Wisconsin Department of Transportation

3D Utility Survey Pilot Project Program

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WisDOT 3D Technologies Implementation Plan

– Utilities Unit in the Bureau of Technical Services was charged with:

• Selecting appropriate projects for this initiative

• Developing a draft policy on the implementation of subsurface utility engineering on specific WisDOT highway improvement projects.
Five pilot projects were identified throughout the state (one per region) to implement the use of 3-dimensional (3D) utility surveying techniques on a limited basis and assess the data collected from the surveys for accuracy and usefulness.
3D Utility Survey Pilot Project Locations

- Superior
- Rothschild
- DePere
- Lake Delton
- Franklin
Field work has been completed for the pilot projects.

- Consultants surveyed underground utilities using Spar and/or Ground Penetrating Radar (GPR).

- The utility facilities were exposed at critical locations and surveyed to check the accuracy of the data gathered.
New Technology – Spar 300
New Technology – Spar 300

- Two 3-d magnetic loop antennas
- 20 Hz – 10 kHz frequency
- 3-axis digital compass
- 3-axis accelerometer
- RTK-GNSS (optional)
- Bluetooth or USB host interface
- Zigbee (wireless sensor networking)
- Model-based optimization processor
- Quick-change 8-hr Li-Ion battery
- 5 hour with internal RTK
### Description

<table>
<thead>
<tr>
<th>Description</th>
<th>Category</th>
<th>Code</th>
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<tr>
<td>Line Util Vert 1: 10cm</td>
<td>Utility Survey</td>
<td>VA</td>
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<td>Line Util Vert 2: 20cm</td>
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<td>VB</td>
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<td>Line Util Vert 3: 50cm</td>
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<td>Line Util Vert 5: 200cm</td>
<td>Utility Survey</td>
<td>VE</td>
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Possible to determine when observations are good or suspect; record and quantify result accuracy.
Fundamental Electromagnetic Principles
Model Based Utility Survey Technology

General Method
- 3-D sensors observe magnetic field
- Compared to hypothetical model
  - 3-D position and current are unknown

Complications (non-modeled)
- 3-D field effects
  - Pipe T’s, risers, curves, etc.
- Adjacent conductors
  - Bleed-off, bleed-over, return current
Model Based Degradation

- Locating Challenges, Tactical Solutions and Expectations
  - Utility Characteristics and Affect on Locating (Age, Condition, Material, Depth)
  - Tracer Wire Installation and Locating/SUE Implications
  - Feature Design (Valves, Tees, Gaskets/Bushings, Joints)
  - Utility Congestion
  - Pressurized Non-Conductive Pipe
Tracer Wire

- Effects on Data

Tracer wire location
Urban Reality – Utility Congestion

Return Current Curves and Tees

Factors and Complex Geometry
Ground Penetrating Radar (GPR)

- Need electrical property contrast
- Vulnerable to changes in soil and moisture
- Will not penetrate clay or highly conductive soil
- Need ground truth for depth interpretation (max depth <30ft)
- Requires experienced operator
Ground Penetrating Radar (GPR)

- Data Interpretation
- Data Analysis
DePere (NE Region) - Example
Lake Delton (SW Region) - Example

NOTES:
GRAYSCALE ALIGNMENTS (LINWORK) REPRESENT UMS PHASE I SURVEY COMPLETED PER C/AGC 39-02.
COLORED ALIGNMENTS (LINWORK) REPRESENT UTILITY POSITIONS OBTAINED UTILIZING THE SPAR 388 EQUIPMENT.
REFERENCE THE GENERAL NOTES FOR SPAR 388 DATA AND ACCURACY INTERPRETATION NOTES AND GUIDELINES.

PROFILES NOTES:
SEE SHEET 18 FOR TEST HOLE 13 PROFILE.

GAS, WATER & CATV PLAN & PROFILES SCALE, FEET 40 40 SHEET 7 OF 11
Superior (NE Region) - Example
Superior (NE Region) - Example
3D Depiction & Design
What Have We Learned?

• Locating underground utility facilities using SPAR technology provides:
  1. Ability to locate underground utility facilities both in the horizontal plane as well as vertically.
  2. A degree of probability that the facility is located within a calculated range, both horizontally and vertically.
  3. Ability to identify unexpected deviations in the placement of an underground utility facility.
  4. Data from which to identify potential utility conflicts with proposed improvements and to make decisions to avoid such conflicts.
  5. Data from which to identify specific locations for necessary subsurface utility excavation.
What Have We Learned?

• Accuracy for locating underground facilities using SPAR technology varies, dependant upon:
  1. Density of utilities in a location.
  2. Depth of the utilities.
  3. Utility facility features (bends, tees, valves).
  4. If the facility is plastic or metal and if there is a tracer wire associated with the facility.
  5. Experienced Spar equipment operator.

• GPR use and data quality dependent on:
  – Soil Conditions.
  – Experienced GPR equipment operator.

• SPAR and/or GPR may not be necessary in all circumstances.
What Will Happen Next?

- After the surveys are completed and final products are delivered, the results will be summarized in a report. The report will be used to assist WisDOT management with the development of a policy of when to use 3D utility survey technology. The report is scheduled to be completed in late Spring 2014.
What Will Happen Next?

The report will include:

- A summary of the pilot projects and the data collected.
- Information on the utility survey practices and policies used elsewhere nationally.
- Recommendations when 3D utility surveying should be employed and where to use. Recommendations will be based on economic benefits, information from designers and project managers stating the usefulness of the collected data, type of improvement projects, and successful practices used elsewhere nationally.
- Recommendations on utility in-field locatability standards and utility as-build standards.
Thank you for your interest and time!

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