2016 AASHTO Right of Way, Utilities, Outdoor Advertising Control & National Alliance of Highway Beautification Agencies Conference

Sunday, May 1–Thursday, May 5
Rosen Centre Hotel
Orlando, Florida
Subsurface Utility Engineering and 3D Utility Mapping
Subsurface Utility Engineering:

A branch of engineering practice that involves managing certain risks associated with utility mapping and appropriate quality levels, utility coordination, utility relocation design and coordination, utility condition assessment, communication of utility data to concerned parties, utility relocation cost estimates, implementation of utility accommodation policies, and utility design.

(CI/ASCE 38-02)
In essence...

Collect, Gather, Interpret, Manage and Use Utility Information in Accordance with Standards (ASCE 38-02)
Utility information and risk mitigation defined through 4 quality levels:

- Quality Level D
- Quality Level C
- Quality Level B
- Quality Level A
Utility information and risk mitigation defined through 4 quality levels:

- Quality Level D
- Quality Level C
- Quality Level B
- Quality Level A
Utility information used for roadway design

- 2-Dimensional utility information (QL D, C and B) added to design file
- Conflict analysis in X,Y (Phase I) and then Z (Phase II) based on utility information
Utility information used for roadway design

- 2-Dimensional utility information (QL D, C and B) added to design file

- Conflict analysis in X,Y (Phase I) and then Z (Phase II) based on utility information
Analyze potential conflicts based on X, Y utility location

Is it a potential conflict?

---

YES

Potential conflict based on depth?

---

NO

Conflict independent from depth of utility (e.g. piers, walls)

YES

Conflict resolution (e.g. modify design, OR utility relocation)

---

NO

In conflict based on Z?

---

YES

NO

Proceed with design

---

“Standard” conflict analysis without 3D information
“Standard” conflict analysis without 3D information

1. Analyze potential conflicts based on X, Y utility location
2. Is it a potential conflict?
   - NO
   - YES
3. Potential conflict based on depth?
   - NO
   - YES
   - Verify conflict through physical exposure of utility
4. In conflict based on Z?
   - NO
   - YES
   - Conflict independent from depth of utility (e.g. piers, walls)
   - Conflict resolution (e.g. modify design, OR utility relocation)
5. Proceed with design

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“Standard” conflict analysis without 3D information

1. Reference UTEXRD.DGN
2. Analyze potential conflicts based on X, Y utility location
3. Is it a potential conflict?
   - NO
   - YES
4. Potential conflict based on depth?
   - NO
   - YES
5. Verify conflict through physical exposure of utility
6. In conflict based on Z?
   - NO
   - YES
   - YES Conflict resolution (e.g. modify design, OR utility relocation)
   - NO Proceed with design

- Conflict independent from depth of utility (e.g. piers, walls)
Analyze potential conflicts based on X, Y utility location

Is it a potential conflict?

NO

Potential conflict based on depth?

NO

Conflict independent from depth of utility (e.g. piers, walls)

YES

Conflict within “risk envelope”?

NO

Conflict resolution (e.g. modify design, OR utility relocation)

YES

Proceed with design

NO

Proceed with design

Depth Estimate “Z”

In conflict based on Z?

NO

Verify conflict through physical exposure of utility
Analyze potential conflicts based on X, Y utility location

Is it a potential conflict?

YES

Potential conflict based on depth?

YES

Depth Estimate “Z”

NO

Conflict within “risk envelope”?

NO

Conflict independent from depth of utility (e.g. piers, walls)

Conflict resolution (e.g. modify design, OR utility relocation)

Proceed with design

NO

Conflict within “risk envelope”?

YES

Proceed with design

Verify conflict through physical exposure of utility

In conflict based on Z?

NO

Proceed with design

YES
Conflict analysis and “Risk Envelope”

Gas line represented in 2D

“Risk Envelope” in 2D

Professional judgment and source of utility information must be documented throughout the process

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Estimated “Z” information and “Risk Envelope”

Gas line represented in 3D

“Risk Envelope” in 3D

Professional judgment and source of utility information must be documented throughout the process

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Estimated “Z” information and “Risk Envelope”

Gas line represented in 3D  "Risk Envelope” in 3D

Professional judgment and source of utility information must be documented throughout the process

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Estimated “Z” information and “Risk Envelope”
Estimated “Z” information and “Risk Envelope”

Quality Level B with depth qualifiers / “Risk Envelope”

Quality Level A at critical locations
How do we obtain estimated “Z” information?

- Dedicated field data collection
- Improvements in surface geophysics
Radar Tomography (RT) – Benefits & Characteristics

- Continuous data with post-processing and interpretation
- Calibration for depth readings
- Positioning (GPS, Total Station)
RT – Benefits & Characteristics

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FDOT Central Office - 3D Radar Tomography Contract

Expectations

• Scan Areas with 3D Radar
• Support with Conventional Utility Mapping
• Obtain 3D Utility Information
• Horiz. & Vert. Accuracy ≤ 0.5ft
• UTEXRD01.dgn & UTVHRD01.dgn
Process

• Obtain Utility Records
• Recover/Establish Project Horizontal and Vertical Control
• Scan Areas and Record Raw RT Data
• Complete Conventional Designating with EDE
• Complete Locating to assist in calibrating RT
• Survey
• Process and Prepare Deliverables
Depth information from all available methods

- Radar Tomography
- Electromagnetic Pipe/Cable Locators
- Direct Measurements
- Analyze, merge and produce vertical data
- Elevations based on DTM
Depth Information from Different Data Sets
Depth Information from Different Data Sets
Depth Information from Different Data Sets
Survey Support

- Tie into existing project control
- 3D radar tomography uses point-to-point RTK GPS receiver to log horizontal positions
- Elevations based on existing DTM
- Standard surveying techniques for 3D position of designating and locating marks
- MS/Geopak for post processing and point/chain database management - PNEZD
Vertical Data Management

Compare and analyze Z from different data sets

Valve
Existing grade

14-inch water line
Depth: 6.00 feet from ground cover to top of pipe in valve box (QLA)

Depth: 4.25 feet from ground cover to top of pipe in test hole (QLA)

Legend
- Depth estimated from GPR (QLB)
- Depth estimated from pipe and cable locator (QLB)
- Depth estimated by interpolation ('best guess') (QLD)
- Depth estimated from existing records (QLD)

Test hole (QLA)

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Vertical Data Management

Compare and analyze Z from different data sets

Legend
- Depth estimated from GPR (QLB)
- Depth estimated from pipe and cable locator (QLB)
- Depth estimated by interpolation (‘best guess’) (QLD)
- Depth estimated from existing records (QLD)

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## Vertical Data Management

Compare and analyze Z from different data sets

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<tr>
<th>Point</th>
<th>TH#</th>
<th>Existing</th>
<th>Elev</th>
<th>Depth/Cut (Feet)</th>
<th>Approximate Electronic Depth/EM Locator</th>
<th>Delta EM/ED vs TH</th>
<th>Depth 3D RT</th>
<th>Abs Value of Delta EM/ED vs TH</th>
<th>Abs Value of Depth 3D RT vs TH</th>
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</table>

#### RADAR TOMOGRAPHY CONTRACT - TIP 1 - DEPTH COMPARISON TABLE

- **TH#**: Target Horizon Number
- **Existing**: Existing Horizon Data
- **Elev**: Horizon Elevation
- **Depth/Cut (Feet)**: Depth/Cut Measurement
- **Approximate Electronic Depth/EM Locator**: Approximate Electronic Depth/EM Locator Data
- **Delta EM/ED vs TH**: Delta EM/ED vs TH Data
- **Depth 3D RT**: Depth 3D RT Data
- **Abs Value of Delta EM/ED vs TH**: Absolute Value of Delta EM/ED vs TH Data
- **Abs Value of Depth 3D RT vs TH**: Absolute Value of Depth 3D RT vs TH Data
- **Delta Comparison Best Value**: Delta Comparison Best Value Data
Export and Preparation of 2D and 3D DGN

Microstation V8i and Geopak (points)
Export and Preparation of 2D and 3D DGN

Microstation V8i and Geopak (chains)
Export and Preparation of 2D and 3D DGN
UTVHRD01.dgn as per FDOT standards
UTVHRD01.dgn to 3D Render/Model
Benefits During Design:

- Elevations throughout the project
- Continuous 3D representation
- Less potential conflicts
Not only pipes and cables....
Not only pipes and cables....

43ft long underground vault
Conclusions:

Where Are We Going With Utility Mapping?

ATTRIBUTES
Quality Level: QLB
Method of “z” value: GPR
Starting elevation: 256.8
Ending elevation: 255.8
Size: 8”
Material: Metal within Plastic
Owner: ATT
Conclusions:

Where Are We Going With Utility Mapping?