts for exclusive utility use near the ROW in conjunction with the other highway construction. Using abandoned large diameter sewer and storm drain lines as tunnels for new, smaller diameter utilities is also a possibility.

Use of Subways for Dry Lines. In urban areas that have subway facilities, these corridors can provide space for “dry” lines such as fiber optics and other telecommunications.

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

V.2 DESIGN STRATEGIES AND ALTERNATIVES

The most effective way to avoid utility relocations is to have accurate and complete utility information in the hands of designers prior to any design activities taking place. In SUE terms, this means Quality Level B data within the 0 to 30 percent design phase. This provides the designer with the maximum flexibility in adjusting alignment and grade, or even obtaining more ROW in order to avoid costly, time-consuming relocations.

In reality, however, this is not usually the case. Conflicting utilities are often not discovered until well along in the design process and the geometric changes that could have eliminated utility conflicts are no longer possible. The cost or time required to do the redesign is too high, other alternatives must be sought.

In the Utility Relocation Survey conducted by NCE, most of the strategies for avoiding relocations during the design stage fell loosely into four groups: alignment and grade changes, drainage changes, structural changes, and slope / curb / retaining wall modifications.

V.2.1 Geometric and Alignment Changes

Changing the grade, or moving the alignment of the roadway is easiest in the planning stage or very early in the design stage (0 to 10 percent). As has been mentioned before, accurate information on the utility location is critical for effective changes to be made at this point. Even as early as 30 percent, there are so many design elements (cross streets, bridges, embankment balance) tied to the selected geometry and alignment that even with computer design systems, re-design is too time consuming to allow for changes. State agencies have stringent project delivery schedules that are driven by budget requirements, funding schedules, and tight construction seasons. So a grade or alignment change of just a few feet that could have saved hundreds of thousands of relocation dollars may not be approved because the delay in design could potentially delay the project an entire season.

Ideally, geometric changes would be made based on Quality Level B data and if grade changes are involved, that would mean some Level A data was collected on the depth of critical utilities as well. If that is not the case, then potentially high dollar decisions are being made based on data of unknown quality.

Case Example: A former Maryland Department of Transportation utility coordinator cites an example of a roadway project that included a bridge which conflicted with multiple utilities, power, water, sewer, etc. An adjustment of a degree or two in the alignment would have placed the bridge out of conflict with the power line with no adjustment to ROW or compromise in bridge function.

The design was complete and construction already well under way when the condition of the utility and the cost implications were discovered. The relocation costs were on the order of $5,000,000.

V.2.2 Drainage Changes

Storm drainage systems and runoff design can take the form of simple ditches tied closely to the geometry of the roadway or can be a fairly complex system of large pipes and inlets that can involve pumping stations in the most sophisticated applications. Transverse structures are those that carry water under the roadway, ranging from small corrugated pipes to box culverts to bridges. For large projects with sophisticated drainage systems, early, accurate information on utility locations is critical for designers to avoid potential utility conflicts.

The alternatives that are available later in the design (around 60 percent) become limited to the less expensive components of the design. Drop inlets, reverse throat inlets, pipe shape, ditch shape, changes from ditch to curb, encasement of the utility and pass through a conflict manhole, etc., may be used to avoid relocating utilities. If a conflict with a large utility and a major storm drain is discovered later in the design process, the re-design time may result in the utility being relocated instead of designed around.

V.2.3 Structural Changes

Structural changes included moving bridge bents and pilings, changing footing designs for piers or other structures or changing the bridge type altogether. Structural changes may also include the accommodation of a utility on the bridge structure by hanging the utility on the bridge, installing the utility in the deck or railing, or passing the utility through the bents. Changes to bridges, of course, need to be done as early as possible in the design process. Footings, and even pilings and piers in some cases, may be made later in the design process without too large an impact on the design schedule. One notable strategy involved pre-drilling pile casings. In this case, a boring is made past the utility, through the zone where the utility might have been damaged. The pile is then inserted in the hole and driven to bearing.

V.2.4 Slopes / Retaining Walls / Barriers

These strategies fall into the clear zone and safety issues that drive many design standards. Many agencies reported making alterations to the slope of the embankment or adding a retaining wall at the toe of the slope to prevent relocating utilities or avoiding encroachment over utilities. These solutions will generally require the addition of guiderails to compensate for the change in slope.

These alterations often occur in narrow ROW where the space required for a widening is limited, and, therefore, alteration to the standard geometry of the agency is warranted. Also included in this category is using barriers to protect above ground utility poles and other utility fixtures within the designated clear zone.

V.2.5 Other Design Strategies and Alternatives

Other strategies that were reported but did not fall into any of the other categories ranged from deleting the proposed design item altogether to increasing the mast arm length on signal standards. Since almost every conflict situation is unique, the potential for creative “out-of the-box” solutions is very high. Agencies with an institutional policy biased toward avoiding relocations will be rewarded with innovative solutions from their staff. The alternative is “we have never done it that way before” and “that is not my job” environments that will lead to continued unnecessary and costly relocations.

Selective Conflict. Selective conflict occurs when there are numerous utility conflicts within the ROW and the highway corridor. The design engineer then decides with which utilities does the conflict occur. A good decision again requires high quality data on the size and types of utilities involved, as well as the relocation costs involved. Other factors that would need to be considered in making this decision are not just relocation costs but user impacts as well. Taking a significant user offline may be a more significant impact on the community than the additional cost to move an alternative utility.

In another case, gravity lines and pressure lines occur in the same vicinity. In this case, the conflict should be directed toward the pressure lines which can be made to go around obstacles and are not affected by elevation changes. Gravity lines are limited in their adjustment possibilities because they are tied to manhole elevations and grade lines.

Case Example: All telephone lines are not alike. A Maryland designer wanted to relocate an overhead telephone line made up of 2700 pair cable. Fortunately, the utility coordinator informed them that the cable would need to be spliced by hand every 120 feet (30 meters) and each splice would require 10 days, delaying the project by 3 months.

Specifications. In some cases, the actual specifications under which a roadway is being constructed may be modified for an overall project benefit. Specifications that are designed with the intention of eliciting the best product in terms of pavement or bridge performance, for example, may not be the most cost-effective when their effect on utility relocation is taken into account.

Altering agency standard or project specifications is not something done lightly. Therefore, the cost or delay to relocate a utility would have to be significant for this option to be used. It should be kept in mind that specifications are not inviolate. They are created through a combination of research, national standards, tradition, past practice, and compromise. They are almost always conservative in order to take into account the construction and material variability inherent in the construction process. A valid way to justify adjusting specifications, then, is to provide assurance that the highest quality materials and workmanship are being used through increased testing or inspections. A thinner pavement section may be allowed if it can be shown that asphalt concrete (AC) contents and gradations are tight and uniform, or a shallower footing provides adequate structural support because the concrete strength is significantly higher than originally required.

Case Example: On the I-15 project through Salt Lake City, the specifications called for a 36-inch (900-mm) structural pavement section to mitigate potential frost damage. This meant that material below the pavement surface had to be granular material down to 36 inches. This was not a problem on the mainline and ramps where the embankment was being built up, but in one industrial area where the local roads were being reconstructed, that depth brought many existing utilities into conflict with the proposed cross section. Approximately 24 inches of material would have had to be over-excavated out and replaced with select fill and this over-excavation would also have run into numerous utilities.

The Corps of Engineers frost depth chart showed potential frost depths were only on the order of 20 inches in this area. The 36-inch frost specification that was intended to help insure 40 years of excellent performance on mainline interstate pavement was being applied to local streets with a 20-year design life. This would provide little in the way of added benefit, and would drastically increase the cost and delay associated with this portion of the project.

A significant amount of negotiation between the Design/Build contractor and the owner was required to reach an agreement. Ultimately, a reduced pavement section was allowed that met the climatic requirements for the location, the performance intent of the specifications, and eliminated the need for an undetermined amount of utility relocations by bringing the bottom of the pavement section up out of the utility zone.

Materials. Material selection is another method for reducing or altering a pavement section so that a utility relocation is unnecessary. Stronger, lighter, or higher quality materials than those typically called for can result in thinner pavement sections and reduced embankment loads that would otherwise force relocation. Using pavement layers with higher layer coefficients such as bound bases using asphalt, lime, flyash, or portland cement can shave inches off pavement structural sections. This can provide the needed clearance over the top of utility lines where the final grade is constrained. Using higher strength concrete can also reduce portland cement concrete (PCC) pavement sections or the thickness or depths of other concrete structural components.

The trade-off with material selection is that better materials cost more and, therefore, must result in time or money savings overall to be justified.

Case Example: The I-15 project through Salt Lake City was a major reconstruction of an urban interstate freeway. Capacity improvements required an increase in width from 6 lanes to 12 lanes typically, and sometimes 14. This resulted in large amounts of fill to raise embankments to accommodate the roadway widths as well as three major interchanges. These fills were often on the order of 50 or 60 feet in height. One of the major design challenges faced by this project was accommodating the large settlements of the soft lakebed soils underlying the project due to these large fills.

In one area, a number of utilities were located below a large increase in embankment for an interchange. The utilities consisted of water and gas mains so the relocation costs and associated delay were huge. The problem was that the potential settlement due to consolidation of the underlying soils was several feet. In other areas, surcharge fills were used to get the consolidation out of the soils prior to final construction but in this case any consolidation would damage the existing utilities.

To avoid relocation, a lightweight geofoam embankment was used. This consisted of big blocks of dense styrofoam stacked in a triangular cross section and covered with fill and a thin cap of concrete over the utility area. Some of the existing fill was actually removed so there was no net increase in load over the utilities. This eliminated any future consolidation that could have ruptured the water and gas mains.

Other types of lightweight fills exist that can significantly reduce the loading on underlying soils.

Standard Drawings for Conflict Resolution. Several agencies have suggested that as utility conflicts become more and more common, there is a potential for developing standard drawings that would deal with the most common types of conflict situations. That would help prevent the process from being put on hold while a solution is sought. It would also create an atmosphere within the agency that promotes avoiding relocations as a valuable and desirable result of the design process.

There are no case examples for this strategy but potential items that may fit well into a standard drawing detail are retaining walls or gravity walls at the edge of a slope to keep from getting into utility easements. Storm drain inlets that are modified to avoid utilities at the edge of the pavement are also good candidates.

Cast-in-Place vs. Pre-cast. Many agencies are using more and more pre-cast concrete products for drainage and other structures to the extent that if the pre-cast section will not fit around a utility, the utility must be moved to accommodate the pre-cast unit. Concrete structures can still be cast-in-place and formed around some utilities without compromising performance of either the structure or the utility.

Adequate ROW Acquisition. In some cases, the utility information is limited early in the scoping process. This has on occasion lead to a situation where a utility had to be relocated because not enough ROW was acquired to accommodate both the roadway and the utility. Depending on the specific site conditions, the acquisition of ROW may be less expensive than a utility relocation.

Case Example: A case has been reported where a foot of ROW would have been sufficient to avoid a major relocation but the need was not apparent during the ROW acquisition process. This is again a situation where having good SUE information very early in the process is necessary for good decisions to be made.

Insulating Covers for Water Lines in Cold Climates. In cold climates such as Alaska, insulating covers have been used to reduce the amount of cover require for water lines.

V.3 SUMMARY OF RELOCATION STRATEGIES

Following is a summary list of the design strategies and alternatives that were reported by agencies responding to the NCE survey. They are listed here as reported, but have been broken into the categories previously described.

Geometric / Alignment Changes

1. Grade
2. Alignment
3. Widen one side of highway as opposed to other
4. Offset location of centerline for short distances
5. Move ramps

Drainage / Ditch / Culvert / Inlet / Curb Changes

1. Move storm drains
2. Low head storm pipe
3. Alternative type inlets
4. Alternative storm drain (oval, etc.)
5. Ditch culverts
6. Narrow ditch widths
7. Redesign ditches from flat bottom to “V” bottom
8. Adjust flow lines
9. Ditch grade changes
10. Use paved ditches
11. Change from ditch cross section to gutter
12. Adjust manhole locations
13. Extend storm pipe runs to avoid ditch cuts that impact utilities
14. Concrete slabs over utilities in ditch bottom
15. Revise or eliminate portions of the drainage design
16. Install closed drainage and curbing
17. Use rip-rap on ditches
18. Add curb and gutter

19. Alternative curb and gutter
20. Reverse throat drainage structures
21. Install a manhole at the conflicting location, encase the utility and pass it through.

Slope / Retaining Wall/Barrier Changes and Additions

1. Barriers
2. Guard rails instead of moving poles
3. Change backslope rate
4. Add retaining walls to the design to reduce slope encroachment
5. Remove slope rounding
6. Change retaining wall types
7. Impact attenuators on above ground appurtenances

Structure / Bridge / Footing Changes

1. Move bridge bents
2. Move bridge end that would conflict with pipeline
3. Alternative foundations
4. Move bridge ends
5. Structural box modifications
6. Structure footing redesign
7. Abutment modifications to allow bridge occupancy
8. Customized foundation design
9. Move bridge pilings
10. Change bridge type
11. Use protective casings
12. Pre-bore and batter pile driving to miss utilities
13. Hang utilities on the bridge, install the utilities in the deck or railings, or pass under the deck through bents.

Other Relocation Avoidance Strategies

1. Insulation over water pipe (AK)
2. Concrete over electric
3. Approved nonstandard design changes
4. ROW reduction to avoid utilities (LA)
5. Signal standard changes
6. Increase mast arm lengths
7. Move proposed signal or sign locations
8. Require hand digging or trench boxes as a design plan note
9. Delete proposed design item altogether
10. Protective shielding (reventment material)
11. Move field entrances
12. Adjust sidewalk alignment
13. Revise detours

Questions to Agencies on Avoiding Utility Relocations

1. Does your agency currently use the Subsurface Utility Engineering (SUE) process, as defined by the Federal Highway Administration, to obtain information about underground utilities?

2. If so, do your in-house designers and/or design consultants use the SUE information in the design of highway projects to avoid or minimize utility relocations?

3. If not, do your in-house designers and/or design consultants use any other sources of underground utility information in the design of highway projects to avoid or minimize utility relocations?

4. At what point in the development of highway projects does your agency notify utilities of upcoming projects that may have utility conflicts?

5. What other coordination activities does your agency engage in with utilities affected by proposed highway construction?

6. Who in your organization determines whether to relocate conflicting utilities or to design around them?

7. What are the factors that might contribute to the design being revised as opposed to the utility being relocated?

8. Are Life Cycle Cost considerations or other economic models used to evaluate relocation redesign issues?

9. What types of design changes have been made by your designers in order to avoid or minimize the need to relocate utilities?

10. During the design process, are there design practices that are implemented during the preliminary design stage to lessen the possibility of a utility conflict? If so, can you name some of these design practices?

11. If a utility conflict cannot be avoided and the utility needs to be relocated, do you have any methods in place to help minimize the cost of relocation?

12. Does your agency have any requirements concerning the placement of new utilities to help avoid future conflicts?

13. Does your agency have any policies or other strategies concerning utilities that may be pertinent to this study?

14. Does your agency have any policies on shared databases?

15. Does your agency do anything else other than the items previously mentioned to avoid or minimize the need to relocate utilities to accommodate highway construction?

	Agency	Contact	1	1 (caveat)	2	3	4
C	Maricopa County	Maricopa County DOT - Patty G. Pauly, Utility Coordinator	Yes		Yes	N/A	Utilities are sent the Bid Date Summary Report (5-year TIP Plan). Utilities are sent the 40%, 70%, 90%, 100% plans for review. Utility conflicts is determined at the 70% plan stage. It is at this plan stage that potential conflicts are potholed and designed around when possible.
M	Columbus, OH	City of Columbus, Public Service Department - Kenneth Alan Yost, Utility Coordinator	No		While some aspects of SUE are being used by some of the city's consultants to identify utility locations, the city has yet to make it a part of the standard engineering contracts.	The city has started to include potholing and better coordination with utilities as part of the engineering process. Current practice consists of calling the state's one-all center to get facilities marked in the field so their survey crews can pick up the marks as part of the topo surveys. Very little coordination, communication or cooperation with the utilities is currently being done by the consultants for utility issues.	I send out engineering notices to all utilities that have facilities in the city, informing them of the scope, limits and schedule for the project as well as the name of the consultant and the project manager. I ask them to respond within 2 weeks if they have facilities within the limits of the project.
P	Private California	Nossaman, Guthner, Knox & Elliott LLP, - Sandra Kanter, Partner	Didn't answer	I am an attorney in private practice. I have represented several agencies with respect to structuring utility relocation matters for their design/build highway projects - for example, the Colorado DOT with respect to the T-REX project. My answers to this survey should be considered in the design/build context only. However, I will not be answering most of the questions as I do not have the necessary specific or technical info.	Didn't answer	Didn't answer	Didn't answer
P	Private Arizona	Salt River Project (Power) - Greg S. Wilson, Distribution Project Leader	I don't know	Haven't read the definition of SUE. We do use pothole info to locate possible UG conflicts.	Yes, as well as "as-built maps" from other utilities	N/A	We have an ongoing monthly utility meeting process that starts prior to the development of ADOTs 15% plans and continues through 100% plans. During this process, this info is exchanged with other utilities and agencies.
P	Private Indiana	Purdue University, Dept. of Building Construction Management, Jeffrey Lew, Professor	No		N/A	N/A	N/A
P	Private Florida	TBE Group Inc. - Steven J. Tidwell, Assistant Vice President	Yes	FDOT is a de-centralized agency. Each district has own SUE program. Each different.	Yes, some more than other.	N/A	Distribute 5-year work program once a year. Distribute 2-year let plan once a month.

	Agency	Contact	1	1 (caveat)	2	3	4
P	Private Georgia	Bell South Telecommunications, Inc. - Marie Piper, DOT Liaison for GA and MS	Yes	The GA DOT is using SUE on some of its projects, primarily on those which call for their assistance with local public utility relocations (i.e. city or county water and sewer facilities).	I have not seen any evidence of the DOT designers using the info to avoid or minimize private utility relocations. However, very few SUE projects have reached the construction stage at this time.	N/A	The first notice that utilities get is with the first plan submission after a preliminary design has been developed.
P	Private Montana	Harding ESE - Richard Clarke, SUE Services Supervisor	Yes	Harding ESE provides a dedicated SUE program.	SUE info is a factor in Montana DOT and Harding ESE design projects.	N/A	Utilities are notified at the preliminary planning stage.
S	Alabama	Alabama DOT - Robert G. Lee, State Utilities Engineer	No	Are considering it	N/A	In-house surveying, potholing by consultants	Send out preliminary plans showing Const. and ROW limits.
S	Alaska	Alaska DOT & Public Facilities - Al Risley	No		N/A	As-builts, locates	Begin of design
S	Arkansas	Arkansas Highway and Transportation Department, Ralph Williams, Section Head, Right-of-Way Division	No	Just let three projects	N/A	One call, in-house survey, coordination inspection	Contact as in 3. 50% design, annual meetings with largest utilities to review proposed projects.
S	California	Caltrans - Lorrie Wilson, Office Chief, Utilities and Systems	No		N/A	Info is directly provided from utilities and pothole work. As builts.	Utility companies are notified of an upcoming project at the early design phase, if not sooner. At the early design phase, utility companies are asked to provide as builts and verify their facilities on the departments preliminary plans.
S	Hawaii	State of Hawaii DOT - Jeffrey Fujimoto, Engineer (Civil) VI	No		N/A	Reference as-built and permit plans. Verify locations of critical utilities by toning.	Sheet wasn't faxed.
S	Idaho	Idaho Transportation Department - Jonathan Lenhart, Utilities/Railroad Engineer	No	Are considering it	N/A	Yes, designers should coordinate with utility companies to determine the location of facilities and work together to design relocation that is best for the project design.	Just after concept approval and beginning of preliminary design.
S	Louisiana	Louisiana DOT and Development - Melvin Bueche, DOTD Headquarters/Program Manager	No	LADOTD has no provisions to pay for this service. LADOTD has in place a LA one-call service--a "ticket" is called in and utility companies have 48 hours to locate facilities.	N/A	Survey info is provided to our design section. A plan-in-hand and joint-plan-review is held (60% completed plans) to review utility conflicts and costs.	Letters sent at the survey stage. Companies are notified of our survey and are requested to assist our survey crews in locating their facilities.
S	Mississippi	Mississippi DOT - Kelly W. Standard, District Two Utility Coordinator	No		N/A	During preliminary engineering, a survey crew topos, the project and collects all utilities	When R/W starts

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S	New Hampshire	NHDOT - Charles Schmidt, Chief of Design Services	No		N/A	The NHDOT places this responsibility upon the owner of the utility. We send plans to them of our surveyed info and they are required to mark up any corrections and or confirm the accuracy.	Approximately the 15% stage
S	North Dakota	NDDOT - Joe Neuenschwander, Utilities Engineer	No		N/A	Yes	Depends on the facility, i.e., large hydrocarbon pipelines, electric transmission lines, and transcontinental or intrastate fiber cables will get the project info 12 to 20 months prior to the bid opening. Other utilities are notified 3 to 6 months prior to the bid opening.
S	Pennsylvania	Pennsylvania Turnpike Commission - Ronald V. DiNinni, Right-of-Way Utility Coordinator	No	We use partial SUE applications on an as needed basis. It is rare that we use Federal money on our projects, but we do, I believe that we will or do incorporate this technique as identified by the FHWA.	When we are in serious doubt, we use some SUE techniques and the info is then used to minimize relocations.	They may combine SUE techniques along with one-call and in-house utility crossing license agreement file and field view data.	The roadway alignment is determined during the preliminary design phase, at 40% the utilities are requested to verify if they are in the area and any potential conflict. An initial field meeting(s) is scheduled with utility companies, municipalities and railroads located within the project. Railroads are under the jurisdiction of the Pennsylvania Utility Commission and their protocol.
S	Wisconsin	Wisconsin DOT - Ernest J. Peterson, Utility/Access Management Engineer	No	Horizontal not Vertical	N/A	We insist that utility facilities be field located horizontally. The utility must locate and mark the facility and design survey crews must pick up that info for the plans.	Early in the design process, utilities are notified of the project. During final design, utilities are sent plans to identify conflicts and design their relocations.
S	Arizona	ADOT - Bruce Vana, Engineer - Manager Utility and Railroad Engineering	Yes		Yes		Utilities are invited to participate early on in the development process. They are allowed to view and comment on the concept level plans through the 30% stage. At this stage once the Alignment has been set, we begin the actual utility locating effort.
S	Arizona	ADOT - Al Field, Mag Freeway Utility Coordinator	Yes		Yes		5%

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S	Colorado	Colorado DOT - R. Bruce Johnson, Statewide Utilities Engineer	Yes	Not systematically	The process is used more often as a means of accurately locating utilities and accurately determining the extent of an apparent conflict. Designers may then proceed to look for less costly alternatives.	Other sources of information are generally not reliable enough to allow one to confidently re-design around utility conflicts.	At some point after what CDOT calls the "Field Inspection Review" which is approximately the 30% completion stage for project plans. At the time of the FIR, we show only unverified, and possibly incomplete, utility info on the plans. Locations are verified and conflicts identified at some point between the (approx.) 30% and 60% design stages.
S	Connecticut	Connecticut DOT - Robert Ritsick, Transportation Utilities Engineer	Yes	We have been using a modified SUE on our own for a long time.	Yes		When we have a project, we inform the utilities as soon as possible.
S	Delaware	Delaware DOT - Fran Hahn, Utilities Engineer	Yes		Yes		When the project is scheduled for design
S	Florida	Florida DOT - Rocco DePrimo, District Utility/Value Engineer	Yes	Extensive use of SUE	Yes		Approximately 60% plans or early if information is available
S	Florida	Florida DOT - Vince Camp, FDOT District 2 Utility Engineer	Yes	My district is currently using SUE to some extent on each and every project within our district work program. We use it on minor signal projects, which involve underground investigation of the proposed signal foundation location…all the way up to complete underground survey and mapping of our right-of-way when a proposed roadway multi-lane project is being designed. Have been managing four SUE district-wide in-house contracts at $750K per contract for over 2 years and we require our consultants in our design scopes to provide SUE services on each project they are designing. My district has been performing SUE at some level for over 12 year. Our district construction office manages one SUE contract for active construction projects to provide the necessary support to field personnel during active construction projects.	Our district-wide SUE contract supports in-house design, and design consultant have it within their design scope to provide and use the SUE info to design around conflicts and minimize relocations.	See No. 2	We provide both monthly and yearly notifications of our work program schedule, 5-year is maximum and concentrate on a 2-year window. We try and coordinate with all utility owners prior to 30% plans. After the PD and E report is finalized, utility owners' facility are surveyed and located horizontally during topo survey phase for entire project. Additional SUE needs are decided and discussed with the utility owner and pre-30 design plans are utilized. Minor projects may not have the first coordination meeting until 60% plans.

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S	Illinois	Illinois DOT - John Bellis, Agreements Unit Chief	Yes	We recently hired three SUE consultants. Illinois is divided into 9 highway districts. One consultant will handle our Schaumburg (District 1) region, the second will handle our Peoria (D4) region, and the third will handle the remainder of the state.	Both in-house designers and our design consultants will utilize the gathered information. The full impact is not known as the consultants have been authorized for less than 6 months.	Prior to the adoption of a SUE policy, the department would require the utility owners to "pot-hole" locations to obtain accurate horizontal and vertical locations. This was done at no cost to the department. Department personnel were generally on hand to provide surveying services. The info was then given to the designer and the project support engineer at the district.	A request for utility location info is sent via certified mail to all the known utility owners within a proposed project location. This is done early in Phase 1 (Planning). The request contains aerial mapping, aerial mosaics, and/or preliminary plan sheets which show the project and existing right-of-way limits.
S	Illinois	Illinois DOT - Cheryl Cathey, Chief of Preliminary Engineering	Yes	IDOT's policy is to utilize SUE consultant engineers on urban projects involving subsurface excavations where potential utility conflicts exist.	Yes, in the limited projects cited above, the SUE info is used extensively in the PEI (planning) and PE II (design) phases.	The district project support engineer in cooperation with the utilities and the statewide One Call System determine the location and depth of the utilities located within the limits of a proposed improvement.	Individual preliminary plans are sent to utilities located within an improvement during the PEI (planning phase) and usually twice during the PE II (design) phase. General info is made available to the industry through the publication of IDOT's 5-year construction program.
S	Indiana	Indiana DOT - Matt Thomas, Highway-Utility Manager	Yes	Limited basis	Yes, we give the info to our designers and ask them to look at it to see if there is anything we can do to minimize impacts on major utility lines.		We involve utility companies in our "grade review" meeting and preliminary field check. We try to collect info on the location of their facilities and gather any major concerns they may have with regards to their facilities. We have utility companies and designers in direct contact.
S	Kansas	Kansas DOT - Al Cathcart, Coordinating Engineer, Bureau of Design	Yes	Only used SUE on one project in Kansas	In the one instance where SUE was used, the info collected was used to avoid utility relocations.	In most cases, the underground facilities are probed or pot-holed to determine depth and location.	We notify utility companies that we have a project when we begin design surveys. We share design plans for the project at field check when plans are about 50% complete.
S	Kentucky	Kentucky Transportation Cabinet - Greg Smith, Transportation Engineer/Branch Manager	Yes	Not routinely	Yes	?	Varies from location to location and project to project. We try to brief utilities regularly on status of 6-year plan so they may plan and budget. We involve companies early enough before project advances form Phase I to Phase II design.
S	Maine	Maine DOT - Brian Burne	Yes	Don't use consultants	Use info collected as described in No. 1.	If SUE is interpreted as only hiring SUE consultants, then may answers to No. 1 and 2 can be used here.	When a project is started, the utilities are notified and coordination occurs throughout. Conflicts are identified along the way.

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S	Maryland	Maryland State Highway - Joe Bissett, Statewide Utility Engineer	Yes	To identify underground utilities	Yes, to minimize utility relocations	N/A	We notify utilities of upcoming projects. We have a 6-year plan and share monthly add schedules. We have project initiation which we have P.I. Meetings with utility companies.
S	Michigan	Michigan DOT - Mark Dionise, Utility Coordination and Permit Engineer	Yes	Limited basis	Yes, MDOT uses SUE on projects which may have significant utility conflicts in order to minimize or avoid conflicts and relocations.	If SUE is used, utility information supplied by the utility owner is used.	We request utility info as early in the design process as possible. Notify company of potential conflicts at 50% plan completion.
S	Montana	Montana DOT - Walt Scott, Supervisor/Utility Section	Yes	Selected projects only	Our designers have been instructed to design around utilities when at all possible.	Our designers have the option to request utility survey from staff personnel, who in turn request underground locates from one call.	A copy of the department's project management schedule is mailed to every utility company in the state four times a year.
S	Nebraska	Nebraska Department of Roads - Mark Ottemann, Utilities Engineer	Yes		Yes	N/A	1 year ahead of letting date
S	Nevada	Nevada DOT - Paul A. Saucedo, Supervisory R/W Agent - Utilities	Yes		Both, to avoid if possible and to minimize if relocation is required	N/A	Usually around 30% design plans, we send out initial plans and request to start process. At 60% plans, we ask the utility companies to begin their relocation design plans.
S	North Carolina	NCDOT - Aydren D. Flowers, State Utility Agent	Yes		Yes, where practical and cost-effective	N/A	Depends in magnitude of project. Low impact projects: probably would not involve utilities until R/W plans were involved. High impact projects: utilities are involved early on, usually during project scoping and preliminary design.
S	Ohio	Ohio DOT - Bruce B. Gaddis, Manager, Central Office Utilities	Yes		Yes, whenever possible	On projects where SUE is not used. Rely on info from utilities through the Ohio one-call system and readily available field info gathered by designer.	Initial stage of project development, utilities are notified of project and provided basic project info.
S	Ohio	Ohio DOT - District 4 - Steve Jones, District Utilities Coordinator	Yes		Yes	N/A	Most of the time. As soon as the scope of services is approved and awarded to a design consultant. 4 stages - utilities are informed no later than stage 1.
S	Oklahoma	Oklahoma DOT - Lynn Whitford, Manager of Utilities	Yes	One time	That is what we hope will happen. Plans have not been submitted yet.	Very recently, ODOT has modified its attitude of relocating utilities to accommodate the construction to considering the cost of relocation compared to alignment.	Didn't answer

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S	Pennsylvania	PennDOT - John G. Proud, Utility Relocation Administrator	Yes	SUE is not used on all projects.	Yes, the info must be provided early in the design to be most beneficial.	On projects where SUE is not used, PennDOT uses info provided by the utility relative to their location. If the info received is questionable, the utility will excavate test holes to determine the horizontal and vertical location.	On major projects, utilities are notified early in the final design. When plans showing existing topography are available (30-40% complete), utilities are requested to verify and correct the info. On minor projects, utilities are notified when a plan is approximately 60-70% complete. These projects have minimal utility involvement and are usually designed and built within one year.
S	Tennessee	Tennessee DOT - Joseph E. Shaw, (No. 2) State Utility Coordinator	Yes	The department has used SUE on 3 projects on a pilot basis. There has been no proposals for independent SUE industry consultants to perform contract SUE work. There is not a standard department policy or procedure for the use of SUE this time.	No, the info provided has been used as a comparison to standard survey methods and primarily as a "locating" function for identifying existing utilities and relative location.	Utility location is done by the utility or by the one-call services. Underground horizontal locations are somewhat accurate based on above ground features. Vertical locations are very questionable.	When the project is identified or defined by the department, normally at the Advance Planning Report. State Statute requires that complete plans be sent to the utility for construction coordination.
S	Tennessee	Tennessee DOT - Joseph E. Shaw, (No. 1) State Utility Coordinator	Yes	Three pilots	This office advocates the use of SUE to guide the roadway designers in the development of projects to avoid utility conflicts if possible. The Survey office has been requested to include this issue in the development of TDOT policy and procedures for SUE.	Two issues in Tennessee. Location of utilities is a continuing problem for department surveys. The second issue is to make the designers aware of the impact of utility relocations to various people.	The department notifies utilities of the general project location as per the Advance Planning Report. The utilities have been invited and have been provided development plans during project development. Utilities are required to be contacted when ROW plans are distributed within 120 days, with stipulation of 45 additional days. There are no penalties for noncompliance with this statute.
S	Texas	TxDOT - Randall W. Anderson, State Utility Coordinator/ROW Supervisor	Yes	Since 1997	Some do, some have admitted they don't use SUE info even when they have it to tweak highway design.	Probably quality level D & C type resources/info	Realistically just before or right after letting. Theoretically - end of advance planning to 30% PS&E.
S	Texas	TxDOT - Gary L. Ray, District Design Operations - Public Utility Coordinator	Yes	State of Texas initiated the use of SUE providers in 1997 and were established for implementation on a statewide basis using 4 SUE providers. A second series were negotiated with 9 SUE providers in 1999. Currently, the Houston District is in the process of developing a local program which will entail the use of 4 SUE providers performing work within a 6-county area.	Yes, identifying utility facilities located within the various highway corridors does allow designers to minimize impact, facilitate the accommodation of utility facilities and minimize inconvenience to the traveling public. Allows us to evaluate the facility with regard to state's utility accommodation policies.	Where SUE is not utilized, designers rely upon field inspection, review of old plan sets/R/W mapping, red-line drawings and utility installation applications, etc.	Upon initiation of the design process. The Houston District began an electronic distribution of our project award schedule on a monthly basis. Per Houston District policy, designers are required to communicate and coordinate with the utility entities themselves.
S	Texas Turnpike	Texas Turnpike Authority Division	Yes		Yes	N/A	We hold annual meetings to discuss upcoming projects with utilities in the region. We start early in the design phase.

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S	Virginia	Virginia DOT - Dave Austin, State Utility Engineer	Yes		Both uses the sup surface info	N/A	At the field inspection phase
S	West Virginia	West Virginia DOT - Guy W. Mick, Chief, Railroads and Utilities Unit	Yes	Sometimes	Yes	Verification plans from utility companies	Utility companies become aware of a project when they are asked to verify their facilities for the project. They become aware of specific conflicts when they are given plans and authorization.
S	Wisconsin	Wisconsin DOT - Sheldon E. Larsen, State Utility Projects Coordinator	Yes	Only on some projects	Yes	Utility locations are determined and placed on plan and plat. Then info meetings are held involving utilities to see if conflicts can be eliminated.	We hold annual utility coordination meetings where we present our 6-year plan (booklet). We invite utilities to our operations projects meeting at inception of project. We also held at least two utility coordination meetings during the design process.
S	Wyoming	Wyoming DOT - David R. Bryden, Utilities/Railroad Administrator	Yes		Yes, but not 100%. The info is used for locating, but little in the way of avoidance.	Yes, field surveys by DOT personnel. Not much done in the way of avoidance.	Sheet wasn't faxed.

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C	Maricopa County	It is the utilities responsibility to provide MCDOT with prior rights documentation if claiming prior rights. MCDOT reviews this info and verifies their prior rights. When verified, the utility must provide an estimate of the cost to relocate their facilities which needs approval from the County Board of Supervisors.	The project manager, designer, utility coordinator.	Safety, cost, R/W, time etc.	We only re-design if it does not compromise the integrity, purpose of the project.	Added curb and gutter, re-designed a storm drain lateral, used an SRP electric pole as a Jt. use pole for a signal, eliminated unnecessary cutting to avoid utilities.	Install curb and gutter, avoid unnecessary cutting, re-design storm drain laterals to avoid utilities, design conduit into bridges for future use, utilize SUE, coordinate with developers to minimize re-relocation, utility Jt. trenches, utilize aesthetic funding to underground electric and pipe irrigation.
M	Columbus, OH	I send out a list of roadway projects monthly that covers a 2-year period indicating the project name, scope, limits and schedule. I currently submit preliminary, final and signed plans to utilities that I know have facilities in the limits of a project. I meet with utilities as needed for individual projects to work out conflicts or relocation schedules.	I will decide, in collaboration with the project manager and the utility to have the consultant re-design to avoid a utility conflict. However, the utilities need to respond to my plan submittals to identify conflicts in a timely manner. If they do not get back to me early in the design, we may not be able to make the changes.	The existence of a utility easement. If a utility has facilities in conflict with the project and it is in a utility easement, the city would have to pay for the relocation. The time and cost to the utilities to relocate the conflicting facility.	The life-cycle cost considerations of the utility facility would be communicated to us by the utility. By the same notion if the city is going to rebuild the pavement, we do not want them to dig into it for 3 years after completion to preserve the pavement life.	Re-design of sewer, traffic, curb, water facilities or construction techniques are all examples of changes we have made to the plans to avoid a conflict with utilities.	I would not call them practices. If I saw a conflict or potential conflict in the preliminary plans, I would ask the consultant or utility to get a better location on the conflicting facility to confirm that a conflict exists. We have communicated to the consultant that relocation of utilities needs to be avoided where possible as part of the scope.
P	Private California	For design/build projects, the project owners delegate to the design/build contractor primary responsibility for coordinating with utilities, requiring the contractor to keep utility owners fully informed as to project matters impacting them, to consider their needs in designing and scheduling the project and to meet with utilities periodically. For the projects I have worked on, the project owners have generally entered into either nonbonding MOUs or binding master agreements with utilities governing the process of utility relocations. the contractors are required to comply with these agreements.	In general, substantial flexibility is delegated to the contractor to make design decisions on a D/B project, including decisions with respect to addressing conflicting utilities.	On the D/B projects, the contractor typically bears both the risk of increased costs and the potential savings resulting from design changes, within specified parameters. Many of the D/B contract require contractor to minimize relocations. One contract requires the contractor to endeavor to avoid multiple relocations, with the provision that the contractor is responsible for all relocation costs reimbursed to the utility owner by the project owner after the first relocation of a utility.	Didn't answer	Didn't answer	Didn't answer
P	Private Arizona	We also attend individual breakout meetings with ADOT's designer and other utilities that are using joint trenches or are adjacent to new planned work areas.	Our water group has that authority. I don't know who makes that call, but I assume that it is the design group.	N/A	No	We are a utility and are usually the one who gets moved.	No
P	Private Indiana	N/A	N/A	N/A	N/A	N/A	N/A
P	Private Florida	District liaison meetings in 6 of 7 districts. State Liaison Committee. Each project has specific utility meetings.	Utility coordinator with highway designer	Cost benefit analysis	Suppose to be, not always followed.	Conflict structures, low head storm pipe, alternative type inlets, alternative foundations, barriers.	Evaluate storm drainage trunk alignment.

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P	Private Georgia	There is very little coordination with utilities by the GA DOT; but rather they expect the utilities to do the coordination themselves - as per an "agreement" which the utilities (voluntarily?) signed in 1986. It is almost impossible to get responses back from the other involved utilities.	N/A	As a utility, we have offered to work with DOT if a design change results in increased costs. In a few instances, we have offered to buy additional R/W or pay the incremental cost difference.	Didn't answer	Didn't answer	Didn't answer
P	Private Montana	Harding ESE works with the MDT Utilities Section. MDT Utilities Section coordinates utility matters affected by proposed highway construction.	On work carried out for the MDT, MDT Utilities Section makes these determinations.	A cost analysis is the major factor in Harding ESE's approach.	Yes, life-cycle cost considerations are a factor.	Storm drain design is a typical example of the type of design influenced by SUE.	Harding ESE takes account of utility factors as early as practical in the design process.
S	Alabama	Utilities sent revised plans at 50% completion and invited to pre-con.	Various	Cost, status of plans when change is considered, schedule, envir. ROW.	Occasionally	Mainly raising the grade	Costs are considered
S	Alaska	Coordinate Design, Agreements, Relocation and Billing.	Design and utility engineer work together, design engineer makes final call.	Cost, schedule, ROW	No	Change alignment and grade, add a culvert in a ditch to prevent cutting around pole, insulation over H2O, concrete over electric.	Change alignment or grade based on cost considerations. Locate utilities prior to design.
S	Arkansas	AHTD evaluates costs and an effort is made to contact small utilities and cities to discuss.	Joint effort between ROW, Utilities Section, and Design Division.	Cost, no matter who is paying, relocation time may be longer than the available Construction time.	Yes, If the facility is under consideration to remain in place, but is deteriorating LCC may affect the decision.	Reduce to curb and gutter sections: change proposed locations and or elevations of storm drains and drop inlets; widen on one side of the highway as opposed to the other; etc.	See 3&4 above.
S	California	It is possible Caltrans will have the utility facility potholed. (positively located) in the field.	The in-house project engineer determines utility conflicts with proposed construction.	Some factors that contribute to the proposed design being revised as opposed to the relocation are the flexibility of construction to work around existing underground facilities.		Approved non-standard design changes e.g. place guardrail to avoid underground utility facility can be made or the protection of the utility facility that would otherwise be difficult to relocate e.g. gravity flow sewers.	Yes, 1) Perform positive location of underground facilities. 2) Obtain facility plans from utility owners. 3) Homeowners verify the location of their facilities on the state's plan sheets. 4) Meetings are held between the departments' engineers and the utility companies to lessen the possibility of a utility conflict.
S	Hawaii	Sheet wasn't faxed.	Sheet wasn't faxed.	Safety, cost, environmental issues, community concerns/traffic impacts, project schedules and deadlines	Life-cycle cost and depreciation are calculated in the utility agreement.	Revised roadway alignments, installing guardrails and other barriers to separate or protect existing utilities from vehicles, bicyclists or pedestrians, design new structures to accommodate existing utilities.	Sheet wasn't faxed.
S	Idaho	Throughout the design process and during the construction process	The designer	If the cost is less to do a design improvement (I.e. place guardrail at $50K rather than relocate large power poles at $100K each.)	No	See No. 7 for example	I don't understand this question. Designer coordinates with utility company.
S	Louisiana	Pre-design conference with all utility companies	HQ utility section and design	Money. Design will look at alternatives to reduce utility costs.	N/A	Re-alignment and/or R/W reductions to avoid utilities (where possible).	Yes, meetings are held to review and consider all alternatives.
S	Mississippi	Each district utility coordinator meets with the utilities to discuss the proposed project.	This would be done by the construction department at the district level.	Major utility such as transmission gas oil lines, time frame for relocation	Yes	Move a bridge end that would conflict with a pipeline.	Detour roads at bridge replacement sites are built on the side with less utilities

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S	New Hampshire	We coordinate all of the relocations in order to show on our design plans. We will also include relocations that they desire that may not be required of our project.	Initially, the individual utility coordinator, then the utility engineer and the chief of design services	Construction delays and potential cost to the consumer, either the taxpayer or the rate payer	No	Drainage, alignment (horizontal and vertical) changes and structural box modifications	Early coordination between the designers, the utility coordinator and the utility owners
S	North Dakota	The utilities that budget on an annual basis contact us when starting their budgeting to see if any of our projects may require relocation or adjustments. The others stay in contact with one of our district offices, the utilities engineer, or by attending public forums, info meetings or public hearings.	Both the designer and the utilities engineer with approval by the design engineer	The impact to the consumers	No	Change in elevations, narrow the ditch widths, change the backslope rate, move storm drain facilities, move lighting or signal standards, increase the mast arm lengths and move signal standards, office location the road center line for short distances, other methods. All of these methods must fulfill the Design Guide criteria and have the approval of the design engineer.	This is similar to the previous response. During the environmental stages, the public hearing process and implementation of the design concept report, future conflicts are brought to the attention of the utilities engineer.
S	Pennsylvania	Once potential conflicts are determined, our consultant or we will set up a meeting with the affected facility (utility) owners in an attempt to resolve the conflict. Possible revisions to our design are considered prior to an order to relocate.	This is a coordinated effort, but usually is decided by the R/W utility manager, and then is presented formerly to the Turnpike Commission by way of the project manager, consultant, assistant chief engineer - design, and chief engineer.	Time as it relates to the project schedule, the ability for a municipality to be able to fund the relocation, an extreme hardship to a utility.	Ease of maintenance would be a consideration.	Alignment and profile changes , also, drainage re-design. Other considerations are re-design of structure footing and abutment modifications to allow bridge occupancy.	An awareness of the utility presence within the project area and early interaction. This may involve telephone conversations with the utility's representative for this work.
S	Wisconsin	Annual meetings where the 6-year plan is distributed to utilities	Highway designer with input form utility coordinator	Notification of the complexity and high cost of a utility relocate. Input from utility company.	No	Adding retaining walls to the design, shifting alignment, changing storm sewer design	Utility coordination meeting during preliminary design. Utilities are asked to identify potential conflicts, especially expensive ones that should be designed around
S	Arizona	Monthly Utility meetings for projects we consider to have significant utility issues.	Joint effort between the utility company, ADOT and our design consultant.	Based on cost effectiveness and project needs.	No	Minor geometry changes, slight adjustments to the location of drainage features. We consider any small adjustment that does not detract from the original concept of the project.	Between the utility locating and pothole data, the slight adjustments mentioned above is about all we can do to session the impact to utilities.
S	Arizona	Monthly Utility meetings and One on One meetings w/utilities	Cooperative effort with ultimate decision by Project Manager.	All factors are considered, gravity flow vs. pressure, outage, availability and cost.	if necessary, benefits one way or the other are usually obvious.	All sorts, too various to list.	All designs evaluate possible cost/benefit trade-offs for total project cost which is to the ratepayer/taxpayer (same person usually)

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S	Colorado	At the FIR or shortly thereafter, CDOT and utility owners do a separate "walk-through" of the project site to verify preliminary plan info and/or inspect areas of probable conflict. May also have follow-up meetings to plan additional investigations, and/or to negotiate relocation requirements.	Project designer usually makes such determinations based on project economic considerations. Designer should make a decision in consultation with our utility liaison. Designer should consider fiscal impact of design decisions on utility customers.	Usually, it will be for reasons that solely benefit the project, such as reduced construction costs or expedited schedule. (In CO, the state must pay to relocate governmentally or municipally-owned utilities). Occasionally, it is determined that for a nominal increase in project re-design costs, a costly utility relocation that would otherwise have been the owner's cost responsibility can be avoided.	Could be considered, but is not routinely used.	A shift in alignment and/or profile grade will be considered as a means of allowing an existing utility line to remain in place.	I am unaware of any such practices.
S	Connecticut	We have meetings with the utilities as needed. We may have anywhere from one to as many as are needed to complete the job.	Our philosophy is to design around them if possible.	We design around them because of the project cost and time involved.	No	We have moved drainage around. This may reduce cuts in certain areas. We look at every avenue to minimize the need to relocate utilities.	We try to avoid them. We don't like to relocate utilities unless there is a problem.
S	Delaware	Regular meetings	Me	If the utility can be avoided without undue cost, then we avoid it.	No	Drainage, geometrics, pavement	Test holes
S	Florida	Some SUE with initial design survey, 30% plan meeting with utilities, utility adjustment sheets, part of plans package. Utility relocation schedules part of highway specifications (life blood of utility coordination).	Team effort designer, utility office	Saving utility company time and money would be a factor. Saving state agency time and money is always a factor.	Life-cycle cost are used	Relocate/change storm drain design, move road to one side of right-of-way, have utility companies provide highway lighting	Yes, preliminary meetings with the utility owners, SUE
S	Florida	My office coordinates some of the additional tasks..roadway lighting provided by the local power companies, lighting maintenance agreements with local governmental agencies, inclusion of utility work into our highway contract, replacement of utility easements taken during the design of transportation projects, utility permit review, liaison activities involving the work program (see No. 4), guidance on the use of utility materials and equipment for placement of utilities within our right-of-way upon direction from the state utility office.	The decision to relocate utilities is a joint decision between the district utility office and the Designer of Record on each project. The District Design Engineer provides the final resolution on situations unable to be resolved between design and the utility office.	Safety is the first factor. Next is constructability. Thirdly, is it economically the best alternative for everyone…both the state and the utility owner?	We do look at life-cycle cost of the road and the utility facility for relocation and redesign issues.	Simple things like changing the design location of a proposed signal and sign location or storm sewer inlet, using black base instead of full depth widening with lime rock, requiring hand digging or trench boxes for certain type of excavation as a design plan note, redesign of ditches from flat bottom to "v" bottom, use of elliptical pipe instead of round pipe thus allowing the underground utility to pass under or over the new pipe. On foundation, we have used spread footers, straddled large telephone duct banks and pressure mains with customized foundation designs, and the simplest thing..deleted the design item all together.	Use of SUE up through Level A is the primary design practice. Extensive design meetings during the 30 through 90% plans development stage, both meeting the utility owners as a group and individually. Each utility owner is required to develop a utility work schedule that identifies their utility facilities within our proposed project and provides a disposition of what is going to happen to that facility during construction, i.e. locate, protect, relocate, adjust..dependent activity..i.e. after clearing and grubbing by contractor, during pipe installation, etc. and the associated maintenance of traffic phase that this work will take place in..i.e. phase I, II, III etc. and the number of days for the utility work to take place. This schedule becomes part of the construction contract and is in the spec.

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S	Illinois	The districts hold annual utility coordination meetings to discuss the projects funded in our annual program, our 5-year program, and our multi-year long range proposed improvements. This info is presented to allow the utility to review their long range improvement plans and as a budgeting tool for future utility relocations.	District office personnel. The project support engineer or a member of his staff will identify the utility conflicts and meet with the designer to see what, if anything, may be changed to avoid the utility conflict.	Ease of making a proposed design change. Will the proposed change compromise the design? Need for additional right-of-way. Cost of making the design change. Additional construction cost.	No economic models are being utilized or life-cycle cost considerations. All cost comparisons are based upon current dollars.	Relocating drainage structures, relocating fire hydrants, adjusting flow lines, adjusting sewer grade lines, use of drop structures, use of encasements and/or protective shielding (reventment material), adjusting/relocating proposed ditch lines, slope etc.	Major conflicts occur as a result of proposed subsurface drainage or expansion of the roadway cross-section. An evaluation of the overall drainage system is made to see if adjustments may be readily accommodated. If an existing utility is not in conflict with the proposed improvement, but will be under the new pavement, consideration is given to allow it to remain in place until such time as it becomes a maintenance problem. Other items include, but are not limited to, those mentioned in No. 9.
S	Illinois	Other than the supplying of plans to the utilities, as stated in No. 4, the utilities are also invited to the preconstruction conference. Recent changes to Illinois Statutes have mandated the organization of coordination councils comprised of state and utility personnel to enhance coordination and communication.	The district's project engineer in cooperation with the project support engineer and the affected utility.	The single most important factor is: can we get the same quality of improvement with little or no extra cost to the taxpayers with a re-design? If this is affirmative, the re-design is normally pursued.	No	Changes include the steepening of ditch backslopes, changing ditch grades, varying storm sewer elevations, changing manhole locations, using elliptical or arch pipes instead of round, adding paved ditches to protect utilities, changing form ditch cross section to a gutter cross section.	No, there are no specific practices to avoid utilities. IDOT's Design and Environment Manual explicity states the desire to avoid utility conflicts when practical. IDOT employs innovation and "thinking outside the box" to mitigate utility conflicts.
S	Indiana	We send utility companies that are affected on a regular basis a quarterly report listing all their upcoming projects. We meet with individual utilities as needed to discuss upcoming projects and their relocation plans.	The utility coordinators act as mediator between utilities and designers. The utility coordinator and the project manager/designer should come to a conclusion as what should be done.	We look at the cost benefit of what it may take to avoid a utility. No specific policy or procedure. Judgement is left up to the engineer doing design work and utility coordinator as to what is reasonable. Utility coordinators work with info later in the project and may suggest alternative ideas to avoid conflicts with utilities.	We do not have models, but we try to take into consideration the age of the utility facilities when we consider design changes, especially when it involves pressurized lines.	Adjust ditch locations. Adjust manhole/storm sewer locations. Extend storm pipe runs to avoid ditch cuts that impact utilities.	No
S	Kansas	Utility adjustment agreements are prepared and executed for utility adjustments where KDOT is funding all or a share of the costs. Local construction office works with utility companies in locating new right-of-way and limits of construction and ditch elevations.	Coordinating Section of the Bureau of Design	Cost of utility relocation. Cost of redesign. Revised construction cost. Need for additional R/W. Access to utility for maintenance.	Not directly	Revise ditch grades. Relocate storm sewers. Move field entrances. Concrete slabs over utilities in the ditch bottom.	On major projects, a utility coordination meeting is arrange to foster cooperation between utility companies. The Discovery Phase of each project allows project scopes to be reviewed in light of possible required utility adjustments.
S	Kentucky	Periodic meetings to track status of projects. Regular meetings with utilities involved on several projects statewide.	Project Design Team chooses the option of designing around facilities. District Utilities Agent, in communication with C.O. Utilities and Rails Branch, make final determination if relocation is necessary and/or compensible.	Cost of facility relocation. Will customers lose service for a significant period of time? Will relocation delay project letting?	No	Raise grades. Change storm sewer locations/elevations/grades.	Utilities are identified. Cost estimates are generated.
S	Maine	We hold periodic meetings to discuss upcoming projects and other meetings to discuss overall policies.	Joint effort between the utility coordinator, project designer and their management.	General work around them unless it degrades the overall design. Both our costs and the utilities' costs are a factor.	There is no formal process to consider these factors.	Revise or eliminate portions of the drainage design, install closed drainage and curbing, highway realignment.	Just getting an idea of where they are before starting the design.

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S	Maryland	We have a number of coordination meetings. At the construction phase, we involve the utilities with the prebid and preconstruction.	We have a combination of highway designers and utility coordination people. These are all discussed at our meetings and it is a joint decision.	We adjust storm drainage, shift alignment. If it is a major cost issue, we will make changes.	Didn't answer	We make storm drainage revisions, adjust curves, profiles, and sidewalk alignments.	In the design stage, we identify all of the existing utilities involved to avoid relocating.
S	Michigan	MDOT includes some utility work in construction contracts. The MDOT contractor is responsible for utility work, thus minimizing potential conflict and delays.	Design project manager along with input from other MDOT staff and utility companies.	Cost of relocation, difficulty of relocation, available R/W for relocation.	No	Mainly re-design of storm sewer systems to avoid large relocation costs	MDOT is currently considering acquiring some utility info during the scoping process (2-4 years before design) so more info can be known.
S	Montana	On specific urban projects, meetings are held with affected utility companies to plan relocation corridors and timelines for placement based on R/W acquisition.	The department's utility agents determine whether to relocate utility conflicts.	Sufficient R/W, high cost of relocating the utility and acceptable terrain.	Life-cycle cost is not a consideration. On occasion, estimated utility relocation costs are presented to design personnel for consideration as possible re-design issues.	Remove slope rounding, steeper back slopes, minor centerline projections, ditch blocks, adjusting storm drain grades, adjusting storm drain pipe dimensions.	The preliminary field review report has a line item for design personnel to indicate whether or not a SUE study will be needed.
S	Nebraska	Pre-construction conferences	Roadway Design Engineer	Cost	No	Adjust back slopes to pull in limits of construction.	Look at utilities during corridor studies.
S	Nevada	The district offices provide info on upcoming projects prior to the 30% design stage.	Project coordinator in conjunction with the project designer and the individual utility company.	1) Is the relocation reimbursable? (See 3) 2) Cost-effectiveness 3) Prior rights status 4) Project deadlines	Not that I'm aware of	Moving of drainage facilities, shorten culvert piper, eliminating certain highway improvements that do not affect highway safety, minor changes for the most part.	No
S	North Carolina	Coordination activities are continuous throughout the life of a project.	Joint effort between the utility section, design, construction and R/W	Cost and difficulty of the utility relocation or adjustment versus the design problem and the possible cost of R/W acquisition	Yes, see No. 7	Altering proposed highway drainage systems, location of bridge pilings, altering proposed grade changes and slight shifts in alignment	Utilization of SUE data in establishing drainage pipe elevation. Utilization of survey data in establishing a design that will avoid a major utility, such as substation, treatment plants, etc.
S	Ohio	On-site field meetings with utilities and preliminary discussions on special needs such as material ordering, time frames, splicing needs, outage restrictions and relocation time frames in general.	Would be a cooperative effort involving designer, the utilities and ODOT utility personnel.	Cost to the project and potential for saving of time during construction.	No	Most common would be to water, sewer or storm drainage - alignment changes would be extremely rare.	Not particularly
S	Ohio	Have two utility coordination meetings during design stages and continue those meetings through construction.	I make sure the final decision after consulting with the design engineers.	The cost, make plan changes as much as possible, consider the utility in conflict.	No	Move catch basins, manholes, storm sewer runs and laterals, underdrain, etc.	We don't have any standard practices. If I don't check the conflict during review, nothing is done to resolve the conflict until construction.
S	Oklahoma	Didn't answer	Didn't answer	Cost of the utility - ease of revision	No	Mostly ditch elevations. Some detours have been revised, curb and gutter sections have been extended to eliminate ditches, stormwater collectors and C.I.C.I. Systems have been modified. Rarely, the grade of the roadway is revised.	ODOT has changed the P.I.H. process to include a 30% plan completion meeting to access R/W and conflicting utilities. Trying to utilize a combination of utility easements and fee tackings to minimize power pole overhang easements.

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S	Pennsylvania	Designers use PA one call to help determine utilities within project limits. A scoping field view is attended by the District Utility Administrator and other department personnel. Personal knowledge and experience of District Utility Administrator. Design Utility meetings.	Project manager/designer with input form District Utility Administrator. R/W Administrator and other affected units.	Time required by the utilities to complete the relocation and the affect this may have on the project schedule. The extent of any design change and the overall affect on the schedule. Cost of relocation.	No	Revisions to drainage items. Change the type of retaining wall. Change the type of bridge or abutment. Use of a retaining wall in lieu of extending fill slopes.	None
S	Tennessee	The Department Business Process Re-engineering effort defined the need for a 20-year plan, 5-year program to identify potential projects. At this time, an outline 3-year program, State Transportation Improvement Program, containing federally funded projects, is provided on the internet.	The designers have the initial responsibility. Normally, utility conflicts are not identified until the ROW plans are issued and the utility has an opportunity to provide input. The utilities office is then responsible for coordinating the relocation or the revision to the design.	Major factor is the time required for relocation. Reimbursable cost to the utility is a contributing factor. The cost, time and effort to re-design normally determine if a plan's revision will be considered by the department. If ROW plans have been issued, the status of property acquisition may contribute to the decision to re-design or not to re-design.	No, current value is considered for reimbursable circumstances.	Roadway template was widened or to relocate to an area on a bridge crossing that required phased demolition. Adding a retaining wall/gravity wall to eliminate encroachment that would conflict with existing utility facilities.	Invite the utilities to the preliminary engineering meetings and as development team resource is an attempt to identify potential conflicts and negotiate a solution prior to ROW plan issuance. The BPR effort also initiated the need for a more detailed project description plan, now referred to as the Final Scoping Report which provides for more advance info concerning utilities and possible utility conflicts.
S	Tennessee	Regional utility staff meet with utilities as required during utility relocation plan development. Utilities office hold statewide meetings with utilities across the state. The department is attempting to make available long range plans, this years adding the 2002-2004 STIP to the website.	Regional utility staff works with the utilities. Resolutions related to re-design are then submitted to the HQ Utility office for coordination with the design office.	Primary factor is delay to construction. Secondary is cost. Utilities have shared in the costs of re-designs that avoid conflict and subsequent relocation of existing facilities.	No	Use of gravity retaining walls to minimize slope encroachment on existing utility facilities. Relocation of ramps to avoid conflicts. Re-design storm sewer location to avoid conflict.	The department implemented project managers, teams and constructability reviews. The teams involve the utility office. We have had three constructability reviews so far. These are the only known practices during the design process
S	Texas	As a result of a Business Process Re-engineering, TxDOT derived the "TxDOT/Utility Cooperative Management Process" to give structure and methodology to utility coordination efforts.	Design/project engineer	Path of least resistance = move the utilities, NOT re-do design	Not to my knowledge	Storm sewer inlets, trunkline modifications, bridge column moves	See No. 5
S	Texas	We have a representative that participates on a Utility Coordinating Council. Houston district hosts a series of meetings. The Houston District produces a newsletter entitled the "Utility Focus". We have been approved to develop a website.	Number of variables involved. WE strive to have utilities located, conflicts identified and be actively pursuing accommodation by the time project design reaches the 70% complete milestone.	a) Project type: sometimes the type of project at hand may dictate available options. b) Compliance with state's utility accommodation policy: facility must be reviewed for compliance or be able to meet the criteria necessary to be granted an exception to policy. c) Type, size and relative complexity of the facility. d) Timing. e) Cost, f) age of facility	See No. 7-f	Those related to storm sewer and the placement thereof. Changes to the alignment and/or elevation or type of storm sewer system used. Designer's ability to fit the proposed storm sewer beneath the curb line or pavement structure. Raising, lowering and resizing of piping to facilitate required clearances. Similar discussion in No. 10	Raising roadway profiles, adjusting location and/or design of proposed structural columns or footings, adjusting location and/or design of retaining wall, changing storm sewer inlet types to increase clearances, enveloping lines in protective casings or utilization of protective slabs, altering design form a deeper open ditch stormwater system to a closed system, utilizing concrete riprap on open ditch stormwater system designs, adjusting flow line grades to clearances, using protective impact attentuation devices for above ground appurtenances. See attachments.
S	Texas Turnpike	The Austin Area Utility Coordination Council.	The Section Engineer/Developer through consultation with TTA	Time to relocate the facility and cost to TTA for the relocation. The extra design/construction cost to avoid the utility may be less than the cost to adjust the utility.	No	Bridge bents, storm drain, and moving the roadway alignment.	Aerial photo. SUE = Q.L. D &C

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S	Virginia	We hold a utility field inspection for affected utilities.	Location and design division	Cost of utility relocation involved	Are considered	Drainage, traffic control	Didn't answer
S	West Virginia	We try to provide yearly project schedules. But recently, this has been very difficult due to schedule changes.	The decision is made by our upper management based on info provided by the utility companies.	Cost of relocating the utilities. Time delay in relocating utilities.	No	Highway route has been altered to avoid high voltage electric lines. A bridge design was altered to avoid high pressure gas transmission lines.	Route selection based on preliminary utility info
S	Wisconsin	Utility coordination meetings (2). Meet with utilities as needed to resolve conflicts.	Joint effort. Utility coordinator, designer and utility representative. Usually a mutual cost-driven solution.	Cost. If design changes can be made to reduce utility cost without compromising the design, they are made.	Yes	Horizontal and vertical alignment changes, pre-bore and batter pile driving to miss utility facilities, special design of storm drainage to allow existing utilities to remain in place.	Describe in No. 9
S	Wyoming	Sheet wasn't faxed.	Sheet wasn't faxed.	Cost to relocate utility and/or critical nature of utility	No	Both alignment and grade changes. Occasional design changes such as moving a storm sewer.	Sheet wasn't faxed.

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C	Maricopa County	We allow the utility to relocate (at their expense) into the new MCDOT R/W at no cost to the utility. Coordinate Jt. trench use, recognize prior rights.	We try to place utilities as close to the new R/W boundary as possible.	We are experimenting on one project with constructing a duct bank for the future use of the utilities within the project area. We follow the Public Improvement Project Guide.	We do not share databases at this time but it may happen in the near future. We do share info through a website (in-house and public). In the process of implementing a project management info system.	No
M	Columbus, OH	No, we would work with the utility to try to accommodate their needs and concerns.	We do not have utility corridor policy. The city's traffic division will look at proposed utility installation plans to see that they will not be in conflict with traffic's proposed facilities.	The City of Columbus has a R/W permit process in place that requires existing utility facilities to be marked to help identify utilities that are encountered in the R/W. Other issues such as coordination and cooperation are also addressed in the R/W ordinance.	The R/W ordinance requires that digital mapping of existing utilities be provided to the city starting in January 2002. However, the standards for this provision has not been established as yet.	The division of engineering works closely with the local damage prevention council. I think overall, the city is doing everything we can to accommodate the utilities. We would like to see better and more timely coordination from the utilities to identify conflicts earlier in the design phase as well as identifying their R/W requirements.
P	Private California	Didn't answer	In many of the master agreements that I have worked on, there is a requirement that the utility owner coordinate with the project owner and/or the D/B contractor as to the placement of new facilities in the vicinity of the project so as to avoid the need for future relocation.	Didn't answer	Didn't answer	Didn't answer
P	Private Arizona	See No. 9	No, we have no control of the ROW.	No	No	Didn't answer
P	Private Indiana	N/A	N/A	No	No	You obtained my name because we authored the FHWA report on the Evaluation of SUE. If you are interested in our background data or SUE, plus our recent SUE data entry state DOTs, please feel free to contact me.
P	Private Florida	Allow concurrent to contract relocation to reduce restoration cost and MOT and clearing and grubbing.	Place as close to ROW as possible.	N/A	No	N/A

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P	Private Georgia	Didn't answer	Didn't answer	Didn't answer	Didn't answer	Didn't answer
P	Private Montana	Didn't answer	MDT Utilities Section makes requirements and recommendations as part of the ROW permitting process.	Harding ESE is developing a utility GIS to allow SUE info to be inventoried in a reliable, current, easily accessible database. This will form a repository of utility info available to DOT staff, utility companies and consultants.	See No. 13	Harding ESE and the MDT are major proponents of subsurface utility engineering and actively promote greater awareness and utilization of SUE.
S	Alabama	State and federal funds pay for utilities that gross <100m/yr	Some permit methods and next to the ROW line.	Do not allow longitudinal placement of facilities in Interstate ROW.	Not aware of any.	No
S	Alaska	Audit utility and work with utility to insure design is cost efficient.	Yes, both written in AK code and try to use good judgment during permit process to insure offsets are sufficient to allow for possible realignment.	Wishes they could use SUE.	Provide utilities CAD files when asked.	No
S	Arkansas	Yes, If the facility is reimbursable, the AHTD will only reimburse for the replacement in kind cost, and the estimate must be in complete detail and itemized for our review and approval.	Yes, the utility must submit a set of adjustment plans for our approval including the exact location of the new facilities at the edge of the ROW.	Yes, All utilities are adjusted, reimbursed and installed under the guidelines of our utility accommodation policy.	We do send highway plans, and receive utility adjustment plans, electronically	No
S	California	The owner of the utility facility is required to provide their own relocation plan. Therefore, it is up to the utility company to develop reasonable methods to minimize the cost of relocation.	Yes, there is a requirements through the Encroachment Permit process that the departments' utility branch check the placement of new utilities to help avoid future conflicts. In proposed highway improvement projects, the department attempts to keep existing utility poles as close as possible to the State right-of-way to avoid conflicts.	Didn't answer.	The departments' online manual can be found at http://www.dot.ca.gov/hq.row/	At the time of construction, the state's contractor is required to call the toll free underground alert telephone number to have the utilities marked in field. The department must comply with Government Code 4215 and 4216.
S	Hawaii	Sheet wasn't faxed.	Sheet wasn't faxed.	The Highways Division is preparing to develop utility agreement procedures. A policy on undergrounding utilities is also being considered.	There are various policies, procedures, statutes and rules or shared databases, such as the Departmental Staff Manual, the Hawaii Revised Statutes, the Hawaii Administrative Rules, and the Code of Federal Regulations.	Requesting utility companies to provide accurate as-built plans that show existing utility locations. Project scoping, done prior to the start of design, identifies aboveground, and sometimes underground utilities.
S	Idaho	The designer should coordinate with utility company for the best location to relocate. Under certain condition, state will pay the cost to relocate.	Utilities are allowed to place their facility in locations determined by district's design. Future conflicts cannot always be determined.	No	No	No
S	Louisiana	Yes, meet with the utility to work out the best plan of avoiding costly relocations and design changes.	Utilities may choose to re-enter LADOTD's new R/W by permit or relocate on private R/W.	N/A	N/A	Joint-plan review are held when plans are 60% complete.
S	Mississippi	MDOT pays 100% if the utility is on private property. MDOT pays 0% if the utility is on public property. A proration is determined if some of both.	We encourage locating on private property, but we do allow utilities on our R/W by permit.	No	Not that I know of	No

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S	New Hampshire	For municipally-owned utilities in state ROW per RSA, the town receives the costs of trenching and backfilling the new structure and they also receive any salvage value of the existing structure based upon a 100-year life.	We require the utilities to be placed in accordance to our Utility Accommodation Manual. This basically stipulates depth requirements.	Didn't answer	No	No
S	North Dakota	No, as all relocation work must be constructed according to the Utilities Accommodation Policies.	See response to No. 5.	Up until a few years ago, we had sent a 2 to 3-year proposed bid opening schedule to each utility company that has facilities in the state. Due to widespread flooding since 1994, the schedule was continually changing, so it wasn't too reliable. We do issue annual press releases through our district offices for the proposed projects for the next 3 years.	Started on GIS program which will use highway inventories, USGS quad maps (1:24,000 scale), and these will be available in the future to the public on a website	Didn't answer
S	Pennsylvania	We will listen to any reasonable suggestion. If requested, we may provide R/W procurement assistance. Per state regulations, cost sharing up to 50% is allowable for municipal facilities.	Ys, we have a specification that is attached to the original license agreement for the crossing, i.e. poles, manhole, boring and receiving pits are to be located outside of our R/W. Casing pipe through the R/W is often used and the amount of cover is 6 feet below the wearing surface at the lowest in the roadway cross section, etc.	No	If the request is reasonable and not sensitive info, we will share a database.	No
S	Wisconsin	No, Wisconsin DOT pays the cost of utility relocations for facilities in newly acquired R/W.	As close to the R/W line as possible.	Continual training of new highway designers on the importance and value of good utility coordination	No	No
S	Arizona	If the utility so chooses, we can add his work into the work to be performed by the states contractor to possibly realize any volume savings. Historically this has only pertained to trenching and other small items as most utilities wish to do their own work.	Yes. During the design review process relocated utilities are placed as best as possible out of the impact area to known future projects.	Begin working with utilities as soon as possible.	None that I am aware of.	No. But when ROW is available we try to confine utilities to a separate corridor.
S	Arizona	None except design alternative selections	Permits require relocation at utility expense No cost permit has a ROW cost benefit utilities value as a relocation cost risk worth the possible cost.	see #15	Question is to comprehensive	Area Governments (mag) have a red letter policy ADOT is contacted prior to construction/design/zoning permits being issued in vicinity of proposed freeway corridor. (It works when used.)

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S	Colorado	If feasible, CDOT may seek to incorporate the utility relocation work into the highway construction contract. May not always have the effect of reducing relocation costs. Consolidating the work under a single contract improves the highway contractor's control over the utility relocation which may result in lower costs.	We try to determine if a proposed utility installation is in the area of future planned highway improvements, and if so, we'll try to have the utility line installed at a location that is least likely to conflict with future improvements. Otherwise, we can only hope to place new utilities at locations within the ROW that are unlikely to be affected in the future.	None that I am aware of, or that occur to me at being relevant.	No	Not that I am aware of, or that occur to me as being relevant.
S	Connecticut	Yes, we try to minimize the impact. We pick one utility and design around it.	Yes, we send out an advertising list. This tells the utilities what projects are upcoming so there are no future conflicts.	No	No	We constantly have meetings with the utilities. We have seminars with the government and we are all open with ideas. We have statutes and avoid trying to relocate because of time and project cost.
S	Delaware	No	Yes	No	No	No
S	Florida	Yes, the department can enter a joint project agreement (work by highway contractor) with the utility owner. This will save the owner money and time. There is no additional cost for backfilling and no coordination time.	No, a study is being proposed through the University of South Florida to address this issue.	See #12. A value engineering study has been conducted on the placement of utility access holes in the R/W which recommends new policy.	No, it is being addressed for future.	Address utilities in the preliminary planning stages. Pay utilities to clear and grub R/W so they can relocate in advance of highway consultant.
S	Florida	One method is to include the work into our contract. Currently, the utility owner is responsible for all cost but the FDOT can participate in any cost above 10% of the FDOT's official estimate prior to the bid..state law..Next, state law allows the FDOT to reimburse a utility owner for clearing the new proposed right-of-way in order to advance their relocation effort.	Currently, the FDOT has the 1999 Utility Accommodation Manual and is studying utility corridor assignments and placement criteria for specialized utility item..i.e. manholes, communication cabinets etc.	Contact Mr. Weldon: kenneth.weldon@dot.state.fl.us	Contact Mr. Weldon	

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S	Illinois	We have no formal process or method to help reduce the cost of a relocation. We will host individual utility coordination meetings on major projects to initiate conversation and dialogue among all the affected utilities. Topics such as joint trenching, utility corridors, joint ventures for contract utility relocations, relocation scheduling, etc. often arise out of these meetings.	Requirements for placing new utilities is spelled out in our "Accommodation of Utilities on Right-of-way of the Illinois State Highway System". Policy is not geared to help avoid future relocations. However, a utility owner is also required to obtain a permit in conjunction with relocations/adjustments required by a highway improvement. The permit must contain the relocation plan. Plan is reviewed by the District Project Support Section and designer to ensure there are no conflicts with the relocation plan and the proposed construction.	Our strategy is to begin utility coordination early in project development (Phase 1 - Planning) and keep it an open interactive process through out the life of the project (Phase 2 - detailed plans, specifications, and estimates) culminating in minimal utility relocations. Minimal relocations will reduce/eliminate contractor delay claims during construction as a result of utility relocation work.	No, we do not store any utility location info. Our SUE consultants have proposed establishing a web-based info center, but the department has not committed to this endeavor. Our Underground Utility Damage Prevention Act requires utility owners to provide utility location info free of charge.	None that I am aware of.
S	Illinois	No method exists per se. However, we feel by minimizing the amount of relocation required, we minimize the costs incurred.	No, those utilities locating on public right-of-way are required by IDOT policy to locate as near as practicable to the right-of-way line. Those utilities electing to relocate to private easement are not bound by any IDOT policies or rules.	It should be noted that not all relocations qualify for reimbursement. Illinois Statute 605ILCS 5/9-113 requires utilities located on public right-of-way to relocate at no cost to the state, when directed by the state.	IDOT does not have specific policies on shared databases. Access to these databases is limited to only IDOT personnel. The supplying of a copy of the information on the database on disk or CD would be addressed on a case by case basis.	Recent changes to Illinois Statutes will affect the policies and procedures IDOT now utilizes. The impact of these changes, most of which have not been mentioned, are as yet to be seen.
S	Indiana	Our state law allows us to financially help a utility if their relocation costs are: 1) greater than 10% of the total operating revenue received by the utility during the utility's most recent full fiscal year. 2) more than 50% of the total estimated cost of a proposed highway or bridge construction or improvement project.	We have minimum depth requirements under ditches and pavement.	N/A	No	
S	Kansas	Communication, cooperation, trust and a good working relationship allow alternative solutions to be investigated.	Our Utility Accommodation Policy	Our Utility Accommodation Policy. http://www.ink.org/public/kdot/burdesign/coorsect/sectndefault.htm	See No. 13	Each project goes through a discovery phase to determine project scope. Utility relocation issues can help to shape the project scope.
S	Kentucky	All contract work is subject to Cabinet approval. Reimbursable work is subject to Cabinet approval (scope).	Utility facilities are installed in accordance with Cabinet policies. Permit work (non-relocation type work) is reviewed to eliminate conflicts with projects on 6-year plan. Utilities proposed for construction that are in conflict with projects in design/planning stages are pre-authorized to allow utility owners to modify plans and design around proposed highway construction.	The Cabinet's utilities function is supervised at the District Level by an engineer who also supervises R/W and design functions. Individual responsible for coordinating all phases of pre-construction to improve delivery times and decrease costs/increase value of projects.	Don't know what this means	KyTC holds quarterly meetings with all Districts to review progress of projects. 6-year plan, including all phases of pre-construction to track progress. District and C.O. meet together to keep projects on schedule. Value Engineering can be used to increase value of projects.
S	Maine	We allow them into our contracts if they so desire.	Yes, our new draft policy is located at: http://www.state.me.us/mdot/utility/uap.htm	Nothing else	Not yet	We try to coordinate with them on their betterment projects to assure locations will not conflict with future highway projects.

	Agency	11	12	13	14	15
S	Maryland	There are based on the prior right. If there is a permit involved, it is their responsibility for the cost involved.	We have a policy to place utilities as close to the R/W. We look at the future plan so they are placed so they are not impacted.	We have our own state policy.	We have our own policy books and manuals.	Didn't answer.
S	Michigan	No, in Michigan, if utility relocation is required, the utility company is responsible to relocate at no cost to the department (unless the utility has property rights).	Yes, in some high population areas, utility attachments to bridges are not allowed unless the utility can show that there is no practical alternative.	No	No	No
S	Montana	Annual unit costs are requested by the department from all utility companies within the state. These unit costs are then applied to relocations by a utility company when submitting estimates and bills for payment.	When a utility company elects to locate within the R/W, they are permitted 5 feet from the R/W line and any additional facilities no more than 4 feet of separation between them. Above ground utilities are installed at or near the R/W line. Any underground facilities placed longitudinally within the roadway prism are allowed by a revocable permit.	No	No	No
S	Nebraska	No	Locate close to R/W line.	Didn't answer	Yes	No
S	Nevada	If the affected utility has a prior right, which is compensable in court, we can reimburse the utility for certain relocation costs.	Yes, we require all utilities to be installed as far to the edge of R/W as possible. Every permit is reviewed to see if any conflicts exist with current or future projects.	No	No	No
S	North Carolina	The only procedure would be to work with the utility owner in making the relocation as minimum as possible, such as adjusting in place rather than doing a replacement and relocating within the highway R/W rather than securing additional R/W for the utility	All requests for new installations are reviewed and approved with any future highway plans in mind. See No. 15.	Attempting to secure input from utility owners in the early design stages so that better decisions can be made.	Not at this time; however, all of our data is shared with the utility owners on a regular basis.	Providing utilities with info on future projects (7-year Transportation Improvement Program) so that utility upgrades or new installations can be made with consideration to the planned highway improvement.
S	Ohio	No	ODOT Utilities Manual incorporates design provisions which can help to eliminate or mitigate future utility relocation. Ohio is an old state with old and congested infrastructure often located on marginally wide rights-of-way - utility avoidance is difficult.	Major emphasis is early involvement and coordination with utilities.	ODOT website has the Utilities Manual available.	No
S	Ohio	The cost of relocation is important but not the first thing considered. Depends on what type of facility is in conflict. Gas and water lines are much easier and cheaper to move than fiber or copper phone cables. If we can elbow around a catch basin, that helps to minimize the cost but most of the time, this is not the case.	No, we buy the minimum amount of R/W to keep project costs down. Therefore, the chances of hitting the utilities I the future are fairly good.	ODOT has a utility manual that covers all the policies in regards to reimbursement, relocations and such.	None other than the printed manual.	No
S	Oklahoma	Try to acquire enough R/W to accommodate all the utilities, thus saving the cost of replacement easements.	New utility placements must apply for a permit and furnish drawings with proposed locations. This does not generally keep utilities form conflicting with new construction.	No	No	No

	Agency	11	12	13	14	15
S	Pennsylvania	None	If the facility needs to be relocated, we prefer that it be outside the R/W. If not possible, then we will consider placing facilities as far from the shoulder as practical. Only in extreme cases will we consider relocating facilities within the pavement cross section.	None	None	None
S	Tennessee	By statute and case law, utilities within public rights-of-way are not eligible for reimbursement. A 1999 statute requires the state to reimburse utilities with less than 500 customers for all relocation cost. The utility is encouraged to include the relocation work in the state contract and this results in a lower cost.	Permitted utility facilities are generally located as near the existing ROW line as possible to reduce the possibility of conflicts resulting form roadway widening. Utility office reviews relocation plans with department.	No	None concerning utility applications.	No
S	Tennessee	Regional staff determine relocation needs. State does have a Utility Relocation Loan Program. State law stipulates reimbursement for Interstate projects or for public utilities with less than 500 customers. Otherwise, the utility staff, construction, and the utility work out in the field the best relocation construction.	All utilities are placed in accordance with TDOT Rules and Regulations for accommodating utilities within highway ROW. Regional utility staff attempt to provide utilities "best" plans for projects. The intent is for the utility to make locations compatible with the preliminary plan in mind. In some situations, this may negate potential reimbursement if they make adjustments for our plans prior to ROW being acquired, e.g. casement of pipes on easements, not needed until ROW is acquired and roadway built.	None other than those already discussed.	Electronic drawings are shared after the utility has signed a disclaimer. General policy is if the agency is working with the department on a project and the info is not used for profit.	As part of the BPR process, we identified a need for a more detailed document than the Advance Planning Report and are establishing a Final Scoping Report that has a section to address utility concerns.
S	Texas	Yes	Utility Accommodation Policy	Penal initiative	Don't know	Just continually emphasizing coordination, communication and cooperation
S	Texas	Yes, we include city water and sanitary sewer facility adjustments/relocations in the project scope of work. We have coordinate joint trenching and adjustment activities between various pipeline entities.	Yes, Houston District procedures dictate that all "Notice of Proposed Installation" forms submitted by a utility entity be circulated to various departments and/or relative design section involved in project. Both state law and TxDOT policy dictate that utility lines shall be located to avoid or minimize the need for adjustment.	Didn't answer	No, but we are in the process of developing a utility website.	Didn't answer
S	Texas Turnpike	Investigate the most economical method of adjustment (alternatives).	Maximize the use of available ROW. Stacking conduit vertically more so than horizontally. If future design is know, adjust utilities to the ultimate design.	The coordinated solution of utility conflicts in Transportation Projects Manual	Limited shared database allowed	Not at this time

	Agency	11	12	13	14	15
S	Virginia	Try to review relocation with utility and designers	No	No	No	No
S	West Virginia	West Virginia now reimburses the total cost of utility relocations.	Permits are required for utility placement in existing R/W.	Not that I am aware of	Not yet	No
S	Wisconsin	If utilities are on R/W, they move at their own cost. If they are on private easement, they are compensable.	Yes, we have a "Utility Accommodation Policy." Copy available upon request.	"Wisconsin DOT Guide to Utility Coordination," and "Utility Accommodation Policy"	Not at this time. Available in the future.	Communicate
S	Wyoming	Sheet wasn't faxed.	Sheet wasn't faxed.	No	No	No

Common Ground Best Practices for Planning and Design

2.6.1 Planning

1. Plat Designation of Existing Underground Facility Easements

Practice Statement: Plats involving development of real property include the designation of underground facility easements.

Practice Description: Various items are required on the plats filed prior to the development of lands. Where plats are required to be filed, the items required include the identification of the easements of underground facilities traversing the land described on the plat. Identification of easements of underground facilities on the plat increases notice to developers and the public about the existence of the underground facilities. Notification to the owners of underground facilities that a plat has been filed alerts underground facility owners/operators to establish communication between the developers and the operators to facilitate a plan and design for the use of the land which complements the underground facility.

Example of Practice: St. Louis County surveyors in Minnesota require that plats show easements of underground facilities. Conditional use permits are required to develop gravel pits in St. Louis County, Minnesota, and a prerequisite to the permit being issued is the notification to the owners of underground facilities that a permit to develop the gravel pit in the vicinity of their facilities has been sought.

Benefits: Often underground facility owners/operators do not receive notice of developments impacting their facilities until excavation activity has commenced. This compromises the optimal use of the land and potentially compromises the integrity of the underground facility.

Reference:
St. Louis County, Minnesota zoning ordinances.

2. Gathering Information for Design Purposes

Practice Statement: The designer uses all reasonable means of obtaining information about underground facilities in the area of the planned excavation.

Practice Description: During the planning phase of the project, all available information is gathered from facility owners/operators. This includes maps of existing, abandoned and out-of-service facilities, cathodic protection and grounding systems, as-builts of facilities in the area if the maps are not current, proposed project designs, and schedules of other work in the area. This information is gathered for the purpose of route selection and preliminary neighborhood impacts, and as part of the process of impact analysis when evaluating different design possibilities.

Methods of gathering information may include contacting a one-call center, facility owners/operators, coordinating committees/councils, other designers, engineering societies, and governmental agencies as a means of identifying underground facility owners/operators in an excavation area. Gathering information may also include a review of the site for above ground indications of underground facilities (i.e., permanent signs or markers, manhole covers, vent pipes, pad mounted devices, riser poles, power and communication pedestals and valve covers). The one-call center provides a listing of operators directly to the designer, or to the designer's subsurface utility engineer. This information is available in formats that are accessible to all users such as voice, fax, e-mail or web-site. Once identified, the designer contacts the operators directly or use the one-call system. The facility owner/operator may locate their underground facilities or provide locations of their underground facilities to the designer by other means, such as by marking up design drawings or providing facility records to the designer.

Examples of Practice:

- As a minimum, the designer responsible for the preparation of plans and specifications for an excavation obtains information on underground facilities within and near the project area. Some states, such as Wisconsin, Pennsylvania and Minnesota have statutes requiring such designers to contact one-call centers within a set time frame to obtain facility information. Where the information obtained suggests facilities may conflict with the excavation, an underground facility survey or subsurface utility engineering is used.

- Designers often utilize an underground facility survey process to minimize conflicts with existing underground facilities. The underground facility survey process employed in New York, NY, by Consolidated Edison and other utilities has several distinct steps. Each of the steps is performed in order, but any higher step may be omitted, depending on the proposed construction and the locations of existing underground facilities discovered in the next lower step.

Underground Facility Survey Steps Include:

- Use company records and contact other facility owners/operators to obtain information about locations of existing underground facilities. This step includes the entire construction/excavation area.

- Using the information obtained in the first step, visit the job site to correlate the information gathered about existing underground facilities with above ground features. This step may be limited to those portions of the construction area where existing facilities are present and where excavation is to occur.

- Use appropriate instruments or other methods to determine the approximate horizontal locations of the underground facilities identified in the second step. This step may be limited to specific areas where existing facilities are expected to conflict with excavation.

- Use test holes to positively determine the exact location of existing underground facilities. At this point, horizontal and vertical control measurements may be taken of the underground facility. This step is usually limited to those specific areas where conflicts are anticipated between existing facilities and proposed construction activities or proposed facilities, or where elevation information is essential to design the proposed facility.

Test holes are used to positively locate and identify an underground facility by exposing the facility by a nondestructive means of excavation. Such nondestructive means can be by hand, vacuum truck, air knife, etc.

Test holes may be requested under the following conditions:

- ♦ the design calls for a grade change,
- ♦ facility records indicate that proposed underground facilities or excavation may be in close proximity of existing underground facilities,
- ♦ elevations of proposed sewers or drains may interfere with existing underground facilities where required to determined potential geometry changes for water main installations,
- ♦ to locate points where proposed underground facilities may be tied into existing underground facilities, and
- ♦ to determine environmental conditions in an excavation area.

Test hole data includes at a minimum:

- ♦ date performed and purpose;
- ♦ type of existing surface and base of roadway or sidewalk and depth of each;
- ♦ general soil conditions found;
- ♦ any indication of oil or waste materials found in the pit; and
- ♦ facility cover, size, configuration, elevations (if applicable), and distance from curbs or other horizontal control.

- SUE is performed by, or under the direction of a registered professional engineer. SUE includes up to four quality levels for gathering underground facility information, to be specified by the project owner to be part of the project planning and design process. The Federal Highway Administration (FHWA) advocates its use and many State Department of Transportations, such as but not limited to Virginia, North Carolina, Maryland, Texas, Ohio, Florida, Washington, and Delaware, use this process.

Subsurface Utility Engineering Quality Levels are:

- ➢ Quality Level D information comes solely from existing utility records. It may provide an overall "feel" of the congestion of utilities, but it is often highly limited in terms of comprehensiveness and accuracy. Its usefulness should be confined to project planning and route selection activities.

- ➢ Quality Level C involves surveying visible above ground facilities such as manholes, valve boxes, poles, pedestals, pad-mounted devices, etc., and correlating this information with facility records obtained in Level D. When using this information, it is not unusual to find that many facilities have been omitted from records or erroneously plotted. Its usefulness should be confined to locations where facilities are not prevalent or are not expensive to repair or relocate.

- ➢ Quality Level B involves the use of surface geophysical techniques to determine the existence and horizontal position of facilities, including those identified in Level C. This activity is called designating. Two-dimensional mapping information is obtained. This information is usually sufficient for excavation planning. Decisions can be made on where to place structures or new facilities to avoid conflicts with existing facilities. Slight adjustments in the design can produce substantial cost savings by eliminating facility relocations.

- ➢ Quality Level A involves the use of nondestructive excavation devices at critical locations to determine the precise horizontal and vertical position of existing facilities, as well as the type, size, condition, material, and other characteristics. This activity is called "locating."

When surveyed and mapped, precise plan and profile information is available for use in making final design decisions. Additional information such as facility material, condition, size, soil contamination and paving thickness also assists the designer and facility owner/operator in their decisions.

Caution: Both the underground facility survey process and Subsurface Utility Engineering (SUE), as described above, may include marking the ground surface to indicate the approximate location of existing underground facilities. Both processes are tools to be used in project design. They should not be confused with underground facility locating (and marking) that is performed in response to a request, usually by an excavator, to a one-call center, immediately prior to beginning excavation work, as described elsewhere in this Report.

Some one-call centers accept calls for design purposes but the locating usually provided in response to such calls should be enhanced as described in this section to be adequate for project design purposes. Such locating, however, may be adequate when planning smaller excavations and less extensive work where excavations can easily be adjusted to avoid marked facilities with appropriate clearances. Such less extensive work might include utility pole replacements, roadside ditch cleaning, smaller homeowner excavations or residential fence posts.

Benefits: Gathering underground facility information and including this information in the planning phase minimizes the hazards, cost and work to produce the final project.

- Safety is enhanced.
- Unexpected conflicts with facilities are eliminated.
- Facility relocations are minimized.

References:

- Wisconsin Sec. 186.075 Stats.
- Minnesota Statute 216D.
- Pennsylvania Act 287 of 1974, as amended by Act 187 of 1996.
- See related Finding Number 3, "Identifying Existing Facilities in Planning and Design."
- "Construction Management Interference Control Manual," Consolidated Edison, New York, New York, June 9, 1997.
- Subsurface Utility Engineering, Federal Highway Administration (FHWA), February 1999, Office of Program Administration (HIPA).
- Florida Department of Transportation Utility Accommodation Manual, Document No.: 710-020-001-d, Section 11.4, January 1999.

3. Identifying Existing Facilities in Planning and Design

Practice Statement: Designers indicate existing underground facilities on drawings during planning and design.

Practice Description: During the planning phase of the project, existing facilities are shown on preliminary design plans. The planning documents include possible routes for the project together with known underground facility information. The various facility owners/operators are then given the opportunity to provide appropriate feedback.

During the design phase of the project, underground facility information from the planning phase is shown on the plans. If information was gathered from field located facilities, from underground facility surveys or from subsurface utility engineering, this is noted on the plans. If an elevation was determined during the information gathering, it is shown on the plan. The facilities shown include active, abandoned, out-of-service, and proposed facilities. The design plans include a summary drawing showing the proposed facility route or excavation including streets and a locally accepted coordinate system. The plans are then distributed to the various facility owners/operators to provide the opportunity to furnish additional information, clarify information, or identify conflicts.

Examples of Practice: The City of San Antonio, Texas, Public Works Department requires three main phases of design in engineering contracts. The 30 percent design submittal includes existing utilities in plan and profile views, taken from existing records. During this phase, the designers have coordinated with the local facility owners/operators and coordinating council to learn what facilities are in the project area. The plans are obtained where available and shown and used in the design. Potential facility conflicts are noted in this phase. A summary drawing is included to orient the project and show the streets and major facilities.

The 60 percent design submittal updates the 30 percent submittal. This phase includes the balance of the field work, geotechnical information, and relative elevations on all facilities in potential conflict. It includes preliminary traffic control plans and Office of Safety and Health Administration (OSHA) requirement considerations. During this phase, the designers visit the site after the facilities have been located.

The 90 percent submittal includes final identification and resolution of conflicts with facilities, final facility designs, project schedule, and description of management of potential hazards.

Benefits: Providing complete underground facility information and including this information on design drawings reduces the hazards, simplifies coordination and minimizes the cost to produce the final project.

SUMMARY OF UTILITIES GUIDELINES AND BEST PRACTICES
Prepared By The
AASHTO Highway Subcommittee on Right-of-Way and Utilities
January 21, 2000

Guideline
Use current available technology to the greatest extent possible.

Best Practices

- Use Subsurface Utility Engineering (SUE) for projects where underground utilities are present and high quality levels of information are needed for design purposes.
- Require utility company certification of as-builts and encourage development of a CADD database system and electronic transfer system.

Guideline
Encourage frequent coordination and communication with local governmental agencies to reduce delivery time, reduce costs, and improve quality in the utilities process.

Best Practice

- Work with local governmental jurisdictions to establish pavement cutting criteria and backfill requirements.

Guideline
Encourage frequent coordination and communication with utility companies to reduce delivery time, reduce costs, and improve quality in the utilities process.

Best Practices

- Provide utility companies with long-range highway construction schedules.
- Host meetings with utility companies to discuss future highway projects.
- Recognize the importance of long-range highway/utility coordination.
- Organize periodic (monthly, quarterly, annual) meetings with utility owners within a municipality, county, or geographic or highway planning region.
- Solicit similar information on utility owners' capital construction programs, particularly where a utility's planned expansion or reconstruction may encroach on and coincide with a planned highway project.
- Consider using the long-range meeting as a convenient forum to discuss other highway/utility issues, such as accommodation policies, reimbursement, etc.

- Provide utility companies with a notice of proposed highway improvements and preliminary plans as early in the development of highway projects as possible.

- Involve utility companies in the design phase of highway projects where major relocations are anticipated.

- Conduct on-site utility meetings or utility plan-in-hands with utility companies to determine utility conflicts and resolution.

- Participate in local one-call notification programs to the maximum extent practicable per state law.

- Invite utility companies to preconstruction meetings and encourage or require utility companies, contractors, and project staff to hold regular meetings, as deemed appropriate, during the construction phase of a project.

Guideline

Improve contract, internal project development, and training processes to expedite utility relocation.

Best Practices

- Use standardized utility agreements.

- Initiate separate contracts for advance roadway work on selected projects prior to utility relocation.

- Set forth responsibilities for appropriate action to reduce delays to contractors.

- Provide utility special provision language in the construction contract.

- Avoid late plan changes.

- Have highway contractors relocate utility and municipal facilities, when possible.

- Acquire sufficient right-of-way for utilities purposes.

- Provide training to DOT utility staff and utility companies' staff.

UTILITY PERMIT MANAGEMENT USING GIS AND INTERNET TECHNOLOGIES

Technology —Making Public Works Work Better 2001 Conference
May 6-8, 2001 - Rosemont, IL
Held jointly by URISA & PWJC

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ABSTRACT. Many transportation agencies lack a system-wide capability to capture and inventory utility facilities and the ability to document and display those facilities in reference to existing and proposed transportation improvements. This handicap also limits the agencies' capability to manage a variety of utility-related procedures such as utility permit applications. This paper describes a geographic information system (GIS)-based model to represent utility facilities located within a highway right-of-way (ROW) and associated attribute data such as ownership, purpose, size, type, and other pertinent characteristics. The paper also describes an Internet-based utility permit data entry and data management system that provides selective access to different users within either transportation agencies or utility companies. The data management system is centralized with distributed map and data access capabilities. The system includes utility company interfaces and administrative interfaces.

KEYWORDS: GIS, utilities, Internet, right-of-way, ROW

INTRODUCTION

Many transportation agencies lack a system-wide capability to inventory utility facilities and the ability to document and display those facilities in reference to existing and proposed transportation improvements. This handicap also limits the agencies' capability to manage a variety of utility-related procedures such as permit applications.

Utility data management practices at transportation agencies and utility companies frequently vary widely, making the data management process very difficult. For example, many utility companies have implemented sophisticated automated mapping/facility management (AM/FM) information systems over the years. By contrast, other utility companies follow a very informal approach to asset management and have very limited spatial data management capabilities. Utility companies tend to be specialized, and so do existing AM/FM information systems and data models *(1) (2).* In the field, however, there is considerable interaction among utilities. For example, telephone lines, data communication lines, and cable TV lines are frequently anchored to electric poles. Likewise, duct bank underground installations can carry several types of utilities.

Normally, a utility company is required to submit a permit application every time the company needs to do work on a utility facility within the highway ROW. At TxDOT, for example, utility companies need to document the proposed work and attach drawings to illustrate the location and characteristics of that work. However, because of the different types of utilities and utility companies with which TxDOT may be involved, there is a wide range in the quantity and quality of the data, e.g. attribution data, map symbology, terminology, and geo-referencing data, provided by the utility companies. This situation affects TxDOT's ability to maintain an up-to-date, reliable utility data management system.

This paper describes the architecture of a prototype utility data spatial and database model. First, a geographic information system (GIS)-based inventory model to document utility facilities and associated attribute data such as ownership, purpose, size, and type is described. Second, a prototype Internet-based utility permit data collection and data entry system is discussed.

SPATIAL MODEL

From the standpoint of a transportation agency, linearly referencing utility features, i.e. defining the parameters to completely characterize the relative position of utility features along highway networks, is important. TxDOT, for example, uses both a control section-distance approach and a reference marker-distance approach for linearly referencing objects or events along the state highway network. With the control section-distance approach, the state highway network is divided into controls and sections, and objects or events are located by determining their relative distance with respect to the beginning of the specific section. Practically all construction projects in the state are tied to the control section-distance model and many districts use this model to locate utilities within the ROW. With the reference marker-distance approach, the state highway network is divided into routes, and objects or events are located by determining their relative distance from one or more reference markers that are physically located at strategic locations on all state highways.

As a base map, TxDOT uses a highway centerline map that was originally digitized using 1:24,000 USGS 7.5' quadrangle maps. The positional accuracy of this centerline map is estimated as being 3 0-60 m (100-200 ft). Unfortunately, this level of positional accuracy, in addition to a lack of geometric detail which is critical in the case of complex geometries such as freeway interchanges and ramps, means that a variety of applications, including utility data management, cannot be properly supported. To address these limitations, TxDOT is developing a new sub-meter level roadbed centerline base map. With the new base map, each roadbed will be characterized by a directional linear feature that represents the roadbed centerline. Each ramp or direct connector will have its own roadbed centerline and each direction of travel (in the case of divided highways) will have its own roadbed centerline. Each roadbed centerline will be divided into 10-20 km (6-14 mi) long segments running between latitude and longitude-fixed anchor points. Each segment will be measured, meaning that each vertex used to characterize the horizontal alignment of the segment will also contain a numerical value equal to the cumulative distance from the beginning of the segment.

To ensure compatibility both with the current and the new road base map, a utility data model has been developed in which utility features can be located and inventoried independently of the road base map used. However, with the model it is possible to overlay utility features on either map to obtain linearly referencing measures. Figure 1 illustrates the concept. Assume a telephone pole located on the north side of Bandera Road in San Antonio, TX, has been inventoried using a sub-meter level global positioning system (GPS) receiver. The telephone pole point feature overlays the new sub-meter level roadbed centerline map. Using GIS linear referencing functions, it would be possible to determine the relative position of the point feature with respect to the beginning of the westbound Bandera Road roadbed centerline segment. Linear referencing measures could also be obtained with respect to the current 1:24,000 centerline map (dotted lines in Figure 1). These linear referencing measures would be different, however, the underlying latitude-longitude coordinates associated with the telephone pole point feature would remain unchanged.

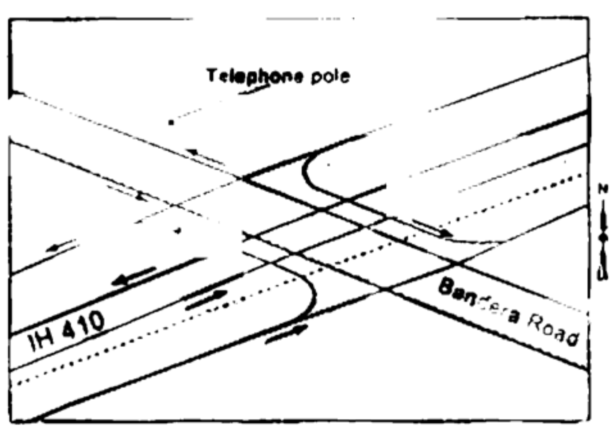

Figure 1. Utility feature overlaying roadbed centerline map (dotted lines represent current 1:24,000 centerline map)

In the model, a utility feature refers to a physical space occupied by the feature (this physical space is in 2-D; utility stacking is handled at the feature user level, as explained in the following section). Utility features can be either point features or linear features. Point features have only one X, Y coordinate pair, whereas linear features can have several X, Y coordinate pairs associated with them depending on the number of vertices used to determine the feature horizontal alignment. Each feature is assigned a unique ID that remains with the feature as long as the X, Y coordinates associated with the feature remain the same. In general, linear features begin and end at point features.

DATABASE MODEL

The database model includes feature descriptors and process descriptors. Feature descriptors refer to spatial and non-spatial attributes used to characterize individual utility features. Process descriptors refer to attributes used to characterize business procedures such as utility permits, utility adjustment agreements, and leases. For brevity, this paper only includes basic feature descriptors and some of the descriptors involved in the utility permitting process.

Feature Descriptors

Figure 2 shows some of the elements of the feature attribution scheme developed. Notice that UtilityClass describes the overall group under which a utility facility can be classified following the American Public Works Association (APWA) Uniform Color Code standard *(3).* Likewise, UtilitySubClass describes a utility subclass used to further characterize the function of a specific utility feature.

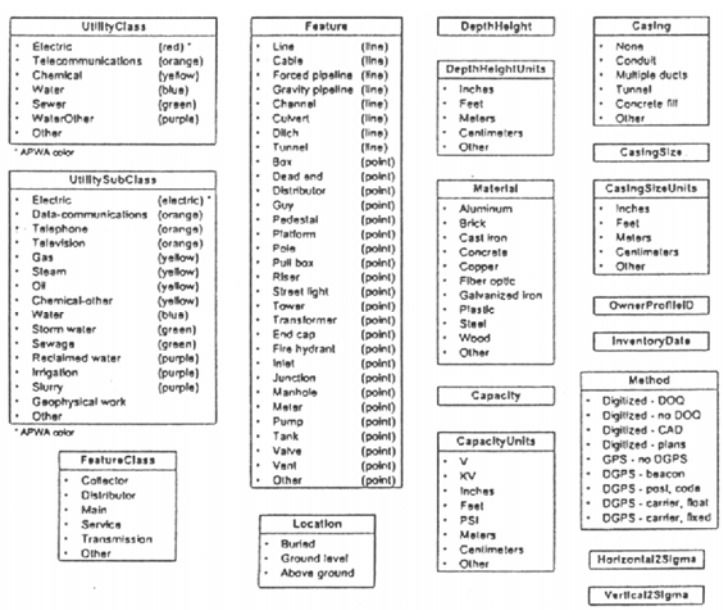

Figure 2. Characterization of utility linear features and point features

In the database, there is a distinction between features, feature events, and feature user events (Figure 3). As mentioned previously, each feature has a unique ID that remains with the feature as long as the X and Y coordinates associated with the feature remain the same. Basic feature attribution is thus given in terms of data that can be used to locate the feature on the ground or by using GIS linear referencing capabilities. Feature events refer to physical changes that affect the feature throughout its lifetime. Examples of possible feature events include changes in geometry (that do not involve changes in X, Y coordinates), changes in physical characteristics, and changes in feature ownership. For example, if a wooden utility pole has been replaced with a metal one, the change would be handled as a feature event. Each feature event is time stamped.

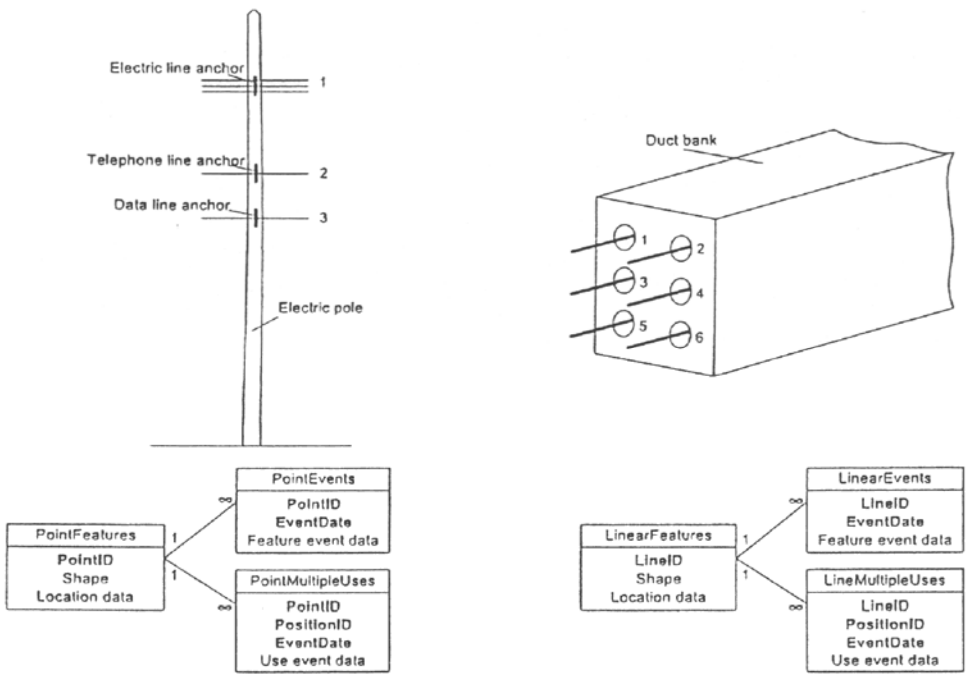

Figure 3. Features, feature events, and feature user events

Feature user events refer to changes that affect one or more feature users. By default, every feature is assumed to have at least one user. However, it is possible for a feature (point or linear) to have multiple users. For example, utility poles (which may be owned by an electric utility company) are frequently used to anchor electric utilities, telephone utilities, and data communication utilities. In the database, each of these utilities would be considered a separate user of the utility pole feature. Likewise, duct banks (which may be owned by a utility company or by a transportation agency such as TxDOT) typically carry various types of utilities. In the database, each of these utilities would be considered a separate user of the duct bank feature. Notice that each user is assigned a position ID within the feature. The position ID remains fixed and is considered a feature attribute.

The linear physical space between two adjacent utility poles is considered a linear feature. By default, the owner of this linear feature would be the primary —or first user of the feature (ownership refers to the feature, not the right-of-way, which belongs to the transportation agency). For example, if the poles were originally installed by an electric utility, the space between the poles is normally occupied by electric lines. This would make the utility company the primary user of the linear feature. However, not necessarily the feature owner is also a feature user. For example, TxDOT is considering the installation of duct banks along several corridors on the state highway network. Under one of the scenarios considered, TxDOT would own the duct banks but would lease the use of the ducts to individual utility companies.

Utility Permitting Process Descriptors

Associated with the spatial model and feature descriptors shown in Figures 1, 2 and 3, a business process database prototype was developed. A simplified version of the utility permit database schema is shown in Figure 4.

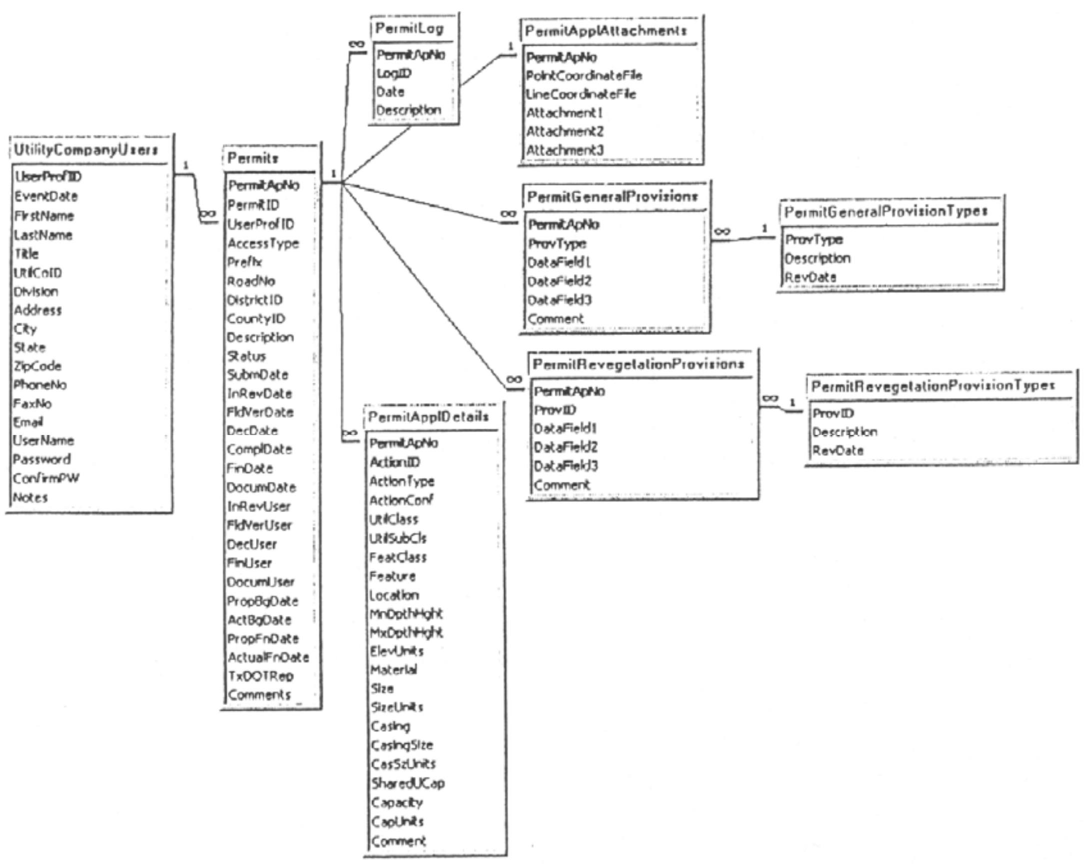

Figure 4. Utility permit database schema (Notes: primary keys are shown in bold)

UTILITY PERMIT DATA ENTRY PROCESS

In the case of TxDOT, roughly 90% of all utility-related activities throughout the state focus on utility permits, and practically all of this is done by hand. A large district handles between 1,000 and 2,000 permits a year and a typical utility permit may take anywhere from a few days to weeks, or even months in some extreme cases, to complete. The amount of paperwork is quite substantial. An automated Internet-based data collection and data entry process could be used to substantially reduce the amount of paperwork, streamline the data capture process, and make the utility permitting process more expeditious.

Figure 5 illustrates the utility permitting process using a Web-based data entry approach. The workflow resembles the actual workflow at TxDOT, except everything to the extent possible would be done electronically. For example, a utility company would use an online data entry form to submit a utility permit application. In addition to text fields, the form provides the user with the capability to upload a file containing coordinate data and also the capability to view this data on an onscreen map. The web server acknowledges receipt of the application and provides the utility company user with the capability to print a copy of the application form that looks exactly the same as the paper form that is currently being used by TxDOT. The server also sends an e-mail message to a designated utility manager at the District office at the time a new permit has been submitted. This manager conducts an initial review of the application online and once this is done, an e-mail message is sent to a supervisor in the maintenance office (or area office if needed) for field verification of the proposed work. The maintenance supervisor conducts the field review and provides comments online. With this information, the utility manager makes a decision as to whether to approve or deny a permit and sends the corresponding online form to the utility company. Assuming the application is approved, the utility company conducts the necessary field work. Upon completion, the utility company is required to submit as-built coordinate data to assist GIS personnel at the District office to make the necessary adjustments to the utility base map.

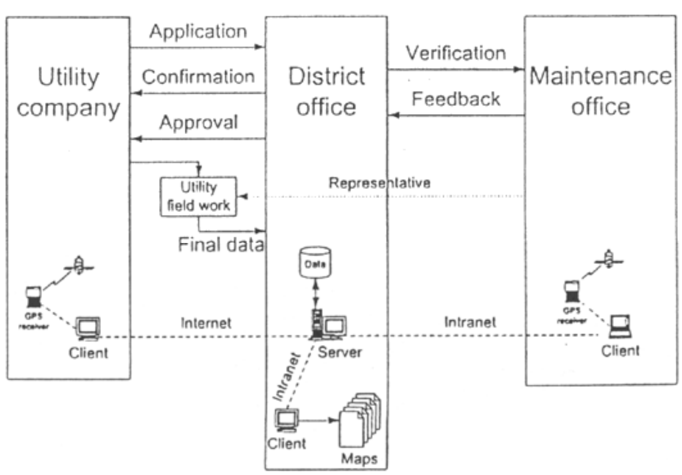

Figure 5. Sample data flow and data collection for utility permits

Utility Company Interfaces

Access to the utility company interface is facilitated through a user profile. The user profile contains contact data, company data, and security data. As soon as a user logs into the system, their profile ID is obtained from the database. This allows user profile data to be stored with all important database transactions and also reduces the work required to complete forms since user profile data are automatically inserted into all forms.

Once the system grants access to a user, a data entry form is displayed on the screen (Figure 6). Where practical for purposes of database consistency, field entries are chosen from a "drop down" list. In the event that an appropriate choice is not available, users may choose "other" and provide a written explanation of this choice. The interface follows a "shopping cart" design approach to provide users with the capability to document several actions associated with the current permit application. This is useful in the case of proposed utility work that involves more than one kind of action in the field, e.g. abandoning a section of pipeline and installing a replacement pipeline at a different location. Notice that the interface requires the user to provide point coordinate data files and/or line coordinate data files to document the proposed utility work in a GIS-compatible format. In order to upload each coordinate file, the user can either provide the path and filename or browse to find and choose the file. After completing the form, the user is shown the completed list of information and is given the opportunity to make changes to the data provided. When the user is satisfied that the permit application form and coordinate files are correct, the user clicks on the "Submit Application Form" button to complete the process. At this point, all the data are permanently stored in the database tables on the server side and the application is given the status of "Submitted". The user is returned to the Utility Permit home page and the application is ready to be processed.

Administrative Interfaces

Following the data flow in Figure *5,* the status of a utility permit application could be one of the following at any given time: Submitted, initial review, field verified, approved, rejected, completed or documented. Each status corresponds to a different administrative responsibility. To facilitate workflow, each time an application record changes status, an email alert is automatically sent to the individual responsible for the next required administrative task. A short description of each of the sequential status options follows.

- Submitted: An application is labeled "submitted" when an electronic confirmation that an application has been received by the server has been sent to the utility company.
- Initial review: An application has undergone "initial review" after a utility coordinator at the District Office has verified the application for completeness.
- Field verified: An application is labeled "field verified" after the Maintenance Supervisor/Area Engineer determines whether the proposed installation should be granted and makes a recommendation (through the interface).
- Approved: An application is labeled "approved" after an application that has been recommended for approval has been printed, signed, and mailed to the utility company.

- Rejected: An application is labeled “rejected” after an application that has been recommended for rejection has been printed, signed, and mailed to the utility company. No further action is needed.
- Completed: An application is labeled “completed” after as-built documentation (coordinates and utility facility attributes) has been received by the server upon completion of the proposed work.
- Documented: An application is labeled “documented” after the GIS utility maps have been updated following the field work by the utility company. Appropriate GIS personnel at the District Office is responsible for this task.

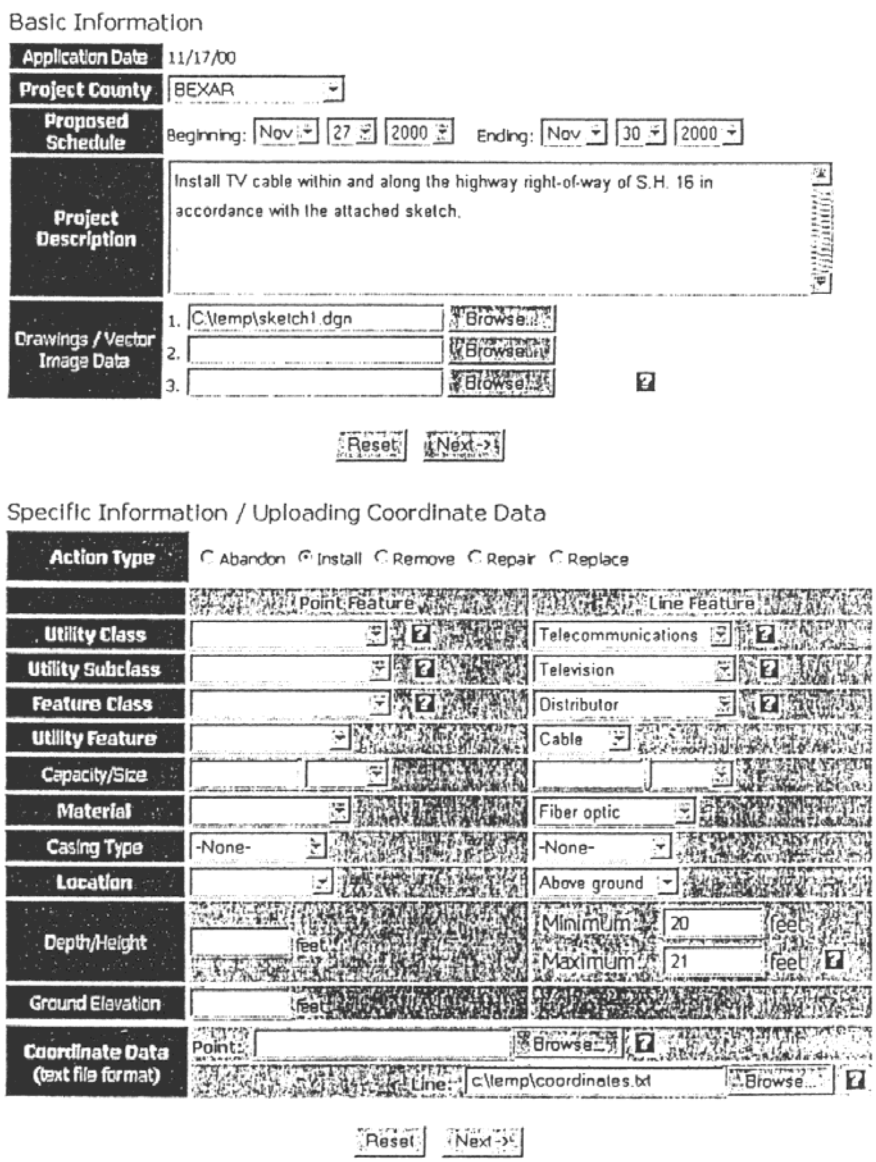

Figure 6. Permit application form interface

CONCLUSIONS

This paper describes a prototype utility data spatial and database model. The paper includes a generic GIS-based model for the inventory of utility facilities and associated attribute data such as ownership, purpose, size, type, and other pertinent characteristics. Two types of descriptors are included in the model: feature descriptors, which refer to spatial and non-spatial attributes used to characterize individual utility features, and process descriptors, which refer to tables and relationships used to characterize business procedures such as utility permits, utility adjustment agreements, and leases. For brevity, this paper only includes basic feature descriptors and some of the tables and relationships involved in the utility permitting process.

The paper also includes an Internet-based data collection and data entry prototype to assist in the utility permitting process. The data management system is centralized with distributed map and data access capabilities. The system includes two types of interfaces: a utility company interface and an administrative interface. The utility company interface provides users with data entry forms that include the capability to "preview" the location of the proposed utility installation work. The administrative interface provides users with the capability to track the progress of the utility permitting process online and alerts affected individuals about specific tasks that result from that process.

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