3D Utility Investigation & Modeling
Design for HP Gas Main Case Study

Western Regional Gas Conference
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Utility Mapping Services, Inc.
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Organizational Member of the ASCE Utility Engineering and Surveying Institute
Key Points

✓ ASCE CI and UESI Standards and Practices
✓ 3D Utility Surveys and Advanced Geophysics
✓ 3D Utility Modeling
✓ Optimized Design (Proactive, Predictive)
✓ Return on Investment
  ▶ Enhanced Damage Prevention
  ▶ Reduced Risk
  ▶ Expedited Construction
Highly specialized in Utility Engineering (UE) Veteran Owned Small Business established in 2002 and staffed by Engineers, Geophysicists, Surveyors, IT Architects and Geospatial data experts.

Approaches UE (which encompasses SUE, conflict analytics, design, coordination) as an innovative, strategic, and technologically advanced professional engineering service.

Active in ASCE UESI and CI, ACEC, AASHTO, TRB, SHRP2

Chair for ASCE “*Standard for Recording and Exchanging Utility Infrastructure Data*”

Vice Chair for the ASCE UESI “*Utility Risk Management Division*”
LEADING CAUSE FOR DELAYS, CLAIMS
Safety Hazards

- Undocumented Utilities create a Minefield
- Rediscovery is never as good as documentation during installation
- Advanced geophysical methods improve rediscovery
5S Utilities

- Sort
- Set in Order
- Shine
- Standardize
- Sustain
ASCE 38 – An Industry Standard

ASCE 38-02 (The Standard)

http://www.fhwa.dot.gov/programadmin/sueindex.cfm

Require by State Law
SB 18-167

BEST PRACTICE
Importance of a 2-D Base Map

American Society of Civil Engineers (ASCE) Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, CI/ASCE 38-02

Quality Levels:

QL D - Verbal Account or Record
QL C - Records and Surface Features

QL B - Records and GP Survey and Analysis (identify, work through discrepancies)
QL A - Exposed and Verified – Discrete

*P.E. Affixes Seal to Product*

ASCE 38 elevates the utility investigation process to a professional effort, akin to a geotechnical investigation or a property boundary survey, providing statutory protections as regulated for professional engineering.
How Standards Compliment

• ASCE Standard Guidelines for the Depiction of Existing Subsurface Utilities resolves issues with poor records on existing utilities. (Resolves the Symptoms)

• ASCE Standard Guideline for Recording and Exchanging Utility Infrastructure Data resolves issues with poor as-built records on new or exposed utilities. (Halts the Cause)

Slide Courtesy of Utility Mapping Services, Inc.
Reality – Lots of Poorly Documented Utilities, ASCE 38-02 Fixes That
Digging Things Up Repeatedly is Ridiculous, As-Built Standard and 3D Management Resolves This
**Standardized** recording and retrieval of utility infrastructure data

Effective utility data **exchange** among stakeholders

Enable **3D modeling**, **building information modeling (BIM)**, and **virtual design and construction (VDC)**, **augmented reality viewing**

**Enhanced damage prevention** and **reduced risk to existing utility infrastructure**

**More focused**, effective utility investigations and **conflict assessments and effective designs**

Resilient, sustainable infrastructure and more effective right of way management of **utility assets**
Status Quo - 2D Drawing Plan Sheets
3D Design and 3D Construction

ASCE XX, Standard Guideline for Recording and Exchanging Utility Infrastructure Data
Why 3D? - 2015 HP Gas Main Case Study

- Permit with 2 Waivers
- “Best Bid Package Ever Seen”
- Bid 10% Below Engineer’s Estimate
- Scheduled for 10 weeks / 2 crews
  Built in 7 weeks / 1 crew
- No damage, no delays, no changes
- Built as designed (as-built)
3D Data Collection and Modeling Now Routine
LAX APM Central Terminal Area
Models Based on Wide Array of “Disparate” Data and Professional Judgement

1. Always a Work-in-Progress
2. Dynamic
   - New Data (records, exposure)
   - Construction (Proposed, New, Modified)
   - Removed, Abandoned, Disuse
3. Manage Attribution (reliability, status)
Equipment Utilized on Projects

- Inductive Electromagnetic (EM) Detection using RD8000
- Direct Connect, Inductive Coupler, Surface Induction; Sonde or Rodder for non-pressurized pipe with access points.
TDEM Heat Map

TDEM (Pink) of Unknown Steel Pipes and Traffic Detection Loops superimposed on TDEM “Heat Map”

Traffic Detection Loops

Anomalous unknown infrastructure crossing
TDEM Conductivity Map of Open Space in Denver (formerly water treatment plant)
Figure 4: MCGPR profile showing apparent utility bored beneath Custer Avenue, just west of National Avenue. This alignment was among many revealed with MCGPR, but not identified in the Phase 1 SUE.
Multi-Channel GPR 3D Alignment
Multi-Channel GPR Tomographic Image
Inductive EM Model Based 3D Solution
Acoustic Soundings
Downhole LiDAR 3D Scans
3D Mesh Object Linked to Feature

Feature in Database
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3D Mesh Object Linked to Feature

Vault Mesh.obj

Pictures Stored with Feature
Custer Ave. 3D Design – Helena MT

NRC / FHWA 2nd
Strategic
Highway
Research
Program R01A
and R01B
Implementation
Funding
Augmented Reality
Project includes multiple iterations of installations by military (petroleum, water, telecom), private installations, and 3 eras of growth for water and sanitary sewer. **127 known alignments** were identified and mapped. In addition, **275 unknown alignments** discovered and mapped in one ½ mile segment, revealed and mapped with MCGPR, TDEM, and SPAR.
Multichannel GPR - HART
Multichannel GPR - HART
Advanced Geophysics Results for Kamehameha Highway 138kV Relocate

- 591 3D QL B linear features mapped on known utility features.
- 104 2D QL B outlines mapped of known utility positions (trenches outlines, backfill / subgrade changes).
- 327 3D QL B alignments mapped on unknown linear subsurface features.
- 185 2D QL B outlines mapped of unknown infrastructure, material changes, or other unknown features (trenches, tanks, foundations, subgrade changes, etc.).
- 775 2D QL B discrete unknown buried features mapped (rocks, drums, etc.).
- 13 2D QL B known discrete points that were paved over or buried.
Potholing campaigns are expensive, disruptive, invasive, provides data with limited use, does not sweep for unknowns, does not verify target was found, does not comply with ASCE standards, and is unnecessary.

Test Holes are for verification, exploration for QL D targets, and QLA accuracy.
Contractors Typically Add a 10% Contingency for Dealing with Poorly Documented Utility Infrastructure.

3D Utility Investigations Typically Add 1% to the Total Project Cost while Grossly Reducing Construction Costs and Expediting Construction.

The Resulting Return on Investment has been observed exceeding 10 to 1.
Project Development Utility Engineering

- Record Research & Project Kick Off
- Map within Project Limits (QL B Data)
- Creation of 2-D Base Map (Per ASCE 38)
- Evaluate Data for Conflicts
- Coordination with Owner and Utility Reps
- 3-D Geophysical Survey (EM, GPR)
- Creation of 3-D Model
- Evaluate 3-D Data on Conflicts
- Determine Discrete Test Hole Requirements
Uncertainty of utilities’ existence, location, and attributes are the common thread and these efforts are methods to standardize the location and existence so that real engineering decisions can be made.
Key Take-Aways

- Standards and Best Practices Exist for Collecting, Managing, and Leveraging Utility Data
- Technology Exists to Make Capture of 3D Data Routine
- Standards Enable Emerging 3D Digital Technologies
- Tremendous Value is Reaped
- Agencies Now Implementing Cradle to Grave Management Practices
Your Time and Attention is Appreciated!

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Vice Chair ASCE UESI Risk Management Division

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