

SURVEYING THE UNDERGROUND

A Surveyor's Guide to Subsurface Utility Location & Mapping

**Maryland Society of Surveyors
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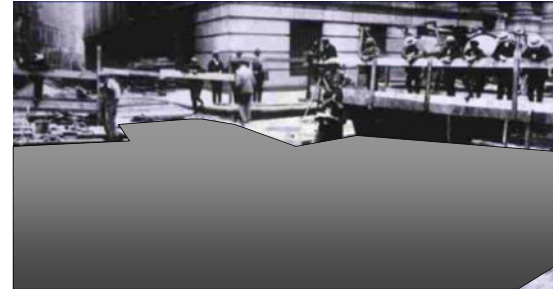


SURVEYING THE UNDERGROUND

Agenda

- Introduce ASCE 38-02 & Subsurface Utility Engineering (SUE).
- One Call System
- ALTA/NSPS Land Title Surveys & Utilities
- Review technical aspects of locating UG utilities
- Field Demonstration – Designating & Test Holes
- Answer questions about surveying & mapping UG utilities

THE CHALLENGE



Source: Federal Laboratory Consortium for Technology Transfer

COMPLEX UTILITY LAYERS UNDERGROUND

THE CHALLENGE



INCREASING COMPLEXITY UNDERGROUND



INCREASING COMPLEXITY UNDERGROUND



WHAT ARE TRADITIONAL METHODS TO MAP UTILITIES?

Records research

Field survey of surface features

- Valves, hand boxes, meters, manholes, hydrants

Perhaps locate One Call - 811 marks if found in field

Fit record information to surface evidence & marks

Disclaim responsibility for underground utilities – “per plan”

RECORDS DON'T TELL THE WHOLE STORY.

Utility records are not always:

- In existence
 - Lost
 - Never drawn
- Available
 - Homeland Security
 - Privacy concerns
 - Personnel and other costs for utilities to share records
- Reliable

RECORDS DON'T TELL THE WHOLE STORY.

Records may be schematic only

Records may be out of date

- Utilities modified but no records made of field changes

Records refer to conditions that have changed

- Roads widened

“As-builts” may not always be

WHAT HAPPENS IF RELIABLE INFORMATION IS NOT AVAILABLE?

Incomplete or inaccurate base data

Designs that cannot be executed or constructed as planned

Construction delays

Re-designs

Change orders

Back charges

Damages

Insurance claims

Loss of profits

Loss of client confidence, loss of client

SURVEYING THE UNDERGROUND

Miss Utility MD – 811 - One Call

Notification Center

Marking by member utilities – multiple different locators

Ticket system per site, per utility

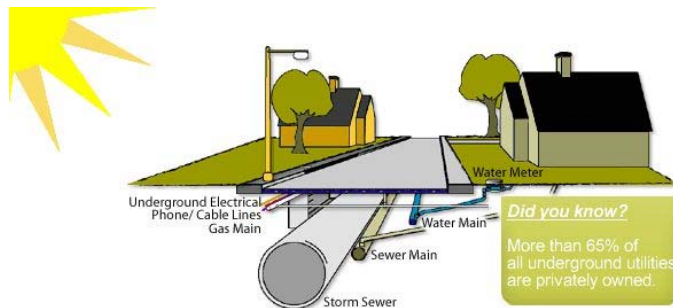
Primarily for Excavation

Private utilities not usually marked (65% +/- of all utilities)

Designer Ticket – October 1, 2010

- 15 day response time.
- Informational Purposes Only
- Not liable for incomplete or inaccurate information provided
- Abandoned/ unknown utilities not addressed
- Something for (almost) nothing – ID of utilities

PRIVATE UTILITIES ARE NOT MARKED BY MISS UTILITY



DISCLAIMER #1

CAUTION!!

THE **LOCATIONS** OF ALL EXISTING UNDERGROUND UTILITIES SHOWN ON THIS PLAN ARE BASED UPON ABOVEGROUND EVIDENCE (INCLUDING BUT NOT LIMITED TO MANHOLES AND INLETS, VALVES AND MARKS MADE UPON THE GROUND BY OTHERS) AND ARE **SPECULATIVE** IN NATURE. THERE MAY ALSO BE OTHER EXISTING UNDERGROUND UTILITIES FOR WHICH THERE IS NO ABOVEGROUND EVIDENCE [OR] FOR WHICH NO ABOVEGROUND EVIDENCE WAS OBSERVED. EXACT LOCATIONS OF SAID EXISTING UNDERGROUND UTILITY SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO ANY AND ALL CONSTRUCTION.

DISCLAIMER #2

LOCATION OF ALL UNDERGROUND UTILITIES ARE **APPROXIMATE**, SOURCE INFORMATION FROM PLANS AND MARKINGS HAS BEEN COMBINED WITH OBSERVED EVIDENCE OF UTILITIES TO DEVELOP A **VIEW** OF THOSE UNDERGROUND UTILITIES. HOWEVER, LACKING EXCAVATION, THE EXACT LOCATION OF UNDERGROUND FEATURES CANNOT BE ACCURATELY, COMPLETELY AND RELIABLY DEPICTED. WHERE ADDITIONAL OR MORE DETAILED INFORMATION IS REQUIRED, THE CLIENT IS ADVISED THAT EXCAVATION MAY BE NECESSARY.

APPROXIMATE LOCATION OF UNDERGROUND UTILITIES ARE SHOWN PER **PRIVATE UTILITY MARKOUT** PERFORMED BY INSIGHT ON FEBRUARY 25, 2015 AND JUNE 27, 2016 AND FIELD LOCATED WITH CONVENTIONAL FIELD SURVEY UNLESS OTHERWISE NOTED.

DISCLAIMER #2 - CONTINUED

UTILITIES:

THE FOLLOWING COMPANIES WERE NOTIFIED BY DELMARVA MISS UTILITY SYSTEM (1-800-552-7001) AND REQUESTED TO MARK OUT UNDERGROUND FACILITIES AFFECTING AND SERVICING THIS SITE. THE UNDERGROUND UTILITY INFORMATION SHOWN HEREON IS BASED UPON THE UTILITY COMPANIES RESPONSE TO THIS REQUEST. SERIAL NUMBER(S) A411400590.

UTILITY COMPANY

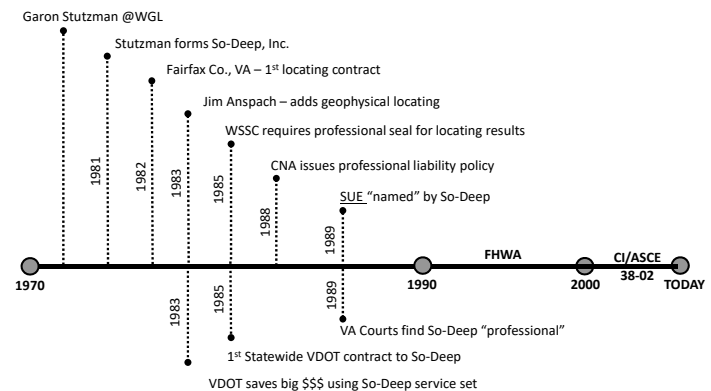
PHONE NUMBER

SUE



THE NEED TO KNOW HORIZONTAL AND VERTICAL POSITIONS & TYPE, SIZE AND LOCATION OF EXISTING SUBSURFACE UTILITIES LED TO THE DEVELOPMENT OF SUBSURFACE UTILITY ENGINEERING

SO-DEEP, INC. – ORIGINAL SUE COMPANY



SUE & FHWA

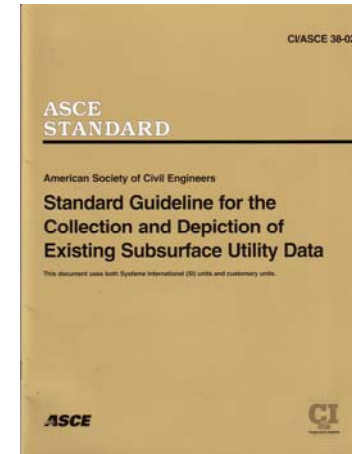
1990's – (Early) – Federal Highway Administration (US DOT)

- Aggressively promotes use of SUE
- Defines “quality level” outcomes
 - ‘D’ – records only
 - ‘C’ – adds surveyed utility features
 - ‘B’ – includes surface geophysical techniques to determine the existence and horizontal position of utilities
 - ‘A’ – excavation to determine the precise H & V position, and type, size, material and condition of underground utilities and structures

1990's – (Late)

- FHWA funds **Purdue University study**
 - \$4.62 in avoided costs for every dollar spent on SUE activities
- FHWA helps **fund** development of **national standard to classify utility data**

CI/ ASCE 38-02



Testimonials

"The Federal Highway Administration has been encouraging the use of Subsurface Utility Engineering on Federal and highway projects since 1991. Proper use of this cost-effective professional engineering service will eliminate many of the utility problems typically encountered on highway projects. Using this technology, it will be possible to avoid many utility relocations before construction and many unexpected encounters during construction, thereby eliminating many costly, time-consuming project delays."

John A. Hone
Director, Office of Program Administration
Federal Highway Administration

"The SUE process, specifically the assignment of 'Quality Levels' to the utility data collected, provides valuable engineering information from which to make risk-based decisions that characterize the delivery of transportation projects. At FHWA's use of SUE in project planning and design allowed us to avoid unnecessary impacts to existing utilities and to save the incalculable costs of equipment not required and delays never imposed on the progress of a transportation project's construction."

John F. Campbell, PE
Chief, MAPPO Services for FHWA & DOT
Director of Program Administration

Subsurface Utility Engineering

FHWA REMAINS AN ADVOCATE

U.S. Department of Transportation
Federal Highway Administration

<https://www.fhwa.dot.gov/design/sue/suebrochure.cfm>

SUBSURFACE UTILITY ENGINEERING

Over the decades, highway designers have had a difficult time obtaining reliable subsurface utility information. Now, this information is available through the use of an engineering process called Subsurface Utility Engineering.

MAJOR SUE ACTIVITIES:

- Scope of Work** – The process of developing a written project-specific work plan package that consists of scope of work, levels of service or risk allocation, project schedule and desired project delivery method. This SUE work plan package is agreed upon by the SUE provider and the client, describing the SUE work to be performed.
- Designating** – The process of using a surface geophysical method to identify the presence of a subsurface utility and mark its horizontal position on the ground surface or on above-ground surface markers.
- Locating** – The process of exposing and recording the precise vertical and horizontal location and providing utility size and configuration of a utility.
- Data Management** – The process of surveying, designating, and locating information to project control and transferring it into the client's CAD system, GIS files, or project plans.
- Conflict Analysis** – The engineering process of using a conflict matrix to evaluate and compare designed engineering information with proposed plans (highway, bridge, drainage, and other) in order to inform all stakeholders of potential conflicts, potential resolutions and costs to cure.

Project Application

STANDARD OF CARE

The American Society of Civil Engineers (ASCE) has developed an important standard of care guideline, Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, CI/ASCE 38-02. This standard guideline describes four quality levels of utility depiction:

- Quality Level D** – Information derived from existing records or oral recollections.
- Quality Level C** – Information obtained by surveying and plotting visible above-ground utility features and by using professional judgment in correlating the information to Quality Level D.
- Quality Level B** – Information obtained through the application of appropriate surface geophysical methods to determine the existence and approximate horizontal position of subsurface utilities.
- Quality Level A** – Precise horizontal and vertical location of utilities obtained by the actual exposure and subsequent measurement of subsurface utilities, usually at a specific point.

To order a copy of ASCE Standard 38-02, please go to the ASCE Bookstore: <http://www.asce.org> or call 1-800-548-2723.

SUE EXPERTISE

Competence. SUE providers should be able to demonstrate a thorough knowledge and understanding of the major SUE activities and should be able to provide these services to the extent desired by the contracting agency.

Experience. Individuals assigned by the SUE provider to carry out the work should be well-trained, experienced, and capable. Those in responsible charge of the work and responsible for certifying deliverables should be engineers, geologists, and land surveyors employed by the SUE provider in accordance with state professional registration requirements.

Equipment. A wide range of equipment is necessary to detect the variety of subsurface utilities that may be present. Equipment available for utilization by the provider should include, but not be limited to, state-of-the-art designating equipment, vacuum excavation or comparable non-destructive locating equipment, state-of-the-art surveying and data recording equipment, and software systems compatible with those of the contracting agency.

Timeliness. Resources of the provider should be adequate to carry out the SUE work in a timely manner, considering other possible commitments of work and the contracting agency's anticipated needs.

Financial Capacity. SUE providers should have the financial capacity to provide the required services.

Insurance. SUE providers should have adequate insurance covering all aspects of work. Minimum amounts should be in accordance with the contracting agency's requirements.

CI/ ASCE 38-02

Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data

©2003 – American Society of Civil Engineers

- Increasing complexity of national subsurface infrastructure
- Subsurface “unknowns” create risks on construction projects
 - Many records are inaccurate, incomplete, out of date
- One Call-811 – in most states a **construction excavation period service**
 - Post-design & after bidding
 - Some States have Designer Tickets – Informational only,
 - **USUALLY - NO LIABILITY FOR INACCURATE INFORMATION**
 - When conflicts arise during construction solutions are costly
 - change orders, extra work orders, insurance payouts and contingency pricing

ASCE 38-02

Scope of 38-02

- Consensus standard guideline
- Defines quality of utility depictions
 - Associated attribute data
- Addresses implementation
 - Methods
 - Available technologies
 - Communication of data

Intent of 38-02

- Establish **classification system** to describe quality of data associated with existing subsurface utilities
- Facilitate **communication** about the quality of utility data needed or provided for construction documents

KEY TERMS

Designating

- Interpret the presence of subsurface utility through surface geophysical methods
- Mark its approximate horizontal position on the ground

Locating

- Expose and record the precise vertical and horizontal location of a utility.

Utility Quality Level

- A professional opinion of the quality and reliability of utility information.

Utility Depiction

- A visual image of existing utility information in a computer-aided design and drafting system (CADD) or on project plan sheets.

QUALITY LEVEL ‘D’

QL D

- Information derived from existing records
 - State and local utility departments
 - One Call Center
 - Landowners
 - Internet
 - Utility companies
- Types of Records
 - Construction Drawings
 - Conduit , Distribution and Transmission Maps
 - As-builts
 - Oral Histories
- May include a field visit to look for visual cues to utility systems
- Composite drawing plotted for schematic representation without registration to ground features – all representation are at QL D
- May be adequate for preliminary planning purposes

QUALITY LEVEL 'C'

QL C

- Perform QL D tasks
- Identify and field survey, process and plot utility surface features
- Correlate applicable utility records to surveyed features considering record utility system geometries
- Determine conflicts between records and surface features and attempt to resolve discrepancies, if possible
- The Information obtained by surveying and plotting visible above-ground utility features and by using professional judgment in correlating this information to QL D information may result in a combination of QL C and QL D depictions

QUALITY LEVEL 'B'

QL B

- Perform QL C Tasks
- Select an appropriate suite of surface geophysical methods
- Apply surface geophysics to search for utilities
- Interpret the geophysics in the field or office depending on method
- Mark and survey indications of subsurface utilities
- Depict approximate horizontal positions of all detected utilities
- *Surveys of depicted positions must be merged with field records & historic documentation through professional analysis and judgment to produce final mapping.*
 - QLB data to be reproducible by surface geophysics at any point of depiction
 - Positions surveyed to applicable project standards
- Recommend to project owner when additional methods such as test holes may be needed to determine positions
- May result in a combination of QL B, C & D depictions

SURVEYING THE UNDERGROUND

PENN DOT DESIGN MANUAL

Note that surveying existing one-call marks does not lead to QL B data, since the genesis of the marks was not under the direct responsible charge of the professional certifying the QL B depictions, and one-call generally does not address unknown utilities, privately owned utilities, utilities without records, abandoned utilities, and so on.

Nor does the professional have knowledge of the field technician's qualifications, training, and level of effort.

QUALITY LEVEL 'A'

QL A

- Perform QL B tasks at appropriate project locations
- Excavate test holes to expose the utility to be measured
- Minimally intrusive excavation
 - Air-vacuum & sometimes hydro-vacuum extraction
 - Hand dig
 - Sometimes as built measurements during construction
- Actual exposure or verification of previously exposed and surveyed utilities and subsequent measurement of subsurface utilities, usually at a specific point
- Horizontal and vertical position, existing grade at ground surface, size and configuration of utility, material type, general condition, ground condition encountered
- Precise horizontal and vertical positions reported
 - Accuracy is typically set to 15-mm (0.05 feet) vertical and to the specified horizontal survey and mapping accuracy of the project

ENGINEER'S RESPONSIBILITIES

Advise owner of potential utility impacts on project
Inform and educate the project owner about quality levels

- costs and benefits of each

Recommend QL, scope, depiction

- required quality level may vary across project
- Recommend formatting of deliverables to be maintained across the project team and throughout the project life

Discuss sequence of acquiring appropriate quality level data

Recommend quality level upgrades as indicated by design needs

Follow one-call statutes, if any apply; e.g. designer ticket number in VA.

OWNER'S RESPONSIBILITIES

Review scope with engineer; amend or approve as appropriate

Assist in contact with existing utility owners; (may improve access to records)

Review quality levels with project team; approve format of deliverables for all team members

Notify the engineer of suspected deficiencies in the utility depiction if familiar with site and utility systems in place

Furnish utility information to utility owners for utility marking for construction (one-call systems)

ASCE 38-02

ASCE 38-02 Originally established for transportation (highway) projects

- Generally public utilities (with records) involved

Can be applied to site specific design projects

- Shortage of available (private) utility records add to challenges on site specific projects
- Patterns of utility configurations are often less regular (and predictable) than in or through transportation corridors

SURVEYING THE UNDERGROUND

Professional SUE providers use ASCE 38-02 as their professional framework for methods and procedures to meet standards of professional care

SUE is distinctly different from One Call - 811

- Meticulous care in research, field investigation – from mains to mechanical room, search & trace unknowns, all conductors, active & abandoned, survey, map, correlate with records
- Comprehensive consideration of all utilities; known and unknown; public & private, active & abandoned
- QL labels inform designer about the reliability of utility
- Test holes are excavated to validate utility designating
- Comprehensive investigation enables SUE providers to assume professional liability

SURVEYING THE UNDERGROUND

ALTA/NSPS LAND TITLE SURVEYS – 2/23/16

5.E. Easements and Servitudes

- i. Evidence of any easements or servitudes burdening the surveyed property as disclosed in the documents provided to or obtained by the surveyor pursuant to Section 4 and observed in the process of conducting the fieldwork.

SURVEYING THE UNDERGROUND

5.E. Easements and Servitudes

- ii. Evidence of easements, servitudes, or other uses by other than the apparent occupants of the surveyed property not disclosed in the documents provided to or obtained by the surveyor pursuant to Section 4, but observed in the process of conducting the fieldwork if they appear to affect the surveyed property (e.g., roads; drives, sidewalks, paths and other ways of access; utility service lines; water courses; ditches; drains; telephone, fiber optic lines, or electric lines; or water, sewer, oil or gas pipelines on or across the surveyed property and on adjoining properties).
- iii. Surface indications of underground easements or servitudes on or across the surveyed property observed in the process of conducting the fieldwork (e.g., utility cuts, vent pipes, filler pipes).

SURVEYING THE UNDERGROUND

5.E. Easements and Servitudes

- iv. Evidence on or above the surface of the surveyed property observed in the process of conducting the fieldwork, which evidence may indicate utilities located on, over or beneath the surveyed property. Examples of such evidence include pipeline markers, manholes, valves, meters, transformers, pedestals, clean-outs, utility poles, overhead lines and guy wires.

SURVEYING THE UNDERGROUND

TABLE A

11. _____ Location of utilities existing on or serving the surveyed property as determined by:

- observed evidence collected pursuant to Section 5.E.iv.
- evidence from plans requested by the surveyor and obtained from utility companies, or provided by client (with reference as to the sources of information), and
- markings requested by the surveyor pursuant to an 811 utility locate or similar request

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TABLE A, Item 11

Representative examples of such utilities include, but are not limited to:

- Manholes, catch basins, valve vaults and other surface indications of subterranean uses;
- Wires and cables (including their function, if readily identifiable) crossing the surveyed property, and all poles on or within ten feet of the surveyed property. Without expressing a legal opinion as to the ownership or nature of the potential encroachment, the dimensions of all encroaching utility pole crossmembers or overhangs; and
- Utility company installations on the surveyed property.

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TABLE A, Item 11

Note to the client, insurer, and lender - With regard to Table A, item 11, source information from plans and markings will be combined with observed evidence of utilities pursuant to Section 5.E.iv. to develop a view of the underground utilities. However, lacking excavation, the exact location of underground features cannot be accurately, completely, and reliably depicted. In addition, in some jurisdictions, 811 or other similar utility locate requests from surveyors may be ignored or result in an incomplete response, in which case the surveyor shall note on the plat or map how this affected the surveyor's assessment of the location of the utilities. Where additional or more detailed information is required, the client is advised that excavation and/or a private utility locate request may be necessary.

QUESTIONS?

What's next

- Locating Theory and Practice
- QLB and QLA

LOCATING THEORY & PRACTICE

Basic introduction to utility detection theory and methods

- Electromagnetic Pipe and Cable Detection
- Ground Penetrating Radar

Utility Designating – Quality Level B

- making a more accurate, more complete plan view utility map

Utility Locating (Test Holes) – Quality Level A

- when x, y, and z accuracy and precision are critical and to validate mapping

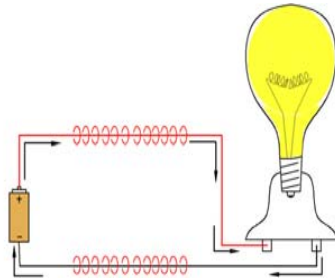
ELECTROMAGNETIC PIPE AND CABLE LOCATING

SOME DEFINITIONS:

Signal: a flow of **alternating electrical current** at a set frequency on conductors such as metallic pipes, wires or cables

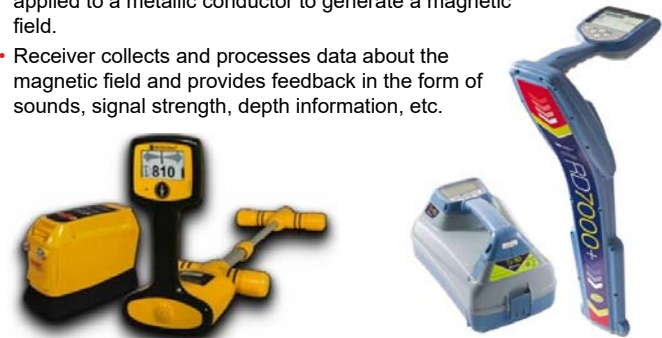
Conductor: a linear object that electrical current can travel through (in our case... a utility pipe, wire or cable)

Magnetic Field: a cylindrical field that forms around a conductor when current is flowing through it



PIPE AND CABLE LOCATING INSTRUMENT SETS

- Typically a two piece transmitter and receiver set
- Transmitter produces tracing signal (current) that can be applied to a metallic conductor to generate a magnetic field.
- Receiver collects and processes data about the magnetic field and provides feedback in the form of sounds, signal strength, depth information, etc.

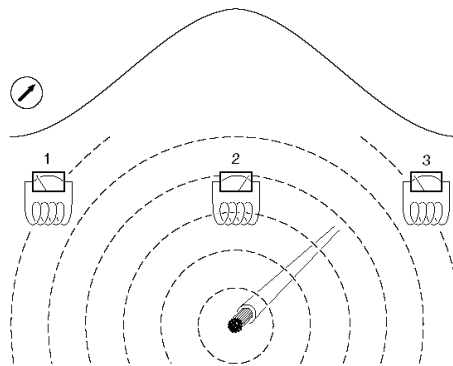


DETECTING MAGNETIC FIELDS



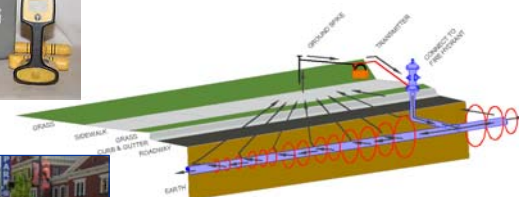
We don't really "locate underground utilities"

What we really do is infer locations based on detected magnetic fields



APPLYING THE SIGNAL

DIRECT CONNECT – ACCESS TO THE CONDUCTOR



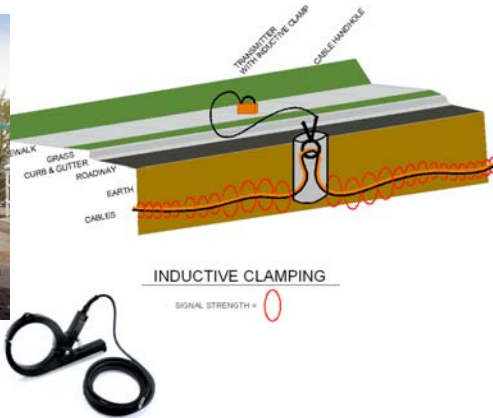
DIRECT CONNECT LOCATING CIRCUIT

CURRENT =

MAGNETIC FIELD SIGNAL STRENGTH = 0

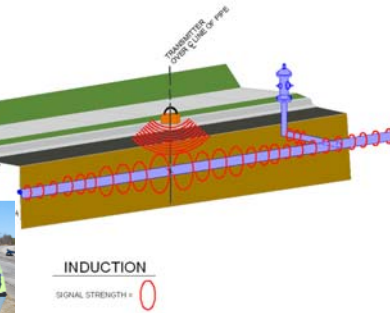
APPLYING THE SIGNAL

INDUCTIVE CLAMPING – ACCESS TO CABLES



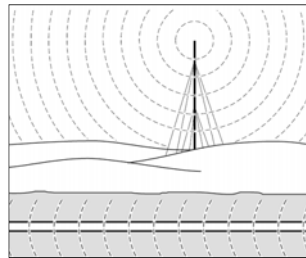
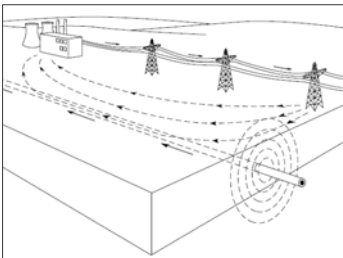
APPLYING THE SIGNAL

SURFACE INDUCTION – “DROP BOX” OR “SWEEP”



PASSIVE SIGNAL DETECTION

POWER AND RADIO SIGNALS CREATE MAGNETIC FIELDS THAT CAN BE DETECTED



ALTERNATING CURRENT AND FREQUENCY

- The frequency measured in Hertz (Hz) is the number of times (cycles) per second that the current begins in one direction, changes to opposite direction and then returns to the original direction. Normal house current in US is...

60 Hz



- There are 10 cycles represented above. If it takes 2 seconds to transmit these 10 cycles the frequency is...

5 Hz

ALTERNATING CURRENT AND FREQUENCY

- Common locating frequencies generated by pipe and cable transmitters range from 512 Hz to 480 kHz
- Low frequency good for long locates on good conductors and don't easily jump on to adjacent conductors. Not good for induction.
- High frequency can overcome resistance in the conductor and are good for induction... good for sweeping.
- Passive receivers can detect the 60 Hz signal on energized electrical lines.
- Some frequencies are better suited to certain utilities and situations.
- A variety of frequencies should be available to locate the wide range of utility types and situations encountered in the field.

COMMON UTILITY PROPERTIES WHAT CAN YOU EXPECT?

Electrical Lines (copper, aluminum)

- Designed to carry a current so by their nature are easier to detect.
- Passive locating in power mode - 60 Hz

Telephone Lines (copper pairs w/ bonding sheath)

- Also designed to carry a current (at a low voltage) so also easy to detect.

Fiber Optic / Other Data Lines

- The individual fiber strands are made of glass (non-conductive) but may have metallic sheath surrounding the strands.
- If no conductor present they can't be detected. May need to rely on buried tracer or snake an adjacent conduit.
- CAT 5, CAT 6 and similar data cables are copper but often not grounded. Difficult to trace.

COMMON UTILITY TYPES...

Gas Lines (steel or wrapped steel, cast, copper plastic)

- Steel lines locate well. Lengths are welded together so current flows freely. However, insulators are sometimes placed in the line to electrically isolate segments and reduce corrosion.
- Copper, not common for gas but easy to locate.
- Cast iron gas can be good or bad. Can also have insulators.
- Plastic gas lines are required to be buried with a trace wire... good if you can find it to direct connect. Trace wires often corrode and / or are not continuous.

Water Lines (ductile/ cast iron, steel, AC,

- If metallic (cast or ductile iron, steel, copper, etc.) can be located but generally buried deeper than other lines. Bell and spigot joints (push on with gasket) can resist current flow. Hard to trace for long distances because current travels to ground.
- If non-conductive (plastic, asbestos cement, etc.) will need trace wire to detect. Acoustic methods might be used but carries some risk.

COMMON UTILITY TYPES...

Gravity Sewers

- Usually rely on surface features and direction / next connecting structure to determine location
- Can be snaked or videoed and then detected (cost and labor intensive)

Other / less common...

- Steam or high temp water is usually welded steel i.e. good to detect.
- Chilled water can be made from same materials as water lines with similar characteristics.
- Irrigation almost always plastic. Can detect control wiring. Often considered expendable and/ or not costly to repair or replace.
- Septic systems – challenging due to lack of access to system components and non-conductive materials

INFLUENCING FACTORS: ELECTROMAGNETIC PIPE AND CABLE LOCATING

Depth of bury

- Shallow - stronger field easily detected
- Deep – weaker field, more difficult to detect

Physical access to utility

- surface induction may be the only option for applying signal

Utility type and material

- The easiest utilities to detect are conductive cables and pipes with minimal resistance to current travel.

Conductor congestion both above and below ground

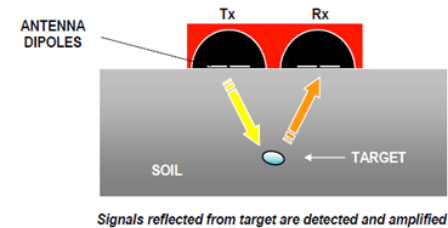
- Interference and signal bleed to adjacent conductors making it difficult to interpret the multitude of magnetic fields present
- Fences, guardrails, building walls and columns and overhead cable can all be sources of interference.

BASIC GPR PRINCIPALS

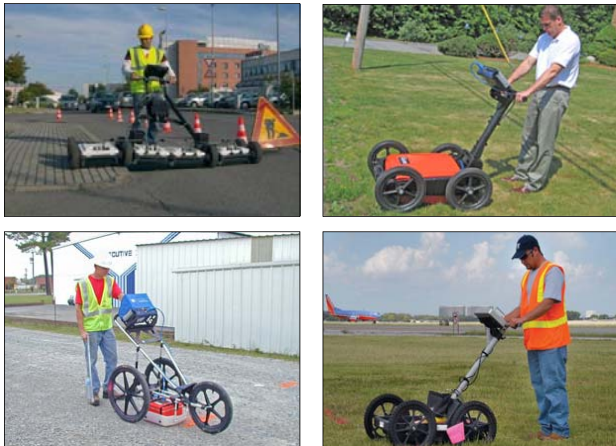
Electromagnetic “pulses” of energy are emitted from transmitting antenna downward through the ground

The pulses reflect back from objects that contrast with the surrounding soils

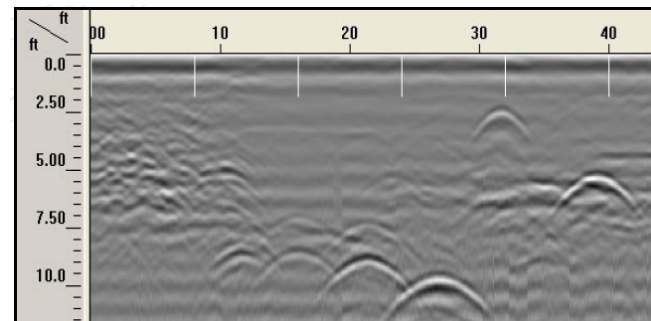
The reflections are detected by the receiving antenna and processed through circuitry and software to produce an “image” of the reflections



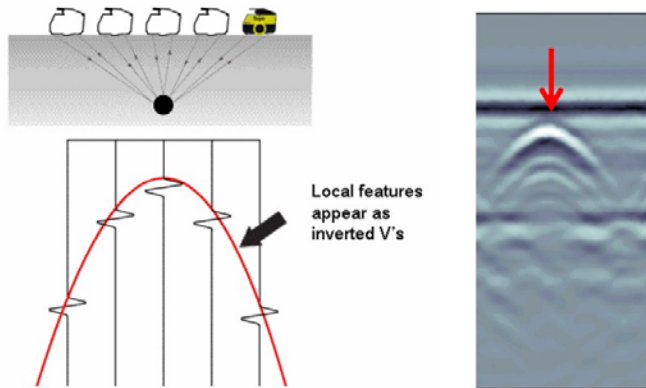
MODERN GPR UNITS



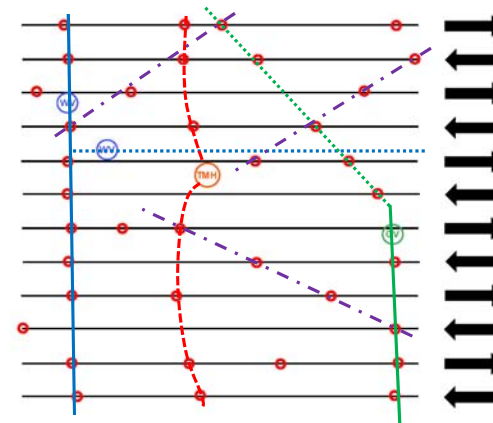
CLASSIC GPR DATA A SINGLE SCAN (CROSS SECTION)



GPR REFLECTIONS HYPERBOLIC SHAPE



GPR SEARCH PATTERN



EM VS GPR COMPARISON

EM Pipe and Cable Locators	Ground Penetrating Radar
Works in variety of soils	Wet or conductive soils will limit or prevent use
Utilities need to be conductive (or snaked with conductor)	Non-conductive utilities can be detected
Small diameter utilities can be detected	Small diameter utilities hard to detect
Instrument detects magnetic field	Instrument detects reflected wave
Best employed on nearly all investigations	Best employed when circumstances dictate
Useful for linear utilities (lines)	Useful for tanks, drums, vaults, voids, etc.
Best bang for buck on most utilities	Expensive to deploy. Used when needed.

DESIGNATING – QL B STANDARDIZED APPROACH

Records Research – Utility Inventory... at least know what's known

Field Investigation

- Geophysical detection tools (utility locating instruments)
- Interpret, verify and/ or correct information from utility records
- Visible field evidence

Field Marking in APWA-ULCC colors

- Red–electric, blue–water, yellow – gas, etc.

Field Sketch, Survey Collect and Reduce to CAD Map

- Utilize survey control established for project

Review in office and / or field

- Reconcile utility records, field sketches and notes with final mapping. Revisit the site to iron out discrepancies
- Determine what utilities should be represented at QL C or D
- Documented Results Represent "Professional Opinion"
 - Most reliable location of utilities short of excavation and eyes on
 - Includes private, public, abandoned and undocumented utilities

UTILITY RECORDS



UTILITY RECORDS

WHY BOTHER? YOU ARE GOING TO LOCATE EVERYTHING ANYWAY RIGHT?

Without records:

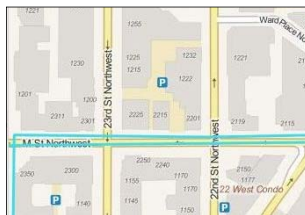
- Some important information may be missing
 - Utility sizes, materials, etc.
- Utilities might be missed if:
 - There are no visible indications that they are present
 - They are non-conductive
 - They are conductive but aren't "discovered"
- There will be knowledge of them if they are missed.
no knowledge = no warning = Potential Disaster

The best way to ensure a utility does not go undocumented is to have a credible record indicating its existence.

RECORD TYPES

FROM VERY GENERAL TO VERY DETAILED

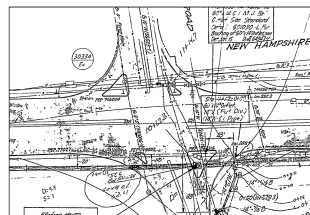
FIBER ROUTE MAP



System Maps / Schematics

- Indication of existence
- Difficult to discern location (somewhere in/ near street?)
- Surface features not shown

WSSC AS-BUILT



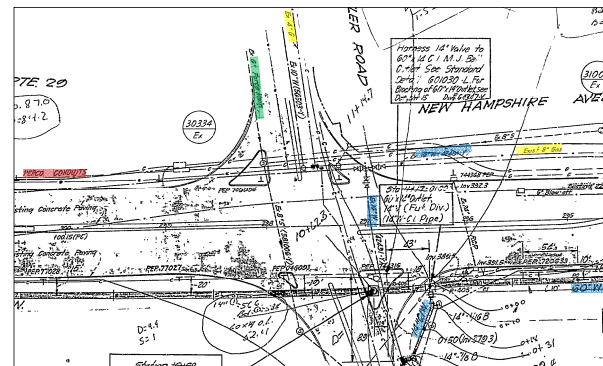
Engineering As-builts

- Good indication of existence
- Good indication of location
- Surface features and sizes
- Other utilities shown

UTILITY RECORDS

SECONDARY UTILITY INFORMATION

1963 WSSC AS-BUILT



DESIGNATING EQUIPMENT

A VARIETY TO COVER A WIDE RANGE OF UTILITY LOCATING SCENARIOS

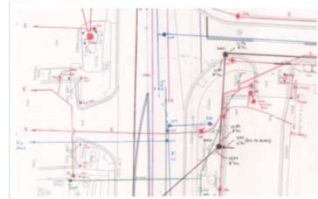


UTILITY DESIGNATION

MARKINGS CAREFULLY PLACED



FIELD SKETCHING, SURVEY & CAD PROCESSING



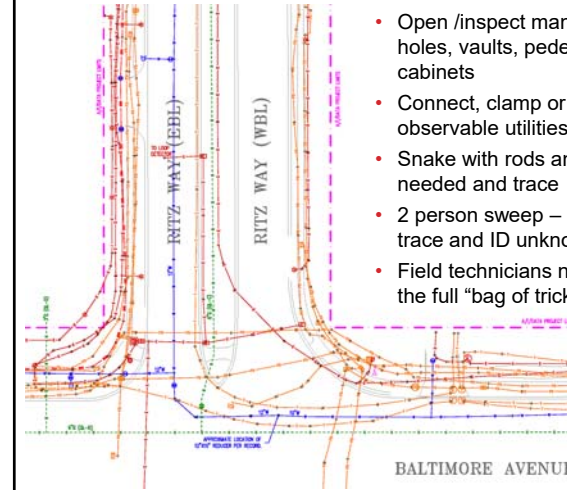
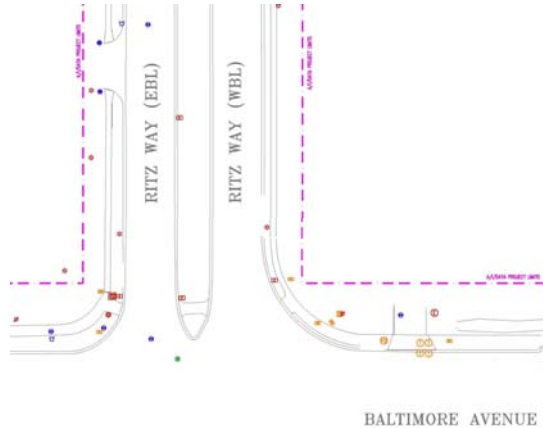
FIELD/ OFFICE COLLABORATION

- Debrief field crew for unique site issues and problems
 - Reduce QL C and D
 - Troubleshoot difficult detection scenarios
- Compare field sketch to mapped results
- Compare records to mapped results
- Extract information from records... pipe sizes etc.
- Assign QL to utility depictions (QL-B is the goal with QL-C or D as needed)
- Provide mapping in AutoCAD or MicroStation



SURFACE FEATURES...

DON'T TELL THE WHOLE STORY!



- Open /inspect manholes, hand-holes, vaults, pedestals, cabinets
- Connect, clamp or induce on all observable utilities and trace
- Snake with rods and sondes as needed and trace
- 2 person sweep – seek out & trace and ID unknowns
- Field technicians needed to use the full “bag of tricks”

SUMMARY

QUALITY LEVEL “B”

A Standardized Procedure

Records Research

Field Investigation

- Direct Connect
- Clamp
- Induce (Sweep)

Field Marking

Field Sketch

Data Collection (Total Station, RTK GPS)

Map & Correlate With Records

Review & Edit

Deliver In AutoCAD Or MicroStation

LOCATING – QL “A”

AIR/ VACUUM TEST HOLES

THE BASIC STEPS

- Perform test hole setup at the site.
 - Test hole plan based on QL B info?
 - QL C or QL D info?
- Notify the One Call - 811 utility notification center.
- Plan traffic control.
- Apply for an excavation permit.
- Coordinate with utility inspectors.
- Schedule the rig, test hole crew and survey crew.
- Compile results and report to client / engineer

VACUUM EXCAVATION

TRUCK MOUNTED UNIT



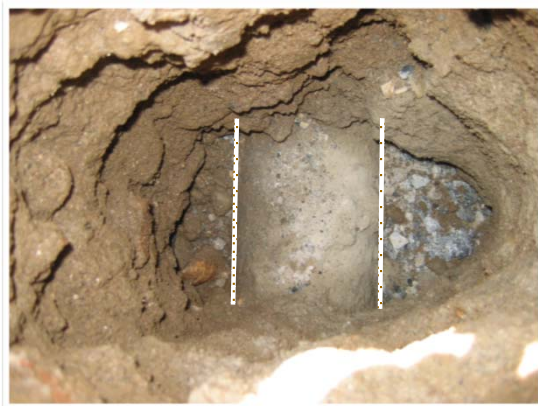
VACUUM EXCAVATION

PORTABLE UNIT



DOWN-HOLE VIEW

UTILITY EXPOSED



TEST HOLE OPERATIONS

SET MARKER,
MEASURE AND
DOCUMENT



BACKFILL,
COMPACT AND
RESTORE



HORIZONTAL AND
VERTICAL
POSITION

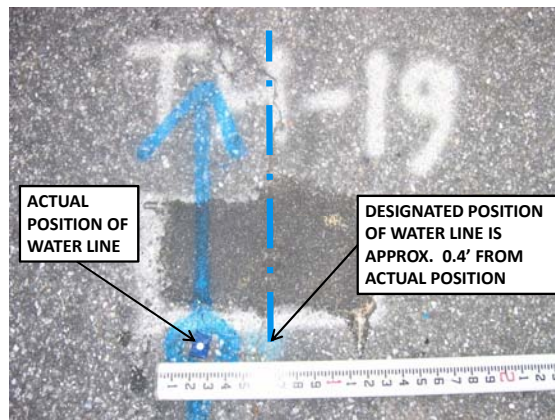


AIR/ VACUUM EXCAVATION COMPARED TO MECHANICAL/ BACKHOE ETC.

- Less impact to utilities
 - Safer than hand digging with bar and shovel
 - Much safer than mechanical digging
- Less impact to property and public
 - Small hole – “test hole” not “test pit”
 - Small work footprint
 - Neat work area (soils contained)
 - Short duration occupancy (1 to 2 hours/ hole)
- Low cost (particularly in paved roadways)
- Effective for majority of utility measurement needs

TEST HOLE DATA SHEET

DETECTION ACCURACY 0.4' +/- OFFSET FROM DESIGNATED POSITION



SUMMARY – QL “A”

Engineering / Survey Grade Data

Most Reliable Determination Of Utility Data however...

- Point Specific Results
- May not accurately predict utility characteristics beyond test hole location. QL B may still be needed.

Minimizes Risk Of Damage To Exposed Utilities

May Be Used For A Variety Of Structure Types

Most often used when precision is needed for conflict identification and resolution

SUE LEGEND & NOTES

UTILITY LEGEND		UTILITY DESIGNATING NOTES	
100	DATA WIRE	100	STORM SEWER
101	DATA FIBER	101	STORM SEWER
102	DATA FIBER	102	STORM SEWER
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199	DATA FIBER	199	STORM SEWER
200	DATA FIBER	200	STORM SEWER

SUE IMPLEMENTATION

Possible Engineer's Note

- Subsurface utilities are depicted by their Quality Levels in accordance with ASCE 38-02 based on professional designating services provided by A/I/DATA on August 5, 2015. Contractors shall validate subsurface utility data to their own satisfaction.
- "designating and locating..." if test holes performed as part of services provided.

Show 38-02 Quality Level definitions in drawing legend.

Use 38-02 labeling conventions in plan view.

- These steps help distinguish "paint on the ground" from professional services rendered
- Design excellence is built on quality base data

EFFECTIVE USE OF SUE

"DON'T JUST RUN OUT THERE
AND DIG A BUNCH OF TEST HOLES"

Why not??? After all... it's the best Quality Level, right?

- Actual locations of utilities in the field may be quite different from what is represented on plans from records.
 - Poor test hole bids/ pricing
 - Additional costs from unknown factors (MOT, etc.)
 - Test holes may be performed where they are not needed
- There may be a lot more utilities out there that you don't know about.
 - These may not be discovered during a pure test hole effort
 - More complete design with better knowledge of underground conditions

Any project with more than sparse utility congestion stands to benefit greatly from a progressive SUE approach. QL B then QL A

COST VS. RISK HOW MUCH SUE IS ENOUGH?



Project progression... Conceptual to Bid Docs

QL D..... C..... B..... A...

QUESTIONS?

FHWA -

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

ASCE - <http://www.asce.org/codes-standards/list/>

COMMON GROUND ALLIANCE

<http://www.commongroundalliance.com/>

UNDERGROUND CONSTRUCTION

<http://www.undergroundconstructionmagazine.com/>

UNDERGROUND FOCUS

<http://www.underspace.com/>

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THE END?

