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## Technical Brief



# Innovative and Effective Techniques for Locating Underground Conduits

NJDOT's fiber optic network and related underground conduit system were studied to identify innovative and more effective techniques for locating different types of conduits. An overall system inventory was developed. Suitable technologies such as Trace Wire (TW), Acoustical Transmission (AT), Ground Penetrating Radar (GPR), Ground Penetrating Sonar (GPSon) and Electromagnetic Impedance (EMI) were researched and tested for ease of use, accuracy and cost effectiveness. A systematic plan for the implementation of the preferred conduit location method was developed.



## Background

The New Jersey Department of Transportation (NJDOT) operates and maintains a network of approximately 600 miles of largely non-metallic conduits designed to carry fiber optic cables that are vital to the New Jersey communication system. These conduits have to be located and marked prior to construction activities to avoid potential damage. Currently, NJDOT locates conduits using TW and radio frequency (RF) detection methods. However, a portion of the network has missing or damaged TW, complicating the location problem. Additionally, the current TW method requires the location of junction boxes and removal of their heavy covers. Alternative detection techniques were investigated and several promising solutions conceived.

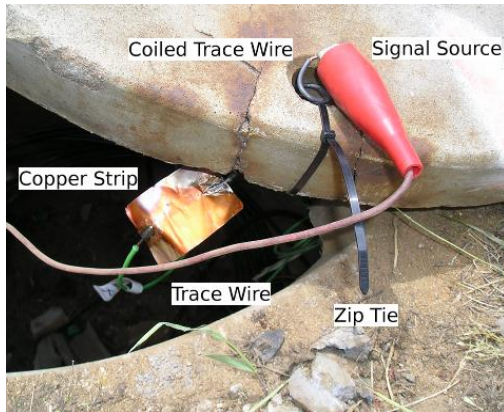
One solution based on Radio Frequency Identification (RFID) techniques was demonstrated, and has a patent application in the process of submission.

## Research Objectives and Approach

Given the limitations of the currently used TW and RF detection tools arising from missing trace wires and the necessity of junction box location and cover removal, NJDOT's fiber optic conduit system was investigated to improve the process of conduit location. An overall inventory database was constructed for sections of fiber optic conduits, and it includes length, type, and

surrounding soils for sections with and without trace wires. Conduit location methods, including, but not limited to AT, GPR, GPSON and EMI were tested in the field. Each method was tested for various conduit materials, cover, and soil conditions, to identify its accuracy, ease of implementation, cost effectiveness, and reliability. An algorithmic approach was developed to help the user identify feasible location methods, based on conduit characteristics, providing relevant tools to implement a real time solution to the conduit identification problem. Best practices for future conduit construction were also investigated.

## Findings



The fiber optic conduit inventory revealed that non-metallic pipes, both rigid and flexible, constitute 63% of the total of 581 miles of conduit; while metallic pipes are 7%, and pipes of unknown material type are 30%. Conduit sizes vary between 1" and 4" in diameter. While GPR can help identify all pipe types, its ability to identify a conduit is limited to 1" of diameter per foot of depth of cover, and is complicated when the area is cluttered with multiple utilities. It was found that the AT method, developed as part of this research, works well particularly under unpaved surfaces. Another

alternative to missing TW is to use a metallic *snake* that can function as a TW up to distances of about 400', if there are no sharp bends along the conduit. The removal of manhole covers to connect a TW signal generator can often be a problem when TW is present. It was shown that this difficulty can be easily alleviated by installing a permanent conductive strip. It was also shown that RFID tags could be used to mark the location of conduits in the absence of TW, along with GIS data creation. A complete inventory of all segments and junction boxes is recommended to facilitate the identification and implementation of the preferred methods.

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A final report is available online at <http://www.state.nj.us/transportation/refdata/research/> .  
If you would like a copy of the full report, send an e-mail to: [Research.Bureau@dot.state.nj.us](mailto:Research.Bureau@dot.state.nj.us)  
and ask for:

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