Underground Facility Pinpointing [Project #3133]

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PRINCIPAL INVESTIGATOR:
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OBJECTIVES:
There are two aspects to locating buried utilities. First, the buried pipe needs to found, and second, the location needs to be documented, so it can be found again. The report objectives were to identify, demonstrate, and/or evaluate technologies for locating buried pipe (conductive and non-conductive) and to develop guidance for using Global Positioning System (GPS) data to document a location.

BACKGROUND:
The Gas Technology Institute (GTI) performed this work in three phases. The Operations Technology Development group, a group of natural gas utilities, supported all 3 phases. The Water Research Foundation funded Phase 2 and 3. GTI provided the Phase 1 report to the Foundation.

Third-party damage, often due to incorrect or non-existent location markings, can affect distribution system integrity. Performance of locating technologies is affected by soil conductivity and pipe characteristics (material, diameter, and burial depth). Electromagnetic (EM) locators are well suited to finding metallic pipe and tracer wire associated with non-conductive pipe. However, they do not perform well in conductive soil conditions, in locating non-conductive pipe, or with broken or non-existent tracer wire. Alternative technologies developed for other fields may be able to overcome some of these obstacles. As an example, ground penetrating radar (GPR) can locate metallic pipe, and to a lesser extent plastic or concrete pipe, because their dielectric constants are closer to that of most soils. Conductivity of the soil also affects the GPR performance with highly conductive soils attenuating the signal.

APPROACH:
The work was carried out in 3 phases, each with its own final report, which have been compiled into this document. Phase 1 focused on EM technologies. Phase 2 focused on alternative technologies with a special emphasis on GPR. Phase 3 focused on location data using GPS. In phase 1 and 2, technologies were evaluated based on their ability to locate pipes in test beds at GTI and Staking University. The test beds included different soils, pipe materials, pipe diameters, and burial depths. Some technologies were demonstrated at off-site locations, such as natural gas utilities.

Phase 1 had 3 tasks. First, the research team tested and compared the abilities of 14 EM locators on the basis of horizontal accuracy, vertical accuracy, ease of use, and ergonomics. Second, manufacturers’ demonstrated the capabilities of 4 GPR locators for
locating pipes in the test beds. Third, the research team identified and assessed 12 other alternative locators for locating buried pipes and future research.

Phase 2 examined technologies that may be used in situations where standard EM locators cannot perform the required functions. The research team considered and assessed the capabilities and limitations of 4 GPR systems and 10 alternative locating technologies (radar, acoustics, electromagnetic, and other emerging techniques). The manufacturers operated their own instruments during the tests. The accuracy of GPR technology was determined.

Phase 3 synthesized existing GPS data collection techniques from government documents, manufacturer’s literature, and utility company practices to create a GPS Data Collection Best Practices and Standards. A group of utility GPS experts reviewed and modified the document. This document only addresses the use of Mapping Grade GPS.

RESULTS/CONCLUSIONS:
Phase 1: The researchers found that electromagnetic locators are cost effective, efficient, easy to use, and a fast way to find buried conductive pipe. Of the 14 models tested, the majority (12) had a horizontal accuracy >80%. Vertical reading capability was available on 10 models and 7 models had a vertical accuracy >80%. GPR and some of the other alternative technologies showed promise, but should be studied further.

Phase 2: GPR performance depends upon soil conductivity, with highly conductive soils attenuating the radar signal. Users need to be highly trained and experienced to successfully operate the GPR and to interpret the results. The four GPRs tested had a horizontal accuracy between 50% and 83%. GPR can be used to effectively locate plastic and concrete pipes. At depths over 4 ft, non-conductive, small diameter pipes may be difficult to locate, but non-conductive, large diameter pipes can effectively be located. No breakthrough technologies have been commercialized that provide all the required functionality. Research is trying to advance the capabilities of alternative technologies (especially in the roads industry) and should be monitored.

Phase 3: In this phase, guidelines were produced for companies to develop Best Practices and Standards for collecting and processing GPS data to maximize the value of the collected data and to ensure it is used appropriately.

APPLICATIONS/RECOMMENDATIONS:
The results of this research will allow utilities to make better technological and cost effective decisions in selecting and using locating equipment and documenting the asset’s position. EM techniques perform reasonably well in locating conductive pipe. GPR should be used to selectively locate non conductive pipes, as it may be more expensive than EM techniques and require trained personnel. GPS may help utilities correctly document and re-locate buried utilities.

RESEARCH PARTNER:
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