Roadmap to infrastructure: Subsurface utility engineering

A new discipline, Subsurface Utility Engineering or SUE, is gaining momentum in Ontario. Here's a look at what it means to civil engineers and others working with utility infrastructure.

By Lawrence Arcand, P.Eng.

Professional engineers working with public and private infrastructure systems and projects may encounter unexpected costs and delays due to inaccurate or incomplete utility drawings. The responsibility for providing accurate utility information is passed around from utility to owner to consultant to contractor. It is a problem that is not unique to Ontario; it is common throughout North America and the world.

We do not have accurate and reliable utility records showing the exact location of our underground utility infrastructure, and yet this information is crucial for increasing efficiency, reducing costs, and improving safety on construction projects. Examples of this problem are evident across the province every day, and it is time to come up with a solution.

In the United States, a system has emerged over the last couple of decades to address this problem. Subsurface Utility Engineering (SUE) combines traditional civil engineering practices with new technologies to develop reliable and accurate maps of underground utility infrastructure. In effect, the SUE process is like setting up a common language that engineers, owners, contractors and utilities can all understand and utilize. SUE is recognized by the American Society of Civil Engineers (ASCE), and is detailed in *CI/ASCE 38-02: Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data*, published in January 2003. The intent of this guideline is to present a unified system for collecting and classifying utility data so all parties can clearly understand what is being shown on drawings, and how that information was collected.

The ASCE guideline outlines four quality levels used to categorize utility information, ranging from quality level D to quality level A. Identifying utility information using these quality level parameters allows users to understand how the information was collected and to recognize when additional information or clarification is required. Using these quality distinctions takes little additional time and yet provides a great deal of additional benefit.

Quality Level Descriptions from ASCE Guideline 38-02

Quality Level D–Information derived from existing records or oral recollections.

Quality Level C–Information obtained by surveying and plotting visible above-ground utility features and by using professional judgment in correlating this information to quality level D information.

Quality Level B–Information obtained through the application of appropriate surface geophysical methods to determine the existence and approximate horizontal position of subsurface utilities. Quality level B data should be reproducible by surface geophysics at any point of their depiction. This information is surveyed to applicable tolerances defined by the project and reduced onto plan documents.

Quality Level A–Precise horizontal and vertical location of utilities obtained by the actual exposure (or verification of previously exposed surveyed utilities) and subsequent measurement of surface utilities, usually at a specific point. Minimally intrusive excavation equipment is typically used to minimize the potential for utility damage. A precise horizontal and vertical locations, as well as other utility attributes, are shown on plan documents. Accuracy is typically set to 15-mm vertical and to applicable horizontal survey and mapping accuracy as defined or expected by the project owner.

Managing risk

The main goal of any utility investigation is to mitigate the risk associated with encountering unknown utilities at the time of construction. This includes risk to personal safety, to the project schedule, to the project budget and more. The key to mitigating that risk is to gather a sufficient level of information such that the engineer designing the project can feel confident that there is a low probability of encountering problems in the field.

A SUE firm manages the risk associated with utilities by effectively managing the quality level of the data gathered during an investigation. It doesn't make sense to risk the success of a critical component of the project solely on the accuracy of a sketchy record drawing, nor does it make sense to install numerous test holes to determine the exact location of a utility that will have little to no bearing on the project. Almost every investigation should include records research and a survey of surface features as a start. This gives a good sense of the congestion of underground utilities that can be used to make a decision on where additional effort is warranted. Additional steps can be taken, where required, to increase the data to quality level B or quality level A.

At the end of the investigation, the utility drawing may show utilities at all four

Technicians install test holes on an existing water main in Niagara-on-the-Lake, Ontario.

different quality levels from D to A, quality level D or C in the non-critical areas, and quality level B and A where precise information is required.

Another major consideration is that the SUE firm responsible for the utility investigation stamps and accepts liability for the quality of the information collected. For this reason, firms offering SUE services would possess a Certificate of Authorization, as well as carry liability insurance. These requirements give the project owner confidence in the information collected and displayed.

Step by step

The following is an example of how SUE principles are used on a typical construction project. Early on during the planning stages, the engineer responsible for the SUE investigation advises the owner of potential impacts the project could have on existing subsurface utilities and recommends a scope for the utility investigation. The earlier the process is started, the greater the benefits that will be experienced.

Typically, the first step in the investigation is then to gather utility records from all available sources. This can include as-built drawings, field notes, distribution maps, and even oral accounts. All the records data should then be compiled into a composite drawing and labeled as "quality level D."

A site visit should be made to survey all visible surface features of the existing subsurface utilities, including maintenance holes, pedestals, valves, etc. The survey may be conducted at the same time as the topographic survey completed for the project. All the information from the surface survey is then compiled onto the drawing and correlated to the records data to identify areas of discrepancy, increasing the data to "quality level C."

At this point, a decision can be made as to which utilities might have an impact on the proposed design and thus warrant the need for further investigation. Using a variety of geophysical techniques, the horizontal position of these critical utilities is designated. This information is surveyed and compiled into the utility drawing as "quality level B" data.

The final step in the data collection process is to install test holes at key locations where the exact size, material type, depth and orientation of the utility being investigated are crucial. The test hole information is surveyed and included in the utility drawings as "quality level A" data.

All the information from the investigation is compiled in a utility layer that can be included with the design drawing or, based on the complexity, can be included as a separate utility drawing in the overall design package. The information is then available for the project designer, as well as the contractor bidding on and building the project. Having this reliable information not only increases the efficiency of the design process, but has also been shown to reduce contractor's bids and virtually eliminate extras associated with utility conflicts in the field.

Asset management

The same SUE principles of using quality levels can be utilized when gathering subsurface utility information for asset management purposes. Managers of underground infrastructure know all too well that when workers find something in the field that contradicts what is shown on their records, they immediately assume all the information is wrong. Assigning a quality level to your data gives the user of the data a confidence level with regard to the spatial accuracy of that data. If data are

SUE–One Stop Shopping

- A SUE firm should be able to handle all aspects of gathering utility information, and coordinating with utility companies to simplify the utility issues on any project. They essentially act as a one-stop-shop for the project owners.
- Subsurface Utility Mapping (SUM)–Utilizing a variety of data sources, SUM generates maps of underground utility networks. Maps can be created in a variety of formats, from sketches, to CADD to GIS data layers.
- Utility Records Research–The SUE firm's strong contacts should expedite the records research phase.
- Utility Designating–All Technicians should be trained and equipped to use the latest geophysical designating tools available, including pipe and cable locators, EM-survey equipment, resistivity survey equipment, ground penetrating radar, sondes, and other techniques.
- Utility Locating–The SUE firm should have access to vacuum excavation equipment to safely and effectively excavate test holes.
- Utility Surveying–A combination of total station and GPS surveys are used to collect the field data.
- Data Management–Utility information can be processed in AutoCAD and Microstation as well as a variety of GIS formats, to efficiently transform the field data to a format that can be used by designs or asset managers.
- Utility Coordination–The SUE firm can act as one central contact for all relocation efforts, managing utility relocations, negotiations, design adjustments, and providing relocation design.

labeled as quality level A, they can be confident subsurface utilities are where the records say they are. Operators of asset management systems would start with quality level D and C and upgrade the information to quality level B and A in critical areas, or on critical infrastructure.

Does it work? The Federal Highway Administration (FHWA) asked the same question after investing millions in grants for SUE projects throughout the U.S. The FHWA commissioned Purdue University to do a study of 71 projects that utilized SUE services, and determine the cost savings obtained as a result. The study found that for every $1 spent on SUE services, there were savings of $4.62 in project costs. Although there are currently not enough completed projects to do a comparative study in Ontario, the results thus far have shown results similar to those experienced in the U.S.

SUE in Ontario

SUE has been utilized on a variety of projects in Ontario over the last three years. The success of those initial projects has won SUE recognition and support by a number of key groups in the province, including the Ontario Sewer and Watermain Construction Association (OSWCA), Ontario Road Builders' Association (ORBA), and the Ontario Regional Common Ground Alliance (ORCGA). The ORCGA lists SUE as a reference for utility surveying that meets its best practices outlined for planning and design practices. Lower contractor bids, reduced delays, reduced redesigns, reduced utility relocations and improved project safety are only a few of the many benefits users are experiencing. Project owners are seeing the benefits of SUE services and its use is steadily increasing in Ontario. Engineers should be encouraged to learn more about SUE and begin to make use of the guidelines set out in the ASCE guideline, such that we can continue to advance to more efficient engineering practices.

Lawrence Arcand, P.Eng., is SUE project manager for TSH/TBE Subsurface Utility Engineers JV. For more information on SUE you can visit the TSH/TBE website at www.tshtbe.ca, or contact Lawrence Arcand at 905-668-8822 ext. 2508 or larcand@tshtbe.ca