Subsurface Utility Engineering Survey
2018/2019

Industry practices, challenges and opportunities
Acknowledgements

The Centre for Advancement of Trenchless Technologies (CATT) would like to acknowledge the contribution and financial support provided by the following organizations:

![ logos of organizations provided financial support]

CATT is also very thankful to the participants who have dedicated their time to complete the survey and to provide valuable data and insights on SUE practices.

**DISCLAIMER**

Findings presented in this report are the authors’ analysis of the data provided by survey participants. The survey results are presented “as is”, without liability for their use, and to provide general industry trends.
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Introduction

Since the late 1800’s, buried water and sewer infrastructure have been and continues to be installed under municipal right-of-ways (ROWs). Over the years, we have also buried extensive networks of telecommunication, power cables and other infrastructure within this ROW. This has created an extensive crowded underground space containing critical infrastructure for the operation of cities and businesses. Underground infrastructure and utility hits have resulted in damages, service outages, public and workers’ safety issues, and costly litigations. Furthermore, the discovery of undocumented buried infrastructure during construction results in extra costs and delays.

In 2000, Purdue University completed the “Cost Savings on Highway Projects Utilizing Subsurface Utility Engineering” study for the Federal Highway Administration. This study found that every $1.00 spent on Subsurface Utility Engineering (SUE) produced $4.62 in project cost savings.

In 2003, the American Society of Civil Engineers (ASCE) published the “ASCE-38-02 Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data”. The goal of this standard is to reduce unforeseen construction costs by minimizing utility conflicts in the engineering planning phase.

Subsurface Utility Engineering (SUE) is “a specialty practice of civil engineering that investigates and depicts existing underground utilities through the collection and analysis of records, visual, geophysical, and/or exposure methods and assigns achieved Utility Quality Levels to Utility Segments based upon the integration of all the analyzed data with professional judgment at a defined point in time.”

Utility Engineering and Surveying Institute (UESI)
The use of SUE and the ASCE 38-02 standard has spread as municipalities, consultants and other users recognize the benefits that are realized by standardizing a repeatable and reliable process under the guidance of a Professional Engineer.

Accordingly, the overall goal of this study was to obtain qualitative data to better understand the current state of Subsurface Utility Engineering practices, barriers, and acceptance across Canada.

This was accomplished by the development of a web-based survey that was completed by utility owners, consultants and service providers. This report presents the analyses of the survey data.
Survey Design

The Centre for Advancement of Trenchless Technologies (CATT) conducted a national survey to better understand how SUE practices are being implemented in the industry, and to identify challenges and opportunities in the sector.

Survey requirements included:

▪ be completed in 15 to 20 minutes
▪ contain no industry jargon so stakeholders with no knowledge of SUE practices could complete it
▪ form a baseline for biennial subsequent SUE surveys to establish changes in industry practices

To achieve these, a voluntary online survey was distributed through CATT’s website, LinkedIn and by email. Ontario Sewer and Watermain Construction Association (OSWCA), Ontario Water Works Association (OWWA), Ontario Good Roads Association (OGRA), NASTT-BC, and Consulting Engineers of Ontario also helped with survey promotion.

The target audience included infrastructure owners, consultants, contractors and technology providers – the main stakeholders in the SUE industry.

The questionnaire, composed of 37 questions, was divided into three main parts:

▪ Part I - SUE process, practices and tools
▪ Part II - SUE approach: program vs. project
▪ Part III - SUE awareness and competency

In eight of the questions, participants had to consider three project phases: planning, design and construction. The planning phase consists of defining a project solution, or a short-list of solutions. In the design phase, the chosen solution is developed in detail, including sizing and drawings, so it can be adequately implemented in the construction phase.

The complete survey questionnaire is available from CATT upon request. Responses were collected from August to December 2018, and results are covered in the next sections of this report.
Participants Background

RESPONDENTS BY PROVINCE

In total, 85 participants with diverse backgrounds provided valuable insights to this study. The majority of respondents, 84%, are from Ontario, while 7% are from Alberta, 6% from British Columbia, 2% from Quebec and 1% from Nova Scotia.

RESPONDENTS BY ORGANIZATION CATEGORY

Respondents were asked to classify their organizations into infrastructure owners, consultants, technology providers and contractors. Since 89% of respondents are owners or consultants, the remaining categories are grouped as “others”.

70% OF THE RESPONDENTS IN THE INFRASTRUCTURE OWNERS CATEGORY EITHER ARE LARGE MUNICIPALITIES OR PROVIDE SERVICES TO A LARGE MUNICIPALITY

86% OF INFRASTRUCTURE OWNERS ARE MUNICIPALITIES

N = 36

N = 85
EXPERIENCE WITH SUE PROJECTS

Survey questions were designed to facilitate respondents’ understanding, even when they were not familiar with SUE. Nevertheless, when asked how much experience respondents have with projects involving SUE, 57% of infrastructure owners and 65% of consultants reported having five or more years of experience. It is important to highlight that 29% of infrastructure owners, 25% of consultants and 50% of the remaining categories – classified as “others” – have one year or less of experience with projects involving SUE.

<table>
<thead>
<tr>
<th>Alternatives:</th>
<th>Owners</th>
<th>Consultants</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>No experience</td>
<td>26%</td>
<td>19%</td>
<td>25%</td>
</tr>
<tr>
<td>&lt; 1 year</td>
<td>3%</td>
<td>6%</td>
<td>25%</td>
</tr>
<tr>
<td>1-3 years</td>
<td>0%</td>
<td>0%</td>
<td>13%</td>
</tr>
<tr>
<td>3 - 5 years</td>
<td>14%</td>
<td>10%</td>
<td>13%</td>
</tr>
<tr>
<td>5+ years</td>
<td>57%</td>
<td>65%</td>
<td>25%</td>
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</table>

N = 35
N = 31
N = 8
Survey Findings

SUE Process, Practice & Tools

Part I of the survey examines how utility data is obtained and recorded according to SUE Quality Levels (QL). There are four Quality Levels – D, C, B and A – that classify the quality of data associated with existing subsurface utilities.

The Utility Quality Levels are defined in ASCE 38-02. They allow for a standardized professional opinion of the quality and reliability of utility information.

To provide context for results, a summary from ASCE 38-02 Qualitative Levels description is presented.

QUALITY LEVEL D

- Information comes from existing records or oral recollections

QUALITY LEVEL C

- Information is obtained by surveying and plotting visible above-ground utility features
- Professional judgment is used to correlate information to QL D information

QUALITY LEVEL B

- Information is obtained through surface geophysical methods to determine the existence and approximate horizontal position of subsurface utilities
- Data should be reproducible by surface geophysics at any point of their depiction
- Information is surveyed to applicable tolerances defined by the project and reduced onto plan documents

1 ASCE 38-02 Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data
QUALITY LEVEL A

- Precise horizontal and vertical location of utilities obtained by exposure (or verification of previously exposed and surveyed utilities) and measurement
- Minimally intrusive excavation equipment is typically used
- A precise horizontal and vertical location, as well as other utility attributes, is 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

The results for the following four questions relate to utility data quality levels, with the corresponding graphs presented on page 11. The percentages for the “if the budget allows” alternative available in the survey questionnaire are not presented, as responses varied from 0% to 2%.

DO YOU VERIFY (CORRELATE) FIELD SURVEY OF VISIBLE FEATURES WITH THE EXISTING UTILITY RECORDS FOR ACCURACY AND COMPLETENESS? (QL C)

Unfortunately, only 36% of the respondents reported using QL C data during the planning phase, where it would have been most beneficial to mitigate project risks. Fifty nine percent of participants reported verifying the field survey information against existing utility records in the design phase, while 75% of respondents reported doing so in the construction phase.
DO YOU USE GEOPHYSICS METHODS TO OBTAIN AND MARK THE EXISTENCE OF SUBSURFACE UTILITIES? (QL B)

Only 30% of respondents reported using geophysics methods for more than 75% of projects during the design phase. Using such methods during the construction phase, as indicated by 39% of participants, could be too late to maximize benefits (e.g. avoid utility conflicts). In contrast, geophysics methods are used in less than 25% of the projects during the planning phase (52% of the respondents), design phase (33% of the respondents) and construction phase (33% of the respondents).

DO YOU CARRY OUT TEST HOLES TO EXPOSE THE UTILITIES TO OBTAIN PRECISE HORIZONTAL AND VERTICAL LOCATION? (QL A)

Only 24% of respondents reported using QL A information in the design phase for 75% or more of projects. This means risks are carried over to the construction phase, where mitigating actions have a greater impact on project time, quality and cost, and damages are more severe. Forty-four percent of participants indicated exposing utilities to obtain precise horizontal and vertical location for 75% or more of projects during the construction phase.
Percentage of projects where SUE is used:

- Not sure
- <25%
- 25%-50%
- 50%-75%
- >75%

**Quality Level D**

- Planning: 9% <25% 13% 25% 48%
- Design: 7% 2% 10% 15% 66%
- Construction: 3% 6% 6% 6% 79%

**Quality Level C**

- Planning: 7% 20% 23% 14% 36%
- Design: 7% 6% 5% 23% 59%
- Construction: 1% 6% 5% 13% 75%

**Quality Level B**

- Planning: 12% 52% 13% 8% 15%
- Design: 11% 33% 15% 11% 30%
- Construction: 9% 33% 13% 6% 39%

**Quality Level A**

- Planning: 11% 58% 18% 5% 8%
- Design: 10% 26% 28% 12% 24%
- Construction: 3% 12% 23% 18% 44%

N = 83 to 85
Extra Information on Part I

Unless indicated otherwise, N=85 for questions presented in this section.

WHAT SOURCES DO YOU USE TO COLLECT SUBSURFACE UTILITY DATA?

This is a mark all that apply question related to QL D, and respondents reported using:

- As-built drawings (68%)
- Previous construction plans/drawings (59%)
- Electronic document research (56%)
- Manual document research (41%)
- Interviewing personnel (31%)

TO WHAT PERCENT DO THE SURFACE-VISIBLE FEATURE SURVEY RESULTS HAVE DISCREPANCIES WITH THE RECORDS?

This question is related to QL C information. At least 68% of the respondents reported that in 25% or more of projects, discrepancies between visible above-ground utility features and existing utility records have been found. This indicates the need for higher quality level data.

WHICH GEOPHYSICAL METHODS DO YOU USE IN SURVEYING?

This was a mark all that apply question related to QL B, and respondents reported using:

- Electromagnetic methods (79%)
- Elastic wave (16%)
- Magnetic methods (15%)

HOW DO YOU DEPICT THE DESIGNATED UTILITIES?

This is a mark all that apply question type, with results as follows:

- CAD (78%)
- GIS (49%)
- Manual plotting (26%)

FOR THOSE WHO CARRY OUT TEST HOLES TO EXPOSE THE UTILITIES TO OBTAIN PRECISE HORIZONTAL AND VERTICAL LOCATION INFORMATION, DO YOU INSTALL ELECTRONIC MARKERS TO ASSIST IN FUTURE LOCATES? (N=81)

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<th>Yes</th>
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<td>12%</td>
<td>88%</td>
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</table>
SUE Approach - Program vs. Project

Part II of this survey aimed to understand whether SUE practices are structured in a program or are only employed in a project by project basis. A SUE program entails defining a scope for mapping utilities at appropriate quality levels, validating records and managing data. The number of respondents for questions in this section is 76.

DO YOU PERIODICALLY REVIEW, VERIFY AND UPDATE UTILITY RECORDS?

This question checked if respondents had a SUE Program, in case they selected the “yes” alternative. Only 4% of the respondents that chose the “no” option are planning to implement a SUE Program. The “not sure” alternative was chosen by 19% of the respondents. Implementing a SUE Program can help organizations, particularly infrastructure owners, to standardize processes and consistently apply SUE practices to underground construction projects.

DO YOU PREPARE/UPDATE UTILITY DRAWINGS OR EQUIVALENT WHEN UNDERTAKING CONSTRUCTION PROJECTS?

Twenty-one percent of respondents never, rarely or sometimes (less than 50% of cases) prepare or update utility drawings when carrying out construction projects. In addition, 62% of respondents indicated they “almost always” (more than 75% of projects) prepare or update utility drawings in the construction phase, which is low. Updated and accurate utility records will help to reduce damage in current and future projects.

DOES YOUR ORGANIZATION HAVE THE REQUIREMENT OF COMBINING AS-BUILT DRAWINGS INTO MASTER UTILITY DRAWINGS AND/OR CENTRAL GIS DATABASE?

This positive result can be improved by further industry training in the benefits of SUE practices.
OVER THE LAST FIVE YEARS, WHAT PERCENTAGE OF PROJECTS INCLUDED A SUE COMPONENT?

Only 14% of participants reported including SUE during the planning phase for 75% or more of projects, while 29% and 33% indicated the existence of a SUE component during the design and construction phases respectively, which is higher but still below expectations. In contrast, SUE was rarely (less than 25% of cases) or never included in the planning (32% of participants), design (11% of participants) and construction (18% of participants) phases.

DO YOU USE A UTILITY CONFLICT MATRIX TO CONSOLIDATE AND COMPARE INFORMATION?

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<th>Owners</th>
<th>Consultants</th>
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<tr>
<td>Yes</td>
<td>17%</td>
<td>28%</td>
</tr>
<tr>
<td>No</td>
<td>53%</td>
<td>59%</td>
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Utility matrix is a tool that helps the identification of conflicts with other utilities, as well as with regulations and standards, and that facilitates conflict resolution by using several possible solutions, e.g., infrastructure relocation, protection, design change or abandon in-place. Results show that 30% of infrastructure owners are not aware of this tool, while 53% still do not make use of it. Targeted training for both owners and consultants should be explored to improve the use of utility matrix as a tool to address utility conflicts.

FOR WHAT PERCENTAGE OF PROJECTS DO YOU REQUEST AS-BUILT OR AS-RECORDED DRAWINGS?

This means that for the remainder 30% of respondents, as-built drawings are requested in less than 75% of projects or are never requested. As a consequence, utility data information is lost in the phase where it would be easier to retain and update records for new utilities – i.e., the construction phase.
SUE Awareness & Competency

Part III of the survey is designed to glean information on some of the key points regarding respondents’ knowledge and experience in the SUE discipline. The yellow boxes present the totals for the combined three respondent’s categories – infrastructure owners, consultants and others.

Comments on specific category’s results are presented in the text, as needed. The number of respondents for all questions in this section is 76.

DO YOU KNOW ABOUT SUE?

87%  
YES

13%  
NO

Most respondents had some degree of knowledge in the SUE discipline. It should be noted that the type of knowledge was not specified and could comprise basic to advanced information.

ARE YOU AWARE THAT SUE INVESTIGATION MUST BE STAMPED BY A P. ENG. OR P. GEO.?

59%  
YES

41%  
NO

Fifty-nine percent of the total respondents are aware that SUE investigation reports and drawings need to be stamped by a P.Eng. or P.Geo. However, awareness about this requirement is higher for the consultants’ category (66% of the respondents), as expected.

ARE YOU AWARE OF THE FOUR QUALITY LEVELS WITHIN SUE?

61%  
YES

39%  
NO

Overall, 61% of participants are aware of SUE Quality Levels. Infrastructure owners are the category that is least aware, as only 53% of respondents selected the “yes” alternative. This could greatly impact Request for Proposals (RFPs) outputs and increase project risk and cost.
HAVE YOU UNDERTAKEN CONSTRUCTION PROJECTS THAT INCLUDED A SUE COMPONENT?

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<th></th>
<th>YES</th>
<th>NO</th>
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<tbody>
<tr>
<td>70%</td>
<td>30%</td>
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On average, 70% of participants have SUE project experience. Consultants seem to be the category that is most experienced (81% of the respondents), while infrastructure owners are the least experienced, with 61% of the positive responses.

DO YOU FEEL THAT THE SUE CONSULTANT ASSISTED IN MITIGATING THE RISK?

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<th></th>
<th>YES</th>
<th>NO</th>
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<tr>
<td>75%</td>
<td>25%</td>
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Seventy-five percent of the total participants chose the “yes” alternative in contrast with 67% of owners and 84% of consultants. Understanding that SUE helps to mitigate project risk is an important concept and should be reinforced.

HAVE YOU ATTENDED SUE RELATED TRAINING COURSES OR WORKSHOPS?

<table>
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<tr>
<th></th>
<th>YES</th>
<th>NO</th>
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<tr>
<td>49%</td>
<td>51%</td>
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</table>

No significant difference in results among the three categories of respondents was noted. There is a clear opportunity to enhance SUE benefits by providing focused training in this discipline. Training offers are still limited and could be greatly improved.

ARE YOU AWARE OF ANY SUE CONSULTANTS IN YOUR GEOGRAPHIC AREA?

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<th></th>
<th>YES</th>
<th>NO</th>
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</thead>
<tbody>
<tr>
<td>64%</td>
<td>36%</td>
<td></td>
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</tbody>
</table>

Awareness about local SUE consultancy services could facilitate the interaction between stakeholders and the use of expert knowledge. Nevertheless, 36% of the total participants and 39% of owners reported not being aware of local SUE consultants.
ARE YOU AWARE OF THE AMERICAN SOCIETY OF CIVIL ENGINEERING (ASCE) UTILITY ENGINEERING AND SURVEYING INSTITUTE (UESI)?

55% YES
45% NO

On average, 55% of the total participants are aware of UESI. Specifically, 75% of the “others” category is aware of UESI, in contrast with 59% of consultants and 47% of owners. UESI supports SUE professionals, provides a forum for research, develops industry standards and promotes best practices.

ARE YOU AWARE OF THE FOLLOWING DOCUMENTS?

This question is a “mark all that apply” type, with the goal to identify respondents’ knowledge regarding SUE industry standards and guidelines. For both consultants (50% of the respondents) and “others” (63% of the respondents), “CSA S250 Mapping of underground utility infrastructure” is the most known standard. The “Transportation Association of Canada (TAC) Guidelines for the coordination of utility relocations” is the most known document for owners (33% of the respondents). In contrast, “ASCE 38-02 Standard guideline for the collection and depiction of existing subsurface utility data” is known by only 28% of owners and 41% of consultants. Furthermore, 42% of owners and 34% of consultants chose the “not sure” option, which is interpreted as a lack of knowledge regarding these documents.

<table>
<thead>
<tr>
<th>Document</th>
<th>Owners</th>
<th>Consultants</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA S250 Mapping of underground utility infrastructure</td>
<td>28%</td>
<td>50%</td>
<td>63%</td>
</tr>
<tr>
<td>Not Sure</td>
<td>42%</td>
<td>34%</td>
<td>25%</td>
</tr>
<tr>
<td>TAC Guidelines for the Coordination of Utility Relocations</td>
<td>33%</td>
<td>41%</td>
<td>13%</td>
</tr>
<tr>
<td>ASCE 38-02 Standard guideline for the collection and depiction of...</td>
<td>28%</td>
<td>41%</td>
<td>25%</td>
</tr>
<tr>
<td>CSA Z247-15 Damage Prevention for the Protection of Underground...</td>
<td>31%</td>
<td>31%</td>
<td>38%</td>
</tr>
<tr>
<td>ISO 15489-1:2001 Information and documentation – Records...</td>
<td>8%</td>
<td>16%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Key Takeaways

PRACTICES

▪ SUE processes are usually implemented on a project-by-project basis, instead of being structured in a program
▪ A significant portion of respondents still do not update drawings or request as-built drawings for construction projects, contributing to inaccurate or outdated utility records
▪ In general, survey participants have shown low to medium awareness levels concerning SUE standards and available tools
▪ Most organizations use Quality Level D and C information, when compared to Quality Level B and A information
▪ Utility information is mainly obtained during the construction phase, when stakes are higher regarding mitigation actions, project cost and quality

CHALLENGES AND OPPORTUNITIES

▪ Structuring the implementation of SUE practices in a program tends to lower construction project risk in the long run, particularly for infrastructure owners
▪ Industry stakeholders would greatly benefit from targeted SUE training, enhancing their knowledge of standards, important documents and tools (e.g. conflict matrix)
▪ Making sure that the cost-benefit of SUE practices is quantifiable and clear for stakeholders is paramount for advancing the industry and lowering project risks. SUE benefits awareness could contribute to a shift in its adoption to the planning and design project phases
Glossary of Terms

**CAD:** computer-aided design

**Consultants:** companies or individuals that provide expert services for planning, designing and executing utility projects.

**Contractors:** organizations responsible to implement utility projects during the construction phase.

**Infrastructure owners:** organizations responsible for investing, operating, maintaining and managing utilities.

**GIS:** geographic information system

**P. Eng.:** professional engineer

**P. Geo.:** professional geoscientist

**RFP:** request for proposal.

**Technology provider:** organizations that design and sell methods, technologies and equipment for engineering solutions.