How SUE Can Provide for Better Design, Cost Savings, and Damage Prevention for America’s Future Infrastructure Improvements

CI/ASCE 38-02 & Subsurface Utility Engineering

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Brief History

East & West Shaking Hands
Brief History

Golden Spike Recreation
Brief History

Winter Steam Festival
On June 17, 1914, the first transcontinental telephone line was completed near this point on the border of Nevada and Utah at Wendover. Construction forces of the Bell Telephone Company of Nevada and the Mountain States Telephone and Telegraph Company met there, making the last splices in the wires which joined East and West in voice communications for the first time.
Brief History

First Transcontinental Telephone Line
Brief History

First Transcontinental Telephone Line
Overview

Subsurface Utility Engineering (SUE)
- What is SUE and why do we need it?
- Managing risks involved with utility mapping.
- Why the “Business as Usual” model no longer works.

CI/ASCE 38-02
- What is the standard and who developed it?
- Quality Level Based Utility Mapping.
- Responsibilities of the Subsurface Utility Engineer.
- Geophysical prospecting equipment & techniques.

Use of SUE in the Mapping and Design Process
- When to use SUE and how it applies to the design process.
- Utility condition assessment.
- Utility coordination & relocation design.
- How to budget for SUE, cost to benefit ratio.
- Conclusion
Subsurface Utility Engineering (SUE)

Branch of Engineering Practice that involves managing certain risks associated with the following professional services:

- Utility Mapping at Appropriate Quality Levels
- Utility Coordination
- Utility Relocation Design
- Utility Condition Assessment
- Communication of Utility Data to Concerned Parties.
- Utility Relocation Cost Estimates
- Implementation of Utility Accommodation Policies
- Utility Design
Managing Risks

Risks Involved with Traditional Utility Mapping Methods

Without proper utility risk management utility owners and facility manager’s alike are left vulnerable to costly project delays and schedule over runs due to:

- Inaccurate utility plan compilation based solely on record data that may or may not be available.
- Unknown utility conflicts discovered during the construction process that could have otherwise been avoided.
- Safety risks posed to construction crews from unknown utility conflicts encountered during excavation or boring activities.
- Utility service disruptions to the general public.
The “Business as Usual” Model

Utility Mapping Compilation

For decades surveyors and engineer’s alike have relied on the “Old Way” of collecting and depicting utility information.

- Compile Available Utility Record Data.
  - No Warrant of Accuracy is Expressed or Implied.
  - Information May not be Available for All of the Utilities.

- Contractor to Verify All Existing Utilities.
  - Creates a change order rich environment.
  - Leaves Projects Wide Open for Construction Delay’s and Re-Design’s.

- Contractor to Contact Local One Call Center Prior to Performing Work (Dig Safe)
  - No Way to Control Quality or Accuracy of “One Call” Service Mark Outs.
  - Not All Utility Owners are Members of the “One Call” System.
CI/ASCE 38-02

What is the Standard?

New and emerging technologies allow for the cost effective collection and depiction of existing subsurface utility data.

- SUE has emerged in the past 30 years as a means to better characterize utility information.
- The 38-02 Committee is a Broad collaboration by a diverse group of experienced professionals and utility owners.
- The CI/ASCE 38-02 Standard clearly shows how to define quality attributes.
Why Was it Developed?

The Nation’s infrastructure is in a state of constant expansion and deterioration. EPA regulations and new construction have necessitated excavation activities in area’s of high utility density.

- Available utility right-of-way’s are becoming limited.
- Subsurface utilities create a large risk for emerging infrastructure projects.
- Poor utility data affects the ability to make informed decisions.
- New utility technologies are proliferating the market
- Design challenges faced by engineers is greater than ever.
Quality Level Based Utility Mapping

Utility Quality Levels

Per the CI/ASCE 38-02 Standard, each utility depicted on a plan shall be prescribed a quality level based on how the information for that particular utility was collected.

- Replaces the “Business as Usual” Model with a cost effective method of utility data collection.
- 4 Quality Levels as defined by CI/ASCE 38-02:
  - Quality Level D
  - Quality Level C
  - Quality Level B
  - Quality Level A
Quality Level D

“QL-D”

Utility information plotted on the drawings based solely on record information, individual recollections or the existence of utility service.
Quality Level C

“QL-C”

Utility information obtained as above for quality level D, plotted to correlate with surface utility features which have been field verified, survey located and accurately reduced onto the design/construction documents.

- Professional Engineering Judgement is used in interpreting the record information.
Quality Level B

“QL-B”

Utility information derived by establishing the surface horizontal location of a utility using Surface Geophysical Prospecting methods (Designation).

- Interpretation of the designation results by an SUE professional results in QL-B data.
- Results are reproducible.
- SUE provider is liable for results produced.
Quality Level A

“QL-A”

Utility information which has been visually verified, survey located (both horizontally and vertically) and accurately reduced onto the design / construction documents.

- Professional Engineering Judgement is used to interpret the QL-A results.
Responsibility of the SUE Engineer

Project Engineer / Project Manager Should

- Advise the Project Owner
- Educate the Project Owner
- Recommend a Scope of Work
- Discuss Plan Deliverable Formatting
- Discuss Incorporation of SUE into the Design Process
- Prepare Utility Drawings
- Review Plans / Designs with the Owner.
- Make recommendations for further investigation work such as upgrading the quality level of specific utility information.
Responsibility of the SUE Engineer

SUE Deliverables Formatting

Per the CI/ASCE 38-02 Standard, each utility depicted on the plan shall clearly state its quality level.

- Determine file format for deliverables .dwg or .dgn file types
- Establish plan sheet layouts
- Develop written reports if required for utility condition assessment
- Provide digital media or CCTV data
Geophysical Prospecting

Quality Level B Methods

Professional Engineering Judgement is always utilized to interpret the collected geophysical prospecting data.

- Electromagnetic Pipe and Cable Locators
- Ground Penetrating Radar
- Metal Detectors
- Terrain Conductivity
- Resistivity Methods
- Optical Methods
- Infrared (Thermal) Methods
- X-Ray Methods (Penetrating Radiation)
- Total Field Measurements
- Gradiometric Measurements
- Acoustic Emission, Micro gravitational Techniques
- Isotopic (Radiometric) Techniques
- Chemical Techniques
- Borehole Geophysics and Geophysical Diffraction Tomography
Geophysical Prospecting

Electromagnetic Pipe and Cable Locators

Electromagnetic Frequency pipe location methods produce the most consistent and viable designation results

- Utilizes radio frequencies to induce signal to utility.
- Allows for direct connection to utility for signal induction. Utility must be metallic.
The experience of the SUE Technician is crucial to the success of the utility investigation process.

- Ability to isolate signals and create reproducible results.
- Existing utility record information is not required to perform designation services.
- Paint or flagging placed at point of peak signal strength.
Geophysical Prospecting

Ground Penetrating Radar (GPR)

Sends Microwave Pulses into the ground and measures reflection received back at ground surface.

- Frequency ranges of 10 to 1,000 MHz.
- Soil conductivity, dielectric constants directly affect results.
- High conductivity soils, areas with heavy salt use, or thick pavement will greatly affect the depth of signal penetration.
- Is able to locate both metallic and non-metallic utilities.
- Cannot locate utilities smaller in diameter than their depth in feet.
Minimally Intrusive Excavation

Air Vacuum Excavation

Vacuum excavation is a very popular test pitting method utilized to obtain quality level A information without fear of damaging the existing infrastructure.

- Utilizes compressed air to loosen soil
- Soil is then extracted with a vacuum hose and deposited in a holding tank
- Once the utility is exposed the excavation spoils are replaced and compacted.
Example of Quality Level A Test Hole Log With Multiple Data Points
Review of Quality Level Definitions

- QUALITY LEVEL D
- QUALITY LEVEL C
- QUALITY LEVEL B
- QUALITY LEVEL A
Use of SUE in Mapping & Design

When to Use SUE and how it applies to the design process

Engineer’s and Surveyors need to properly define the project specific SUE needs at the onset of any given project prior to the commencement of engineering services.

- Quality Level D Data is used for planning
- Quality Level C Data is used for conceptual design
- Quality Level B Data is used for preliminary design.
- Quality Level A data is used for final design.
- Depending on the project requirements, any or all Quality Levels may be appropriate at any phase of a project.
- Data may also be gathered as a project progresses.
Use of SUE in Mapping & Design

Quality Level B Mapping Phase

The existing utilities are electronically designated, survey located and the results are accurately reduced on the project base plans.

- Location of the preliminary alignment is revised to avoid conflicts with existing utilities where possible.
- Based on the revised alignment and the quality level B utility information; precise locations may now be selected for exact horizontal and vertical information data collection. (QL-A Data Points)
Use of SUE in Mapping & Design

Quality Level A Phase

Quality Level A data is collected by either traditional or non-destructive test pitting methods. The information is then accurately reduced onto the engineering documents.

- QL-A Data is plotted on a test hole log profile showing the exact utility locations and sizes.
- The proposed improvements can now be designed to minimize the impact on existing utilities.
- Informed decisions can now be made where utility relocations are required.
Use of SUE in Mapping & Design

Utility Condition Assessment

Now that the geophysical data has been collected and depicted on the project documents, we can turn to other non-destructive means of utility condition assessment for additional utility data collection.

- CCTV Pipe Inspection
  - Robotic CCTV Inspection Crawlers
  - Push Rod Camera Systems
Use of SUE in Mapping & Design

Utility Condition Assessment Cont.

- Ultrasonic Pipe Testing
  - Measures Existing Pipe Wall Thickness for iron and steel pipes.
  - Primary method for determining useful remaining pipe life.
Use of SUE in Mapping & Design

**Utility Coordination and Relocation Design**

All information possible to obtain through SUE techniques has now been collected and depicted on the project documents.

- Contact the affected utility company as early as possible.
- Consider the relocation design of the utilities affected.
- Determine most cost effective way to address utility conflicts.
- Develop a utility relocation plan or a proposed design modification.
Use of SUE in Mapping & Design

Communication of Utility Data to Concerned Parties

- Let the contractor know how the utility information was obtained
- Include Quality Level Based mapping in the construction documents.

Utility Relocation Cost Estimates

- Consider the cost of forcing a utility to relocate.
- Total project cost concept & reimbursement policy.
Use of SUE in Mapping & Design

How to Budget for SUE

- On average, the SUE budget for most DOT projects works out to be approximately 1% - 2% of the total project cost.
- On average, for most DOT based projects, the SUE component should comprise of approximately 10% - 20% of the total design budget.
- SUE is very project specific and requires an individual project approach.

Project Cost Savings

- $4.62 in savings for every $1.00 spent on Subsurface Utility Engineering*

*(Purdue University Study,1999)
Use of SUE in Mapping & Design

100% Guarantee???

- Can a 100% guarantee be provided as to the location of underground utilities for a particular area?

- The simple answer is “yes”

- 100% guarantee for a particular area requires exposure of the entire area using non-intrusive methods. This leads to costs far above the potential savings and reduced risk of damage.

- Exposure is also necessary to prove the non-existence of utilities for example at proposed boring locations, using vacuum excavation to ensure that utilities are not damaged.
Conclusion

- Significant cost savings and prevention of damage to utilities will result from appropriately managing the risks on a project. Subsurface Utility Engineering, as a branch of engineering practice provides a means to manage these risks.

- At each stage of a project the risks, impacts and costs should all be assessed and the optimum solution determined. A qualified Subsurface Utility Engineer, as defined by ASCE 38-02 can be of great assistance in this process.

- When assessing costs, consideration should be given to indirect costs not directly attributable to the project and costs to entities other than the project owner.

- Damage prevention measures can only happen when the risks are fully understood and accounted for.