

Analysis of Cross-Bores in Unmarked Sewer Service Laterals

Samuel T. Ariaratnam, M.ASCE¹

Abstract: With an increase in trenchless methods being used for the installation of natural gas lines in urban areas, unmarked sewer service laterals present a risk of accidental and unknown cross-bores with these distribution lines. Although the physical damage to underground facilities is always unwanted, a cross-bored plastic natural gas distribution pipeline in a sewer is vulnerable to mechanized sewer cleaning tools that may be used in the event of a backup, with potential explosive consequences. Mainline sewers and storm sewers are also at risk from cross-bores; however, the scope of this paper is sewer service laterals. Although good practices exist for operators of horizontal boring equipment, these assume that the existing underground structures are marked and/or located. State legislation mandates the marking and locating of underground infrastructure; however, the question of who assumes responsibility for marking and locating sewer service laterals is a contentious issue. Sewer system owner/operators generally place the responsibility of locating and marking in the hands of unsuspecting property owners claiming that the laterals are on private property. In reality, property owners lack the expertise and equipment to mark and locate these service laterals. This paper describes the challenges with respect to natural gas cross-bores in unmarked sewer service laterals and presents data obtained from a survey of 43 contractors involved in the distribution contracting industry. The results further support the need for immediate action related to unmarked underground sewer service laterals. DOI: 10.1061/(ASCE)PS.1949-1204.0000156. © 2013 American Society of Civil Engineers.

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Introduction

The underground utility industry is facing some unique challenges as a result of unmarked sewer service laterals. With an increase in trenchless methods, such as the use of horizontal directional drilling (HDD) and pneumatic piercing tools, unmarked laterals present a risk of accidental and unknown natural gas cross-bores with distribution lines (Bruce 2012). Although the physical damage to underground facilities is always unwanted, a natural gas distribution line that intersects a sewer lateral is vulnerable to mechanized sewer cleaning tools that may be used in the event of a backup, with potential explosive consequences. Fig. 1 illustrates a typical cross-bore of a natural gas line in a sewer service lateral from a closed circuit television (CCTV) camera inspection.

Good practices exist for operators of horizontal directional drilling equipment; however, these assume that the existing underground utilities are marked and/or located. The question of who assumes responsibility for marking and locating sewer service laterals is a contentious one. State damage-prevention statutes and legislation mandate the marking and locating of underground infrastructure (CGA 2012). Most state statutes have language to the effect of “The owner or operator of an underground facility is responsible for locating the approximate horizontal location of that facility.” There is much debate about who is responsible for locating and marking service laterals. Should the responsibility lie in the hands of the property owners who have legal title to the laterals,

or the municipalities, the entity that generates revenue, or perhaps the contractor? Most municipalities claim that they do not own the service laterals past the property line, and therefore should not be responsible for locating and marking them. Others feel that property owners do not possess the expert knowledge to address the marking of laterals. In other words, owners of homes and businesses will rarely have knowledge of the route of the lateral, the expertise to locate it, or the equipment to perform the locate. Therefore, the municipality or organized sewage district, as the operator, would likely be in the best position to perform lateral locates. This paper describes the challenges with respect to natural gas cross-bores in unmarked sewer service laterals and presents the data obtained from a survey of 43 individuals involved in the distribution contracting industry.

Current State of Practice

As mentioned previously, there has been an increase in the use of trenchless methods such as horizontal directional drilling (HDD) and pneumatic piercing tools for the installation of polyethylene natural gas distribution lines in congested urban environments. These are necessitated by the need to create minimal disruption to surface activities in urban settings and a desire to adopt lower-cost installation methods. A major concern facing contractors today is the issue of the responsibility for locating and marking of sewer service laterals. Fig. 2 shows a typical scenario facing natural gas distribution contractors. The lack of locating and marking with regard to sewer service laterals was identified as a major issue by contractors that participated in *Underground Construction* magazine’s “2003 Annual Contractors Roundtable” (Carpenter 2003).

A typical One Call ticket involves the marking of utilities in the area of proposed construction including, in most cases, telecommunications, water, wastewater, gas, cable, and electrical lines (CGA 2012). The real issue is the sewer service laterals, which are

¹Professor and Construction Engineering Program Chair, School of Sustainable Engineering and the Built Environment, Arizona State Univ., Tempe, AZ 85287-0204. E-mail: ariaratnam@asu.edu

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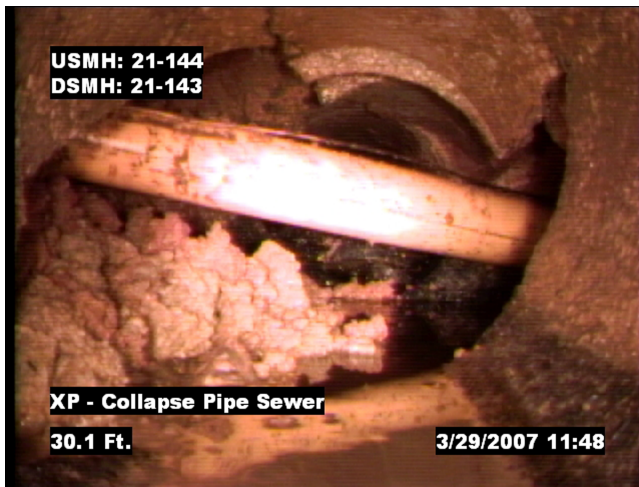


Fig. 1. Cross-bore of a natural gas distribution line in a sewer service lateral

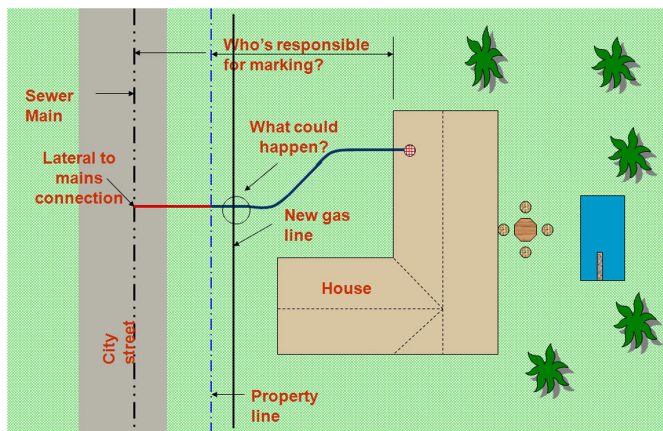


Fig. 2. Typical scenario involving sewer service laterals on private property

exempt from marking by most One Call statutes. The thinking is that these are on *private* property and as such are not the responsibility of the sewer system owner/operator. Municipalities, government agencies, trailer park owners, and other owner/operators are often hesitant to mark the location of laterals because of added costs and lack of proper as-built records; however, this poses a significant risk to public safety. One exception is the city of Mesa, Arizona, which provides the marking of sewer service laterals in the public right-of-way. City personnel diligently research available records to try and identify current service lateral locations. These are then shared with the respective contractor. Currently, several Arizona municipalities have agreed to undertake pilot projects to evaluate the viability of providing locates.

Overview of Current Underground Facility Damage Prevention Laws

By state statute, excavators are responsible for notifying their respective One Call center before excavation to have all buried utilities in the area of excavation located and marked. Once marked by the utility owner, it is then the responsibility of the excavators to

operate in a safe and prudent manner by taking actions to protect those existing buried utilities and to ensure no damages are caused through negligence on their part. For example, various state statutes have minimal separation distances for operating mechanized equipment. Furthermore, best practices for exposing and verifying marked utilities before excavation or trenchless construction are outlined in various documents (NULCA 1997; NTSB 1997; USDOT 1999; Bennett and Ariaratnam 2008). The National Telecommunications Damage Prevention Council developed a “Model State One-Call Bill” as part of the Underground Facility Damage Prevention and Safety Act (NTDPC 2002). The intent was to provide minimum recommended guidelines for uniform state One Call legislation. To date, all 50 states follow various recommendations of the guidelines.

For example, in Arizona, State Statute ARS 40-360.28(C) states that “If the owner or operator fails to locate or incorrectly locates the underground facility, pursuant to this article, the owner or operator become liable for resulting damages, costs, and expenses to the injured party.” It is unreasonable to hold excavators responsible for striking a buried utility that they have no knowledge of, nor the expertise to locate. In reality, facility owners or operators working with their as-built drawings and locators are in the best position to locate sewer service laterals and to make a record of these laterals for the future, as in the case of Mesa, Arizona.

In 2005, an arbitrator in the state of Washington ruled in favor of an excavator who filed a claim against a municipality for failing to provide locate marks to denote the location of a sanitary sewer service lateral that was subsequently damaged during excavation (Scoccolo 2005). The arbitrator felt that, because the municipality requires permits to be issued and as-built drawings to be provided to the municipality upon completion of any additions or modifications to their sanitary sewer system, they were in the best position to manage the information and to provide it to excavators through the One Call system. The municipality argued that they only owned the sewer mainline and that the laterals were actually owned by the private property owner. This argument is a contentious one, because that would indicate that all property owners are responsible, by law, to subscribe to the One Call system. Consequently, all residents would be breaking the law and should be liable for the costs to repair any damage to their own laterals from third-party excavators. In reality, the intent of One Call regulations is not to include private property owners.

As stated in Section 1(10) of ORS 757 in the state of Oregon, *operator* means any person, public utility, municipal corporation, political subdivision of the state, or other person with control over underground facilities. According to Jack Dent, Oregon’s public utility commissioner, “The intention here was the operator of the sewer main (municipality or organized sewage district) would have the best knowledge of where the lateral would be (they controlled the installation) and they would have the expertise and equipment to perform the locate. If it is an ‘unlocatable’ facility, they could provide the best information available to assist in its location.”

Distribution contractors would be wise to be proactive and reach out to legislators, encouraging them to pass laws requiring operators of sewer systems to be deemed responsible for marking and locating sewer service laterals. Certainly, a less-than-proactive approach could be to sit back and allow the courts to decide. One such example is the case of *Wycon Construction Company* (a corporation, Plaintiff-Appellant), v. *Wheat Ridge Sanitation District* (a quasi-municipal corporation, Defendant-Appellee), April 8, 1998, heard in the state of Colorado, Court of Appeals. In this case, a contractor brought action for declaratory judgment that a municipal sanitation district had statutory duty to mark individual sewer

service laterals in a public thoroughfare before the contractor commenced any excavation work. The District Court of Jefferson County entered judgment in favor of the District, resulting in an appeal by the contractor. The Court of Appeals held that the District had a duty to mark *all* individual sewer service laterals before any excavation of public thoroughfare under the state's Excavation Requirements Article. The ruling further stated that the municipal sanitation district, rather than private property owners, had a duty under the Excavation Requirements Article to mark individual service lines, as well as main sewer lines and taps. Although both District and property owners fit the statutory definition of underground facilities owner, individuals lack specialized knowledge to mark a route through the thoroughfare to where their lines attach to the main line. In addition, the two-day notice from the excavator required under state statute One Call laws would be unrealistic for most property owners, but not for the District, to locate and mark lines.

The state of Georgia Utility Facility Protection Act was revised through Senate Bill 274 that called for an amendment to Chapter 9 of Title 25 so as to revise comprehensive provisions relating to utility facility protection; to add provisions regarding sewer laterals; to revise provisions relating to design locate requests; to revise provisions relating to the responsibilities of excavators and facility owners or operators; to provide for responsibilities of sewer system owners or operators with regard to sewer laterals; to provide for attempted location of utility facilities and sewer laterals by excavators in certain circumstances; to provide for installation of sewer laterals in a manner to make them locatable; to provide for use of a locator; to provide for the standard of care for trenchless excavation; and for other purposes. Section 25-9-2 requires that the location of sewer service laterals be made known to persons planning to engage in excavating operations. This could be done through the use of a permanent marker, which is defined as "a visible indication of the approximate location of a utility facility or sewer lateral that can reasonably be expected to remain in position for the life of the facility."

Currently, regulations in 40 states place the responsibility of locating the approximate horizontal location of an underground facility on the owner or operator of the facility. Ten states have interesting interpretations of underground facilities. These include New Jersey, New Mexico, Oklahoma, Rhode Island, Texas, Virginia, Missouri, California, Kansas, and Vermont. For example, in Kansas and Vermont, a sewer line is not designated as a *facility*. In California, nonpressurized lines are exempt from the state locate laws, as are privately owned sewer and water lines in Missouri. Table 1 presents the statute language of eight states that exempt sewer laterals from local locating laws, whereas Table 2 contains the statute language of three states with unclear language subject to interpretation.

It is anticipated that more states will adopt changes in their current legislation, making the responsibility for marking and locating sewer service laterals on private property to the entity that collects revenue from the facility. This would prevent facility owners and operators from placing the responsibility of marking sewer laterals on private citizens. Regardless, more clarity is definitely warranted in interpreting damage-prevention legislation.

Available Methods for Locating Sewer Service Laterals

Most sewer service laterals are composed of nonmetallic pipe material, thereby making them challenging to detect using conventional technology. There are several methods either used or considered for identifying buried utility systems that could be applied to sewer service laterals. These include (1) surface ground penetrating

Table 1. States That Exempt Sewer Laterals from Locating Laws in Underground Facility Statutes

State	Language
California	Excludes nonpressurized lines
Kansas	Sewers not included in list of items designated as facilities
Missouri	Sewer lines owned solely by the owner or owners of the real property to which such lines provide service shall not be considered underground facilities
New Jersey	Includes only forced-sewage lines; does not include gravity sewers
New Mexico	Sewers not included in the list of public utilities
Rhode Island	Sewers not included in the list of public utilities
Texas	Water, slurry, and sewage lines are excluded
Vermont	Only gas, electricity, and telecommunications are included

Table 2. States with Unclear Language in Underground Facility Statutes

State	Language
Connecticut	Only public utilities are required to mark the approximate location.
Kentucky	"Operator" means any entity or individual owning underground facilities to service the public . . . operator shall provide temporary markings . . .
Oklahoma	Operators of municipally owned sewage . . . need only notify the excavator . . . that they have facilities located in or near the proposed area of excavation. No exemption from notifying/locating is given for private lines in the right-of-way.

radar (GPR); (2) traceable wires/electronic markers; (3) acoustic signatures; (4) seismic; and (5) CCTV camera inspection. Ground penetrating radar has proven to provide an indication of the presence of an underground object; however, geological ground conditions often pose a limitation on the technology (Peters et al. 1994). Conditions such as clay soils often interfere with the signal and may result in inaccurate readings. The use of traceable wires or electronic markers provides a detectable way of locating nonmetallic sewer service laterals. New legislation passed in the state of Arizona mandates that all new and active underground facilities installed after December 31, 2005, include a *detectable* underground location device. This bill was unanimously passed 30-0 by the state legislature and was signed into law by the governor. Although this legislation addresses only new construction, a committee has been formed to address existing underground facilities and other related issues that have arisen.

CCTV camera inspection systems provide an excellent method of visually confirming the condition and location of sewer service laterals. Systems with a smaller scope camera can be deployed through a manhole in the mainline sewer and capture valuable lateral data. These are often used in conjunction with sondes to transmit the location and depth of the CCTV equipment. Approximate costs for deploying camera systems range from \$75 to \$175 per lateral, depending on the sewer main diameter, cleaning requirements, and laterals per setup (Ariaratnam and Kemper 2006).

Distribution Contractor Perspectives

A survey questionnaire (Appendix S1) was developed and distributed to 43 contractors involved in the natural gas distribution

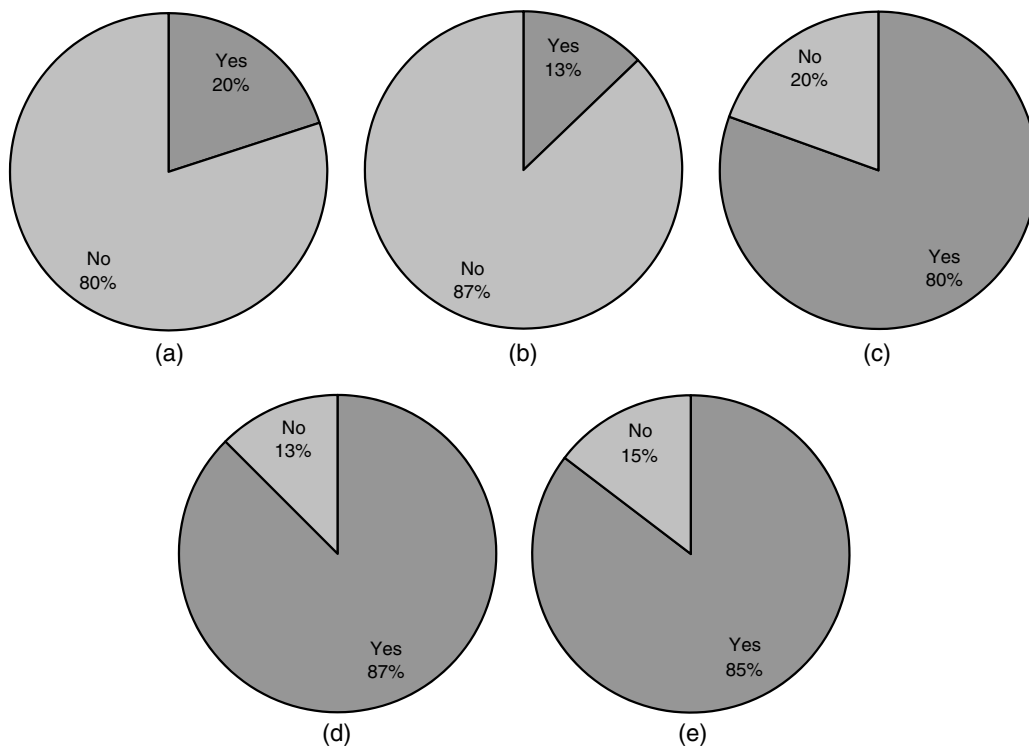


Fig. 3. (a) Owner marking requirements (water); (b) owner marking requirements (sewer); (c) owner marking requirements (electrical); (d) owner marking requirements (natural gas); (e) owner marking requirements (communications)

construction industry. A 100% survey response was achieved through followup. Using a Likert scale of 1 (lowest) to 10 (most important), the respondents rated the issue of unmarked sewer laterals as being a critical consideration in their daily business, with an average score of 9.29. All of the respondents agreed that there is a pressing need for better enforcement. This further supports the need for better allocation of responsibility for locating and marking sewer laterals.

The respondents were asked about their experiences with owners of underground infrastructure in areas where they did business with regard to marking their utilities. Fig. 3 provides a percentage breakdown of requirements for locating and marking based on (1) water to the building (20%); (2) sewer to the building (13%); (3) electrical to the building/meter (80%); (4) natural gas to building/meter (87%); and (5) communication to building (85%). Not surprisingly, owners of electrical, natural gas, and communication infrastructure were typically required to mark their facilities. However, it is alarming that owners of water and sewer infrastructure were generally not required to mark their facilities. Sewer service laterals are typically composed of nonmetallic material, subsequently creating an additional challenge for locating and marking. It is also more difficult to detect the presence of a cross-bore in a water or sewer service lateral compared with electrical and communication lines where the end user would immediately notice an interruption in service.

The surveyed contractors were asked about the annual number of One Call tickets that the company typically requests. As illustrated in Fig. 4, most (43.9%) indicated requesting 1,000 to 5,999 tickets per year, followed by 26.8% requesting less than 1,000 tickets per year. Of those contractors, 78% stated that they had to pay a fine or claim resulting from striking an existing underground utility that was not required to be marked either by state statute or regulation. Fig. 5 shows that 62% of the respondents had between 1 and

10 claims over the past 5 years as a result of striking an existing utility. Another 16% indicated having between 11 and 25 claims during the same timeframe. Over the same 5-year period, 71% of the respondents indicated facing repair costs of over \$25,000 for striking underground lines. As show in Fig. 6, 16.1% incurred total repair costs of over \$200,000. Eighty-eight percent of the respondents indicated having at least one single repair claim in excess of \$100,000. Overall, the highest reported claim cost was \$1,750,000 with an average of \$130,697 for the 43 surveyed contractors. The types of utilities cross-bored by the respondents were sewers (29%), water (18%), communication (16%), natural gas (14%), electrical (13%), and TV cables (10%), as illustrated in Fig. 7. Examples of such incidents are as follows:

1. In one case, property damage occurred as a result of striking an unmarked sewer lateral during an HDD operation; drilling mud migrated to the basement of the residence resulting in a claim from the property owner;

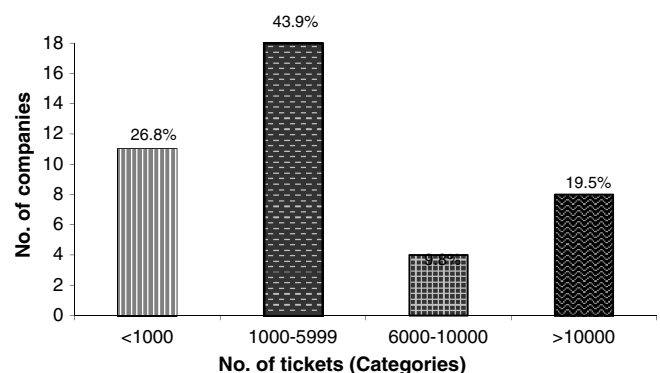


Fig. 4. Number of tickets requested annually

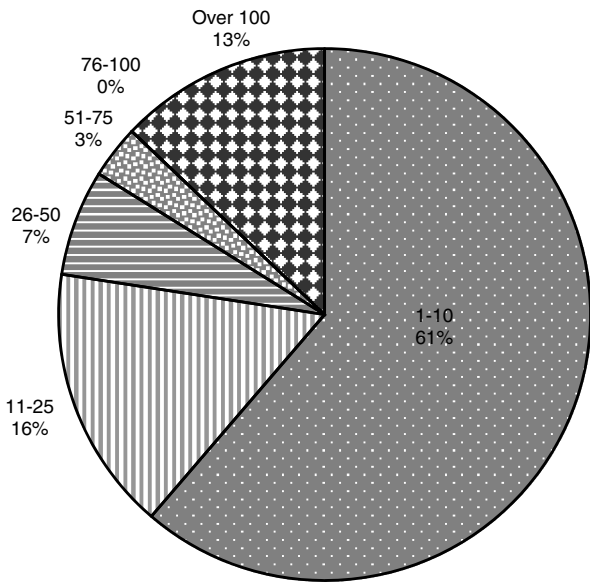


Fig. 5. Number of times a claim occurred

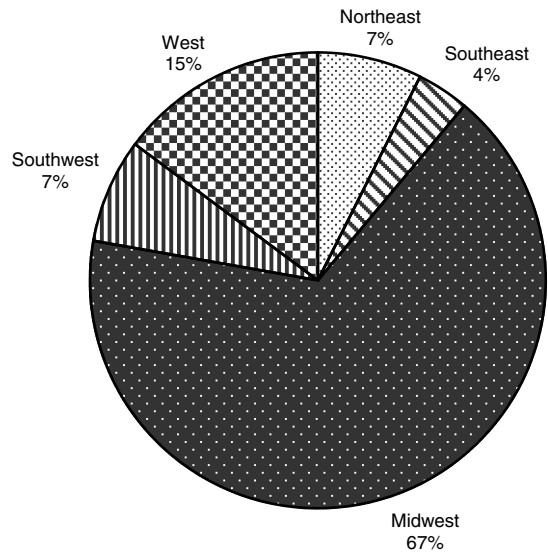


Fig. 8. Geographic location of recorded cross-bore incidents in the United States

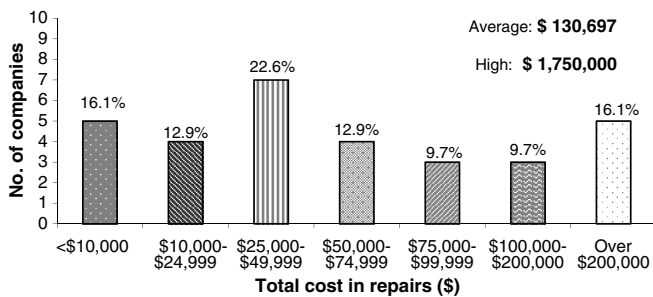


Fig. 6. Total cost incurred in repair to a struck line in a 5-year period

3. Several sewer laterals were cross-bored during an HDD installation of natural gas lines; and
4. A sewer lateral in a private trailer park was cross-bored during the installation of a natural gas line, resulting in a fire that damaged three trailer homes.

In terms of geographic region where the respondents had knowledge of cross-bores, an overwhelming majority (67%) occurred in the Midwest region of the United States (Fig. 8). In one inspection program in an undisclosed midwestern municipality, approximately 11,000 sewer laterals were inspected using CCTV cameras. During the inspection, 250 cross-bores were uncovered. Although comprising only 2% of the inspected system, this is a low frequency, but highly consequential situation. Unnoticed natural gas cross-bores are ticking time bombs that could result in catastrophic circumstances. Another Midwestern town revealed 24 cross-bores during an inspection of a single four-block area. Fifteen percent of the respondents had knowledge of cross-bores in the Northeast region. The geographical representation of the survey respondents was fairly evenly distributed among the East (30%), Midwest (33%),

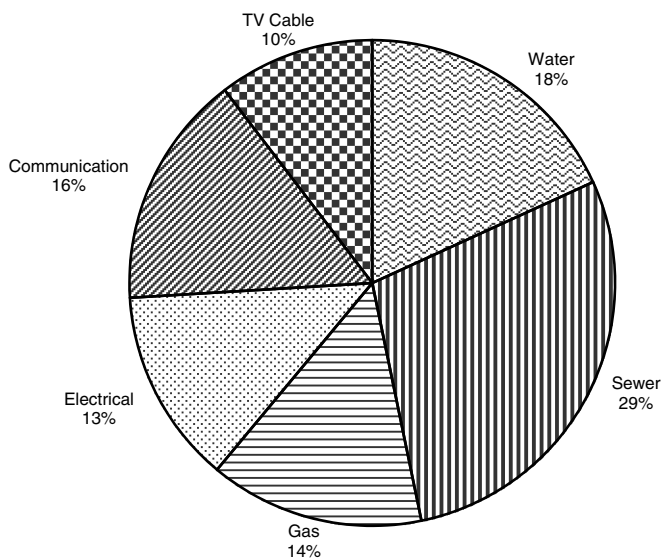


Fig. 7. Types of cross-bored utilities

2. A sewer lateral was cross-bored during the installation of a natural gas distribution line that was installed several years previously; a plumber attempted to dislodge the blocked line using a mechanical tool resulting in a fire;

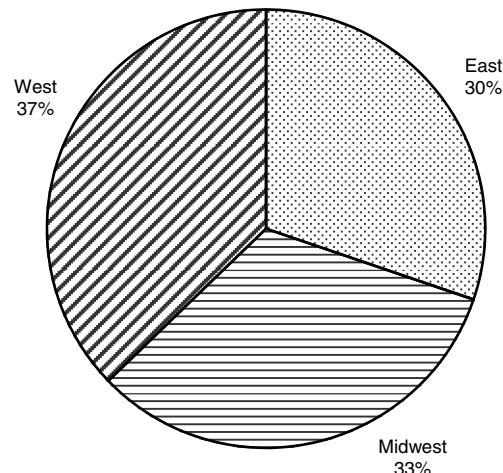


Fig. 9. Surveyed contractors' geographic work area (general)

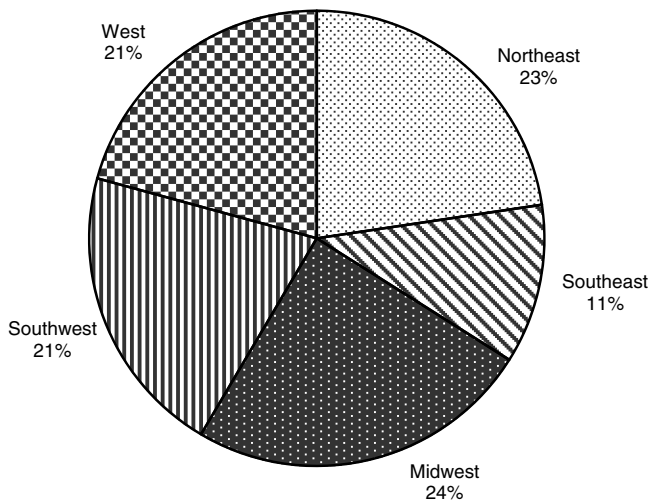


Fig. 10. Surveyed contractors' geographic work area (detailed)

and West (37%) regions, as illustrated in Fig. 9. A further detailed breakdown of these regions is shown in Fig. 10.

Conclusions and Recommendations

The issue of responsibility for locating and marking sewer service laterals is critical and must be addressed. Although the physical damage to underground facilities is always unwanted, a major concern facing distribution contractors are catastrophic losses resulting from utility lines that are exempt from locating laws. In a survey of 43 natural gas distribution contractors, they considered unmarked sewer laterals as being a critical consideration in their daily business with an average score of 9.29 out of 10 (most important). Even the most prudent contractors are being held liable for hitting these unmarked, unknown lines. Seventy-eight percent of the surveyed contractors indicated that they had to pay a fine or claim resulting from striking an existing underground utility that was not required to be marked either by state statute or regulation. Not surprisingly, the most prevalent utilities cross-bored by the contractors were sewer (29%) and water (18%) lines, given that these two utilities had the lowest requirements for locating and marking at 13 and 20%, respectively, in their areas of business. Additionally, public safety is paramount to this controversial issue, given the potential consequences of natural gas cross-bores with sewer service laterals. A closed circuit television (CCTV) camera inspection of 11,000 sewer service laterals in a midwestern municipality uncovered natural gas distribution cross-bores in 2% of the system. This is a low frequency, but highly consequential situation. Unnoticed natural gas cross-bores are ticking time bombs that could result in catastrophic circumstances. This paper contributes to the overall body of knowledge by providing empirical data obtained from 43 natural gas distribution contractors, who related to their experiences with cross-bores in existing utilities. The information presented further validates the need for immediate action related to unmarked underground sewer service laterals.

Over the past few years, several states including Arizona, Minnesota, Georgia, and Oregon have passed legislation requiring new sewer lateral installations to be locatable from the surface. Additionally, Oregon and Minnesota require the system owner/

operator to mark the location of all sewer service laterals in the public right-of-way. The intent is to place the responsibility on the party that is in the best position to perform the locate. Currently, there are eight states that do not require sewer service laterals to be located or marked.

The initiation of clearer laws and regulations, and the development of better methods for locating nonmetallic pipes, are necessary to reduce the incidents of cross-bores. These efforts are imperative in the interest of underground damage prevention and public safety. Currently, the field of subsurface utility engineering (SUE) is becoming more prevalent during the engineering design phase because some state One Call laws fail to address the marking of all underground utilities. ASCE Standard 38-02 provides excellent guidance for the collection and depiction of existing subsurface utility data (ASCE 2002).

Supplemental Data

Appendix S1 is available online in the ASCE Library (www.ascelibrary.org).

Acknowledgments

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References

- Ariaratnam, S. T., and Kemper, M. (2006). "Issues related to sewer laterals and horizontal cross-bores." *Proc., American Gas Association's 2006 Operations Conference* (CD-ROM), American Gas Association, Washington, DC, 1–7.
- ASCE. (2002). *Standard guideline for the collection and depiction of existing subsurface utility data (38-02)*, Reston, VA.
- Bennett, R. D., and Ariaratnam, S. T. (2008). *Horizontal directional drilling good practices guidelines*, HDD Consortium, Arlington, VA.
- Bruce, M. (2012). "Cross bores: Ticking time bombs?" *2012 Excavation Safety Guide*, Infrastructure Resources, Bloomington, MN, 38–39.
- Carpenter, R. (2003). "Annual contractors roundtable." *Underground Constr.*, 58(2), 27–29.
- Common Ground Alliance (CGA). (2012). *Best practices 9.0 manual*, Arlington, VA.
- DOT. (1999). *Common ground: Study of One-Call systems and damage prevention best practices*, Research and Special Projects Administration, Office of Pipeline Safety, Washington, DC, 252.
- National Telecommunications Damage Prevention Council (NTDPC). (2002). *Model state One-Call bill*, Washington, DC, 12.
- National Transportation Safety Board. (1997). "Protecting public safety through excavation damage prevention." *Safety Study NTSB/SS-97/01*, Washington, DC, 106.
- National Utility Locating Contractors Association (NULCA). (1997). *Excavation practices & procedures for damage prevention: A guide for protection of underground facilities*, Spooner, WI.
- Peters, L., Daniels, J. J., and Young, J. D. (1994). "Ground penetrating radar as a subsurface environmental sensing tool." *Proc., IEEE*, 82(12), 1802–1822.
- Scoccolo, M. (2005). "New legal challenge to the One-Call law—Arbitrator's decision noteworthy." (www.nucaofwashington.com/onecall) (Nov. 15, 2012).