COMMON TRENCHING—STATE OF THE ART

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In urban areas, expansion of existing utility systems and the possibility of adding utilities increase competition for available installation space. Installation and maintenance of these utilities cause pavement cuts resulting in more frequent repaving and attendant traffic congestion. Common trenching, the installation of multiple utility lines in a single trench, offers the potential for reducing the number of places in which pavement cuts are made. Although many companies indicate that they use common trenching, it is not a universal practice. The English made a detailed study of common trenching for use in public housing developments and developed standard trench designs and suggested coordinating and operating procedures. Many of these procedures are applicable to the United States. One suggestion, for example, was the use of a single crew for installation, which has proved successful when tried in the United States. Major areas of concern to the utilities are coordination, compatibility, and cost sharing. Coordination can be handled in many ways. Coordinating committees, joint utility procedures, design by a single engineering firm, or use of an outside engineering firm to supervise design and installation and provide scheduling have proved to be successful. Compatibility problems may be eliminated by proper design and choice of construction materials. Cost-sharing formulas have been developed to prorate costs among the utilities. Past research indicates that cost savings from 10 to 20 percent can be anticipated by using common trenching. In addition, if the use of common trenching allows quicker installation, developers, utilities, and highway departments should experience savings.

•EXPANSION of underground utilities in urban areas produces increased competition for available installation space. Such competition is already common for utilities in densely populated areas of larger cities. In suburban areas, the problem is not so acute, but, with increased emphasis on underground utilities, improved installation practices obviously would be highly desirable for both aesthetic and economic reasons. Common trenching, or the installation of multiple utilities in the same trench, could lower costs and reduce the number of trenches required. Although the common trench could be located beneath the roadway, it also could be located outside the roadway. If utilities must be located within the roadway, common trenching would reduce the number of times the pavement would be cut during installation.

In many cases, existing utility facilities are located in the path of proposed highway construction projects. As a result, relocation, replacement, or adjustment must be performed. Thus coordination and scheduling of utility installation are required between the highway contractor and the utility-construction crews. If this coordination is overlooked, project delays that can increase cost to both highway contractor and utilities may result. Use of common trenching can reduce required installation time, amount of space required for utility installation, number of trenches needed, and, if the utilities are located within the roadway, width of pavement that would be subjected to cuts for maintaining the utilities. For highways, minimizing the area of pavement over the utilities could reduce interference to traffic during repairs and the need for repaving the roadway.

Common trenching raises a number of potential problems. Perhaps the major problem is in coordination and scheduling of installation between the developer and the involved utility companies, although compatibility between utilities and allocation of cost quite often are cited as problems. The purpose of this paper is to summarize current practices and point out advantages or disadvantages to the implementation of common trenching. Greater details on the use of common trenching and the institutional and technical problems involved in this method of utility installation can be obtained from another report (1).

As population increases, demands placed on utility-distribution systems also increase. In addition, population migration from center city areas to suburbs produces a need for wider utility distribution. Current trends indicate that utility companies that have located most of their distribution systems overhead will increase the fraction of distribution systems that are located underground.

Data on which to project future utility needs are sketchy; in the case of certain utilities (such as water and sewers), determining merely the total number of miles (kilometers) of pipes in existing systems is impossible because no central organization appears to keep track of such records.

In an earlier phase of this study for the U.S. Department of Housing and Urban Development (HUD), an attempt was made to estimate growth of various utility systems by using statistical data from utility company annual reports and other sources (2). The results of this study are given in the following tabulation and indicate that large yearly growth rates can be anticipated (1 mile = 1.6 km):

System	Estimated Annual Growth (miles)
Water	10,000 to 15,000
Sanitary sewers	10,000 to 25,000
Natural gas	20,000
Electric power, underground installation only	6,700
Telephone, underground installation only	50,000 to 60,000
Community antenna television, underground installation only	5,000 to 6,000

Estimated annual growth for electric power and telephone is in cable miles (kilometers).

CURRENT PRACTICES

A review of the literature on common trenching in the United States indicates that little documentation exists on the application of this method of installation. However, a survey of 33 utility companies made as a part of the 1969 Institute of Electrical and Electronics Engineers Conference on Underground Distribution found that all but 3 of the companies responding used some form of common trench with telephone companies or other utilities (3). Six of the companies reported 100 percent common trenching with telephone. A third of the companies indicated 80 percent common trenching with telephone. Eight of the companies said that they had performed common trenching with gas utilities, and 1 company reported a recent common installation with a water utility. Unfortunately, detailed data on these installations can be obtained only from the utility companies involved. A few contacts have been made with utility companies, but determining the amount of common trenching that has been installed or is anticipated to be installed in future installations has not been possible.

A number of factors appear to have encouraged the use of common trenching. First, public pressures regarding aesthetics and the environment have led to increased pressure on utilities that use wires to locate their lines underground. Underground distribution is more expensive than overhead distribution, and any installation system such as common trenching that might reduce this cost difference is of interest to all parties concerned. Second, development of new power cables, such as the concentric neutral cable, has increased the safety aspects of common trenching by reducing the possibility of shock if the cable is accidentally severed. Finally, changes made in the National Electrical Safety Code to allow random separation (no fixed spacing required between power and telephone cables below certain voltages) has allowed narrower trenches to be used (4). Furthermore, current highway safety efforts under the federal-aid highway program include the advancement of projects for removing or relocating aboveground obstructions, such as trees, sign supports, lighting poles, and utility poles, that might pose a hazard to motorists because of their proximity to the highway. In some cases, this has resulted in an increased need for locating utility facilities underground.

As a separate part of our studies, we have examined the legal aspects of the underground installation of utilities (5). We found that there appears to be no legal deterrent to common trenching. In fact, some state utility regulatory agencies appear to favor common trenching in their rules and regulations on installing underground utilities in new subdivisions by stating that, whenever possible, electric and telephone cables and gas lines should be installed in the same trench (6).

The first reported instance of the use of common trenching was in 1960 by the Commonwealth Edison Company and Illinois Bell Telephone (7). In the initial trials, a trench 6 in. (150 mm) wide by 36 in. (900 mm) deep was used with the power cable located at the bottom of the trench, and the telephone cable was placed 12 in. (300 mm) above the power cable. Initial trials indicated that (excluding the cost of the service connection) savings of 12 to 15 percent were achieved. Currently, Commonwealth Edison Company and Illinois Bell Telephone are using random separation in their installations. A unique feature of their operation is that 1 crew installs both the power and communication cables (8). New work is split up so that each company does 50 percent of the excavation and installation. As a result, each company performs half of the work, and the cost is shared equally.

Detroit Edison and Michigan Bell use much the same approach as that used in Illinois (9). In 1969, in one new subdivision, the entire job of excavation, installation, and backfilling was reported to have been contracted to an outside firm. Although use of this method has been limited, the trial installations were very successful.

An interesting common trench was designed for an urban renewal project in Pittsfield, Massachusetts (10, 11). Four utilities—gas, power, telephone, and community antenna television—were included in the trench. Because of the large number of power and telephone cables, ducts were located in the bottom of the trench. The resulting trench (Figure 1) was 5 ft (1.5 m) wide and 6 ft (1.8 m) deep. A formula for cost allocation was developed based on the total area of excavation required for each utility to be installed in a separate trench subtracted from the total area of the common trench. Any excess area in the common trench then was split equally among the 4 utilities. Costs then were calculated on the basis of a percentage of trench area.

In 1968, in England, the Ministry of Public Building and Works organized a committee for coordinating underground services on building sites to look at the potential use of common trenching in public and private housing developments (12, 13). An analysis has been made of the proposed English system to study its applicability to the United States and determine areas where the system would have to be modified to be used in this country (14). The committee found that technology did not appear to be the main problem with the possible exception of service connections, which they proposed to install at the same time that the common trenching of the distribution was performed. To be successful, this required that the location of the housing units be fixed early and not be changed. A typical cross section of their proposed trench is shown in Figure 2 (12).

It appeared to the committee that coordination was the main area in which changes would be required for successful application of common trenching (13). They recommended that greater participation take place among all parties involved, that coordination be initiated in the earliest planning stages, that consideration be given to installation by

Figure 1. Typical cross sections of common trenches.

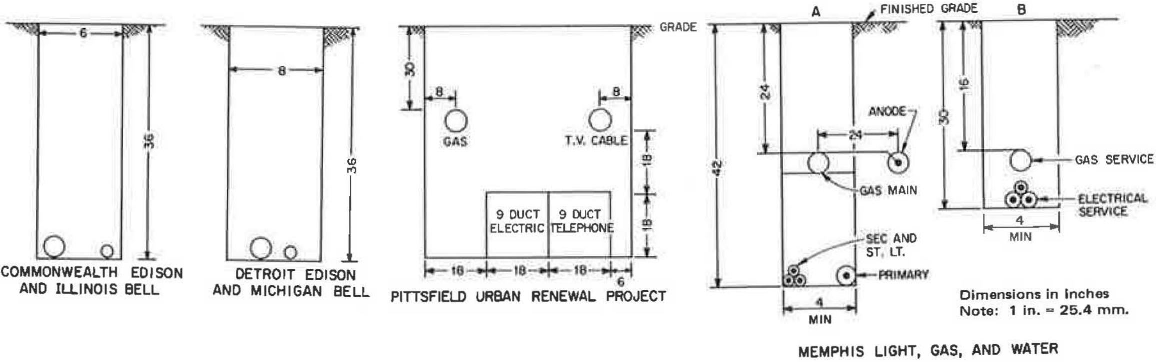
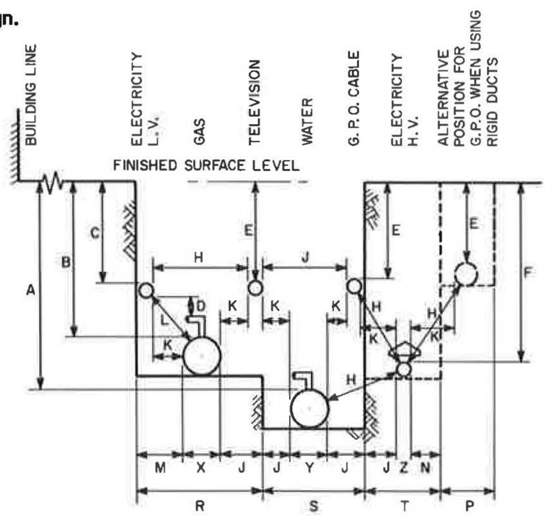


Figure 2. Proposed English trench design.



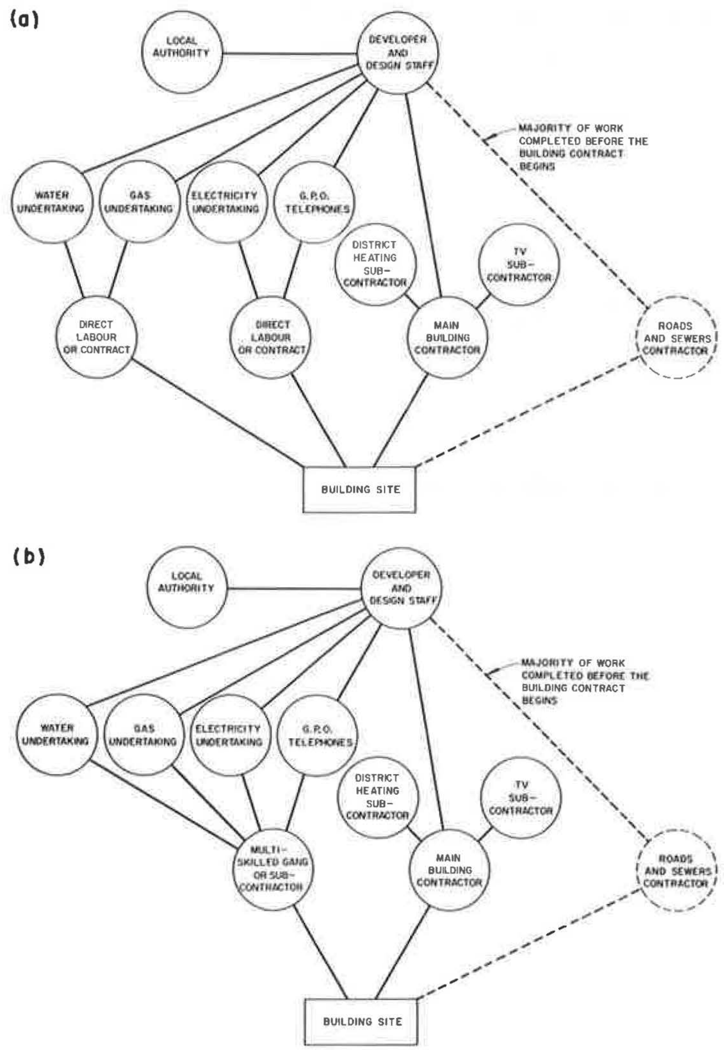
LETTER	DIMENSION BRITISH (ft)	(in.)	METRIC (mm)	REMARKS
A	3	0 min	900 min	
B	2	0 min	600 min	
C	1	6	450	
D		6 min	150 min	WITHOUT ADDITIONAL INSULATION
E	1	2 min	350 min	
F	2	6	750	
H	1	0 min	300 min	DISTANCE OF H.V. CABLE FROM G.P.O.
J		6 min	150 min	REFERS TO MULTICORE CABLE ONLY.
K		4 min	100 min	G.P.O. REQUIRE CLEARANCE OF 1ft 6in. (450 mm).
L		8 min	200 min	FROM SINGLE CORE H.V. CABLE.
M		9 min	250 min	WHEN L.V. INCLUDED, OTHERWISE 6 in. min (150 mm)
N		5 min	150 min	
P		9 min	250 min	
X	VARIABLE		VARIABLE	GAS PIPE OUTSIDE DIAMETER
Y	VARIABLE		VARIABLE	WATER PIPE OUTSIDE DIAMETER
Z	VARIABLE		VARIABLE	H.V. CABLE OUTSIDE DIAMETER

$R = M + X + J$

$S = 2J + Y$

$T = J + N + Z$

Figure 3. Organizational arrangements for (a) use of pairing and (b) use of multiskilled crew or contractor.



a multidisciplinary crew, and that either the developer or the utilities be encouraged to assume financial obligation for the project and be repaid later. Some of their proposed organizational systems are shown in Figure 3.

Many of the cited utility problems also occur in the United States. The major problem appears to be that the developer does not notify the utilities early enough to allow the necessary coordination. Furthermore, the exact location and plan of the housing are subject to greater fluctuation than that envisioned in the English system. Instances have been reported where utilities have joined together on their own initiative to use a common trench. Pressure from developers, building contractors, or highway organizations does not appear to be a factor in their decision. Rather, they appear to have approached the concept on the basis of reduced excavation, and, it is hoped, cost.

COMPATIBILITY

One of the frequently cited concerns in common trenching is compatibility among the various utilities in the trench. There are concerns over interference between electric cables and communication and signal circuits, corrosion of pipe utilities from stray electrical currents, and possible contamination of water supplies if sewers are in the common trench.

In 1968, the Edison Electric Institute and the Bell Telephone System completed a study evaluating random separation of power and telephone cables (15). This study utlimately led to a revision of the National Electrical Safety Code to permit random separation. Woodland (16) recommended that random separation with telephone not be used when "feeder" cables are involved and that it should be used only on the subscriber end. Also, on runs longer than 0.5 mile (0.8 km), an analysis should be made to determine whether interference will occur.

Pipe may be subject to corrosion in certain soil conditions, and the presence of stray electrical currents from adjoining power cables might increase the rate of corrosion (17, 18). This could be alleviated by using cathodic protection or plastic gas and water pipes.

Sewers do not appear to be compatible with common trenching because of excess depth of burial and the need to be installed to grade. Also, many state health departments insist on spacing from 6 to 10 ft (1.8 to 3 m) between water lines and sewer lines (19). If a gas leak were to occur, gas possibly might leak into the sewer system.

COORDINATION

Coordination can be achieved in a number of ways from informal group meetings between the developer and the utilities to formalized procedures and committees. The developers of Foster City, California, attempted to install a coordinated utility system (20). To do this, they hired an electrical engineering design firm as the coordinating agency. Detailed drawings were prepared that showed the exact location of each service for each residential lot. Unfortunately, use of common trenching was not specified and, as a result, was not used extensively.

In 1965, a firm named Coordinated Utilities, Inc., was formed in Berkeley, California, to market a patented system of utility installation that used a special design of common trench (21). It was first used in Walnut Creek, California. U.S. Patent Number 3,263,577 was issued to cover the concept, which included common trenches containing certain utilities under the sidewalk on each side of the roadway. The major feature of the design was the use of a smaller common trench perpendicular to the roadway at each lot line so that utilities from each side trench passed back and forth across the street only once for each 4 lots served. Unfortunately, the owner of the firm died and the company went out of business.

Another example of design and construction of multiple utilities by a single coordinator existed in New York City where a new police headquarters building was being constructed (22). Under a single contract, an engineering firm was employed to determine locations of existing utilities, determine placement of new utilities, schedule work, prepare plans and specifications, and oversee the installation. The utilities agreed to deposit sufficient funds to cover their share of the work. Each deposit was later adjusted on the basis of bid prices and the actual cost of the work.

In California, the Inter-Utility Underground Committee has been formed and is in the process of preparing a written manual of procedures for joint construction (23). This manual will contain forms that will be used to notify the utilities of intent to construct joint facilities, formulas for allocating trench costs for residential and commercial areas, and procedural agreements in effect among various utilities in the state. In addition, in the San Francisco area, Pacific Gas and Electric and the Pacific Telephone Company have developed details for handling common trenching for gas, electric, and telephone lines. These procedures outline planning steps, billing procedures, and cost allocation.

The American Public Works Association in conjunction with the U.S. Department of Transportation has been conducting a research project on the location of utilities in relation to highways. One result of this research has been the organization of a nationwide committee to implement the organization of utility-coordinating committees. Their research findings and recommendations for future actions are covered in a recent report (24).

One of the major concerns of utility companies is excavations, or dig ins, caused by the installation or maintenance of other utilities. Location of all utilities in a common trench possibly could reduce the frequency of dig ins because contractors would know that other utilities exist in the area and therefore would be more careful during excavation. Studies also have shown that dig ins happen less frequently to deeply buried facilities; the use of a common trench can provide this advantage to utilities that normally make shallower installations (25).

ECONOMICS

Economies in the construction of utility-distribution systems that use common trenching result from: (a) savings in the amout of excavating, backfilling, or repaving; (b) more efficient use of labor through use of a single-crew concept; and (c) improved rate of return on invested capital from a shortened construction schedule.

Although general agreement on the validity of potential cost savings was expressed by the organizations engaged in common trenching, quantifying these factors generally has been difficult because of mixed feelings about the extra planning and coordination required to implement a successful common trenching program. This is in part because any project must be installed one way or another, and few projects are exactly alike. Therefore, comparison of alternatives necessarily requires estimates for alternatives not actually performed. Furthermore, our contacts with utility companies indicate that they are unable to supply information that they feel would be meaningful on the cost of planning, coordination, supervision, and inspection. If common trenching reduces the traffic interference associated with utility installation maintenance and the need for repaving, then reduced costs to highway departments should accrue.

The economics of common trenching are not well documented. Most references merely indicate that money is saved by reduced excavation, but they make no mention of possible increases in installation costs or costs from coordination. In a case study in England to evaluate the recommendations of the Committee for the Coordination of Underground Services on Building Sites, utilities occupying the deepest portion of the trench reported savings of about 5 to 10 percent (26). Utilities occupying the shallow portion of the trench experienced no savings; however, it was felt that in future installations larger savings would occur. In the United States, cost savings have been estimated to be 5 to 10 percent in early trials with an upper limit of about 20 percent after operations have been standardized. These are savings to the utilities only, and do not represent the overall savings that also will accrue to the builder, developer, or highway contractor because of faster installation of utilities and less construction interference caused by trenching. Until more documentation is available, these potential savings cannot be estimated. A detailed case study from planning to final construction will be required to quantify adequately the economics of common trenching.

CONCLUSIONS

Common trenching has been practiced in the United States to a limited extent since 1960, and a survey of recent literature indicates that increased use of this method of installation is occurring. Various trench designs, methods of installation, and cost allocation procedures have been reported; however, no standardized procedures are commonly used in most of the reported installations. In England, a study was made of common trenching that is probably the most comprehensive evaluation of common trenching problems and procedures in existence. This study pointed out that advantages will occur through greater cooperation between building developers and utility companies if common trenching is used. However, some of the procedures suggested might not be possible in the United States at this time. One of the most obvious of these would be the use of a common crew to install all of the utilities in the trench. This might require changes in union regulations concerning jurisdiction over the installation of various utility lines and the increased training of installation crews.

Benefits accrue to utilities, developers, and highway departments from use of common trenching (reduced excavation costs, faster installation, reduced right-of-way requirements, and possible reduction in dig ins) because all utilities would know the location of the others in the common trench and pavement cuts would be restricted to only a portion of the pavement during maintenance. Whether these factors could reduce the frequency of repaving is not known. There is a need for a detailed, documented case study of common trenching to determine whether the use of common trenching provides the benefit suggested in the literature and to develop standard procedures applicable in the United States.

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REFERENCES

1. W. J. Boegly, Jr., W. L. Griffith, A. L. Compere, W. H. Brown, and J. H. Lord. Technical and Institutional Aspect of Common Trenching. Oak Ridge National Laboratory, Oak Ridge, Tenn., ORNL-HUD-28, Aug. 1974.
2. W. J. Boegly, Jr., and W. L. Griffith. The Feasibility of Retrieving Utility System Capital and Maintenance Costs From Annual Reports. Oak Ridge National Laboratory, Oak Ridge, Tenn., ORNL-HUD-16, Sept. 1970.
3. J. L. Mulloy. URD Utility Reports—Coordination. Special Technical Conference on Underground Distribution, Institute of Electrical and Electronics Engineers, New York, 69C1-PWR (Sup.), Dec. 1969, pp. 72-75.
4. Safety Rules for the Installation and Maintenance of Electric Supply and Communication Lines. In National Electrical Safety Code, National Bureau of Standards, U.S. Department of Commerce, Supplement 2 to NBS Handbook 81, March 1968.
5. W. H. Brown. Legal Aspects of Underground Utilities. Oak Ridge National Laboratory, Oak Ridge, Tenn., ORNL-HUD-27, April 1973.
6. Rules for Residential Electric Underground Extensions. Florida Public Service Commission, Order 5077, Docket 69246-PU, May 22, 1971.
7. J. C. Smith and L. A. Kemnitz. Power and Telephone in Common Trench Cut Underground Cost. Electrical World, Vol. 157, Jan. 15, 1962, pp. 48-51.
8. M. F. Tuntland. Single Crew Installation of Joint URB Cuts Costs. Transmission and Distribution, Vol. 19, No. 6, June 1967, pp. 32-35.
9. R. R. Lieberman. URD Trenching Installations. Special Technical Conference on Underground Distribution, Institute of Electrical and Electronics Engineers, New York, 69C1-PWR (Sup.), Dec. 1969, pp. 241-246.
10. E. S. Gardner, Jr. Pittsfield Urban Renewal Project. Special Technical Conference on Underground Distribution, Institute of Electrical and Electronics Engineers, New York, 69C1-PWR, April 1969, pp. 44-50.
11. E. S. Gardner, Jr. Joint Utility Planning and Use of a Common Trench Can Work. Transmission and Distribution, Vol. 22, No. 12, Dec. 1970, pp. 60-62.
12. Coordination of Underground Services on Building Sites: 1. The Common Trench. Ministry of Public Building and Works, Her Majesty's Stationery Office, London, research and development bulletin, 1968.
13. Coordination of Underground Services on Building Sites: 2. Coordination Management. Ministry of Public Building and Works, Her Majesty's Stationery Office, London, research and development bulletin, 1968.
14. W. J. Boegly, Jr., and W. L. Griffith. Urban Utility Technology. In Civil Defense Research Project Annual Progress Report, March 1971-March 1972, Oak Ridge National Laboratory, Oak Ridge, Tenn., ORNL-4784, 1972, pp. 1-9.

15. Buried Power and Telephone Distribution Systems—Analysis of Primary Fault Tests and Evaluation of Experience With Random Separation. Edison Electric Institute and Bell Telephone System, 1969.
16. F. Woodland, Jr. Electrical Interference Aspects of Buried Electric Power and Telephone Lines. Special Technical Conference on Underground Distribution, Institute of Electrical and Electronics Engineers, New York, 69C1-PWR, April 1969, pp. 245-251.
17. P. J. Kassak. Joint Trenching—Good or Bad? American Gas Journal, July 1968, pp. 33-36.
18. P. J. Kassak. Design Considerations in Joint Trenching. Proc., 1968 Distribution Conference, Operating Section, American Gas Association, 1968, pp. 193-198.
19. Recommended Standards for Water Works. Great Lakes-Upper Mississippi River Board of State Sanitary Engineers, 1968.
20. K. S. Oliphant. Coordination Cut Costs of Undergrounding. Electrical Construction and Maintenance, Vol. 65, No. 3, March 1966, pp. 116-120.
21. A Look at Leisure Living: Above Ground and Below. Electrical West, Vol. 132, No. 1, Jan. 1965, pp. 34-35.
22. J. J. Kassner. Relocating Substreet Utility Lines. Civil Engineering, Vol. 38, No. 4, April 1968, pp. 86-88.
23. Procedure Manual. Inter-Utility Underground Committee of Southern California, 1970.
24. Accommodating Utility Plant Within the Rights of Way of Urban Streets and Highways. American Public Works Association, Research Project 71-1, 1974.
25. M. R. Plummer. A Characterization of Bell System Problems With Buried Cable Dig-Ups. 1971 Conference on Underground Distribution, Institute of Electrical and Electronics Engineers, New York, 71C42-PWR, 1971, pp. 210-212.
26. The Coordination of Underground Services: A Case Study. National Building Agency, London, Rept. SBN 901502 170, July 1970.