Subsurface Utility Engineering
for Highway & Road Design

Jimmy Stewart, PE
InfraMap

ASHE Old Dominion

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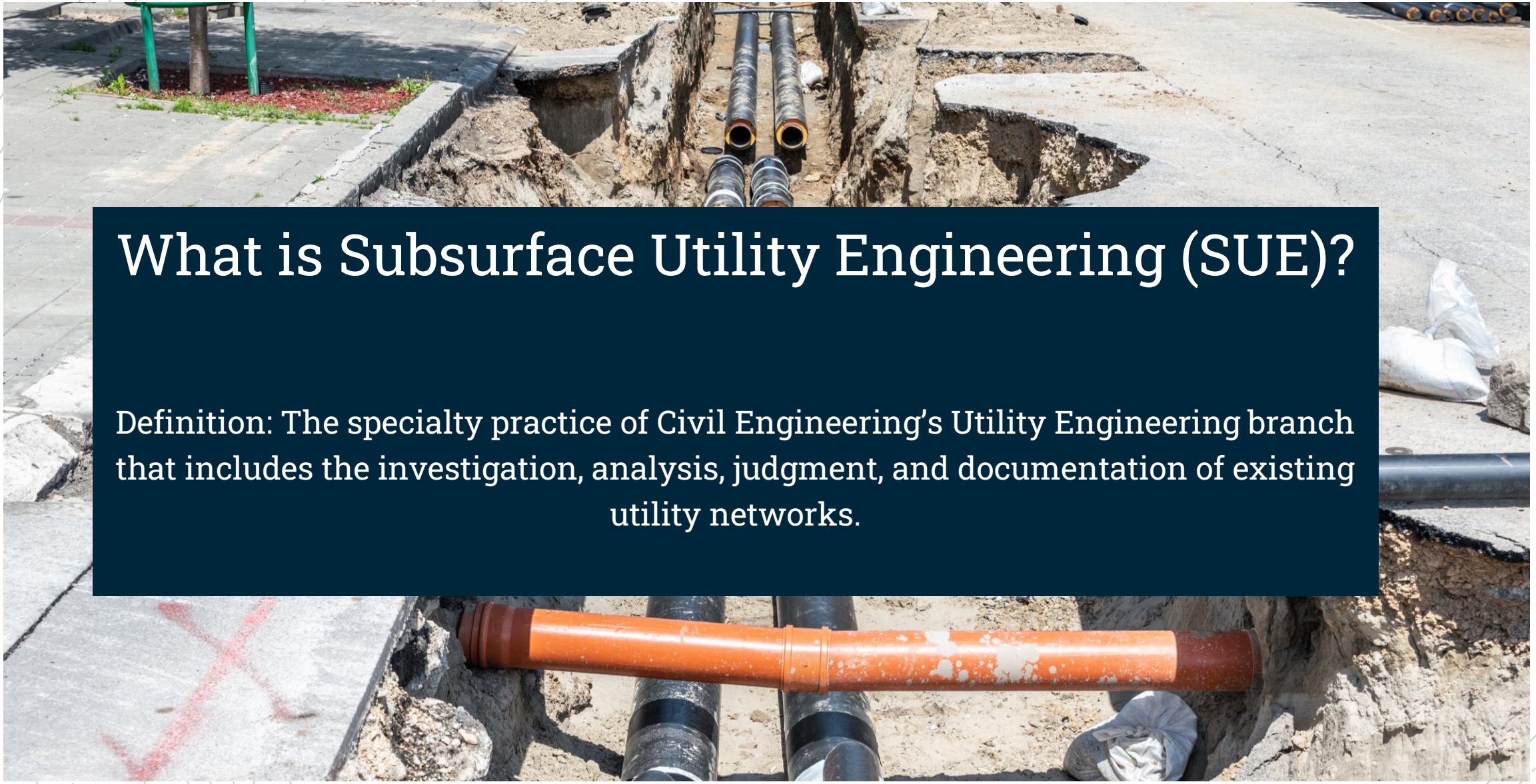

What is Subsurface Utility Engineering (SUE)?

Definition: The specialty practice of Civil Engineering's Utility Engineering branch that includes the investigation, analysis, judgment, and documentation of existing utility networks.

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Why Utilize SUE?

Utility related issues during construction have historically been the cause of billions of dollars in cost overruns, claims, redesign costs, and significant project schedule delays.

Complete, accurate, and comprehensive utility investigations early in project development enable effective risk management decisions by designers and constructors.

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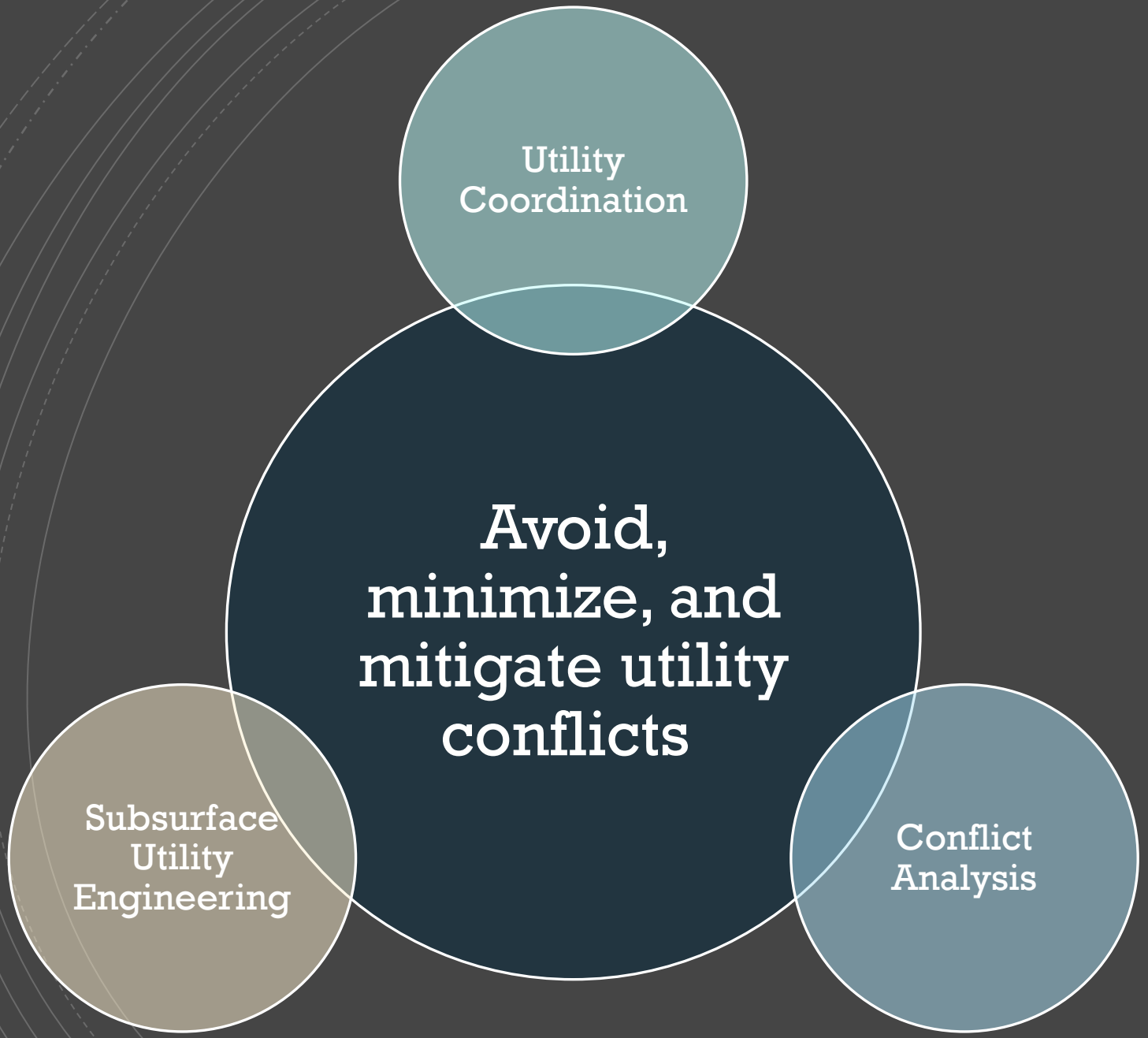
Utility Coordination
Avoid, minimize, and mitigate utility conflicts
Subsurface Utility Engineering
Conflict Analysis

Engineers and Surveyors recognize the inaccuracies or unreliability of records, and add notes on construction documents or specifications for contractors, example:

- *"Information as to the location of existing utilities has been collected from various sources, the result of such investigations are shown on the contract drawings and are not guaranteed as to accuracy.*

- *"The engineer/surveyor makes no guarantees that the utilities shown comprise all such utilities in the area."*

- *"The engineer/surveyor does not warrant that the underground utilities shown are in the exact location noted."*

- *"All utilities on the project must be field verified by the Contractor prior to start of any construction."*

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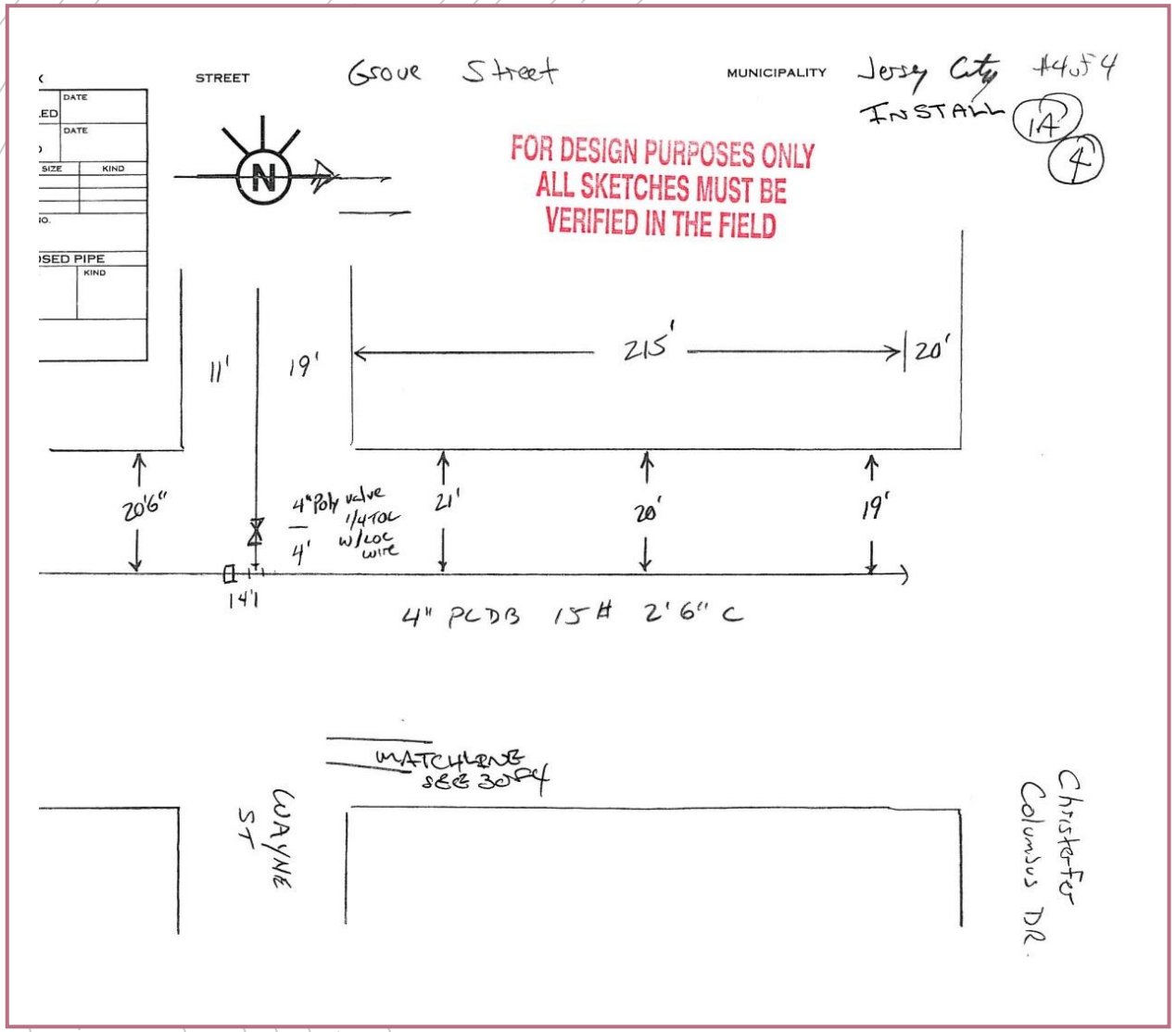

WHY NOT JUST GET RECORDS FROM THE UTILITY COMPANY?

- **Utility records can be inaccurate, incomplete, and unreliable**

WHY NOT MAKE ONE CALLS, LET THEM MARK IT OUT, AND SURVEY MARKS?

- **Lack of liability and accuracy**
- **One Call is there to protect the excavator, not for design**

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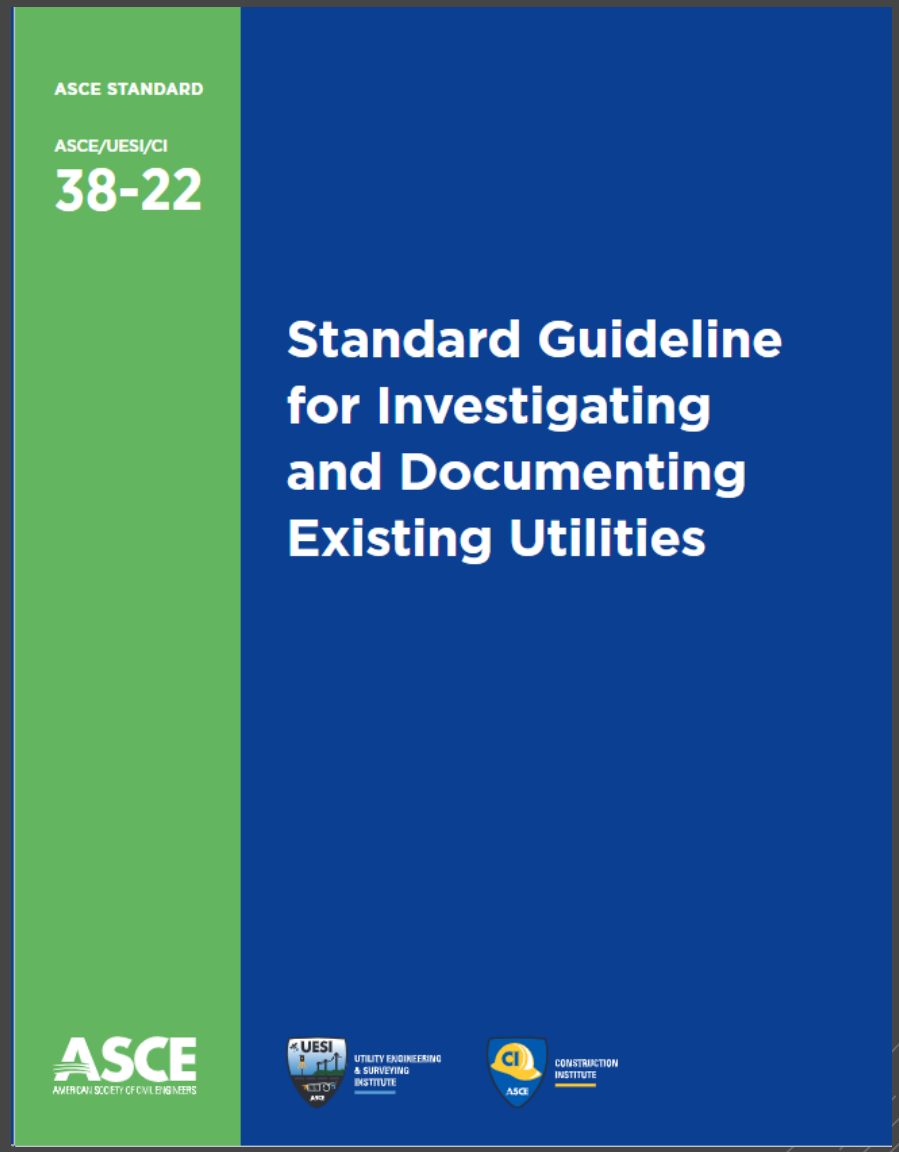
PROBLEM: AN ABSENCE OF A UNIFORMLY ACCEPTED STANDARD RESULTS IN DIVERSITY OF FORMATS.

- Deficient utility records
  - (insufficient and non-standardized format, attribution, size, and spatial referencing)
- Ambiguities in position, spatial dimensions, and the nature of utility infrastructure
- Increase risk and costs for civil projects, private developments, and utility infrastructure installations.

SOLUTION: ASCE/UESI STANDARD 38

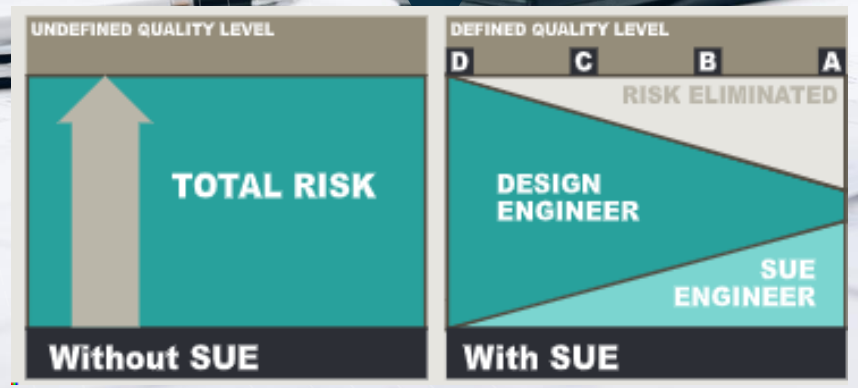


Applying SUE to your projects in adherence with ASCE 38:

Quality Level D (least precise) through Quality Level A (most precise)

SCOPING

Process for Investigating and Documenting Existing Utilities



Designer and SUE professional should meet to jointly understand the proposed design, project limits, and develop a project-specific SUE scope of services:

- On some small projects where information about subsurface utilities is believed to be generally accurate and comprehensive, this will only involve making a conscious decision to proceed with the project using readily available information.
- On larger, more complex projects, the project owner may elect to employ a SUE provider to obtain expert advice and to use available technologies to provide better information.

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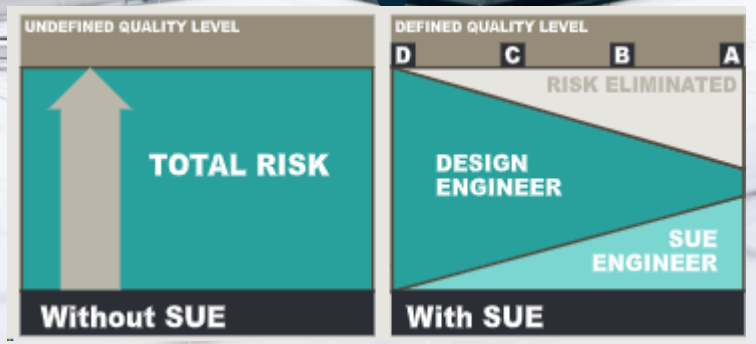
SCOPING

Process for Investigating and Documenting Existing Utilities



Information to provide to help prepare scope of SUE services:

- Project limits
- Any conceptual design plans and files that may have been prepared
  - (topo, design, alignment, etc.)
- Coordinate system and survey tie-in information
- Any utility information already obtained
  - Ownership info.
  - Utility Records / as-builts / GIS data

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Quality Level D:
RECORDS RESEARCH

- Most basic level of utility information, typically obtained from utility records
- Often-times unreliable
- Information obtained may include:
  - Utility Agency Owner / Utility Company
  - Type (W, G, T, E, San, etc.)
  - Size
  - Material
  - Type of Record Received (electronic, plans, aerials, plates)
  - "Identified by (e.g. 811, record, etc.)"

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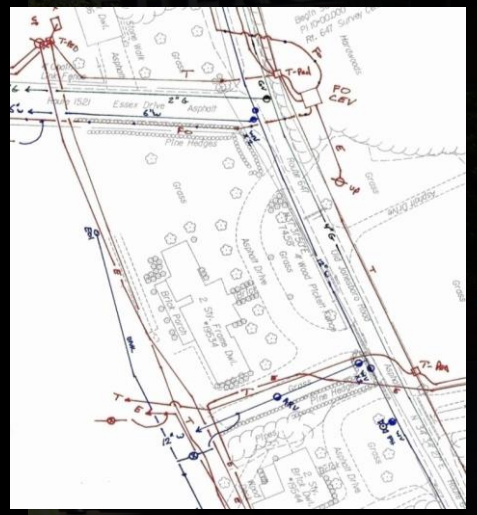
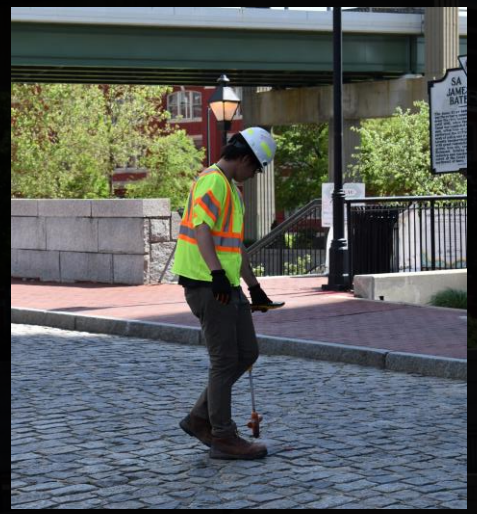
Process for Investigating and Documenting Existing Utilities

Quality Level C: Records & Surface Features

UTILIZING ABOVE-GROUND UTILITY FEATURES WITH RECORDS

- Survey of the above ground utility infrastructure such as manholes, valve boxes, posts, and other related features and correlating this data with the QLD information.
- May be useful on rural projects where utilities are not prevalent or not too expensive to repair or relocate.





Preliminary Design

Process for Investigating and Documenting Existing Utilities

Quality Level B: “Designating”

Determine existence and approximate horizontal location of utilities

Quality Level B: Designating

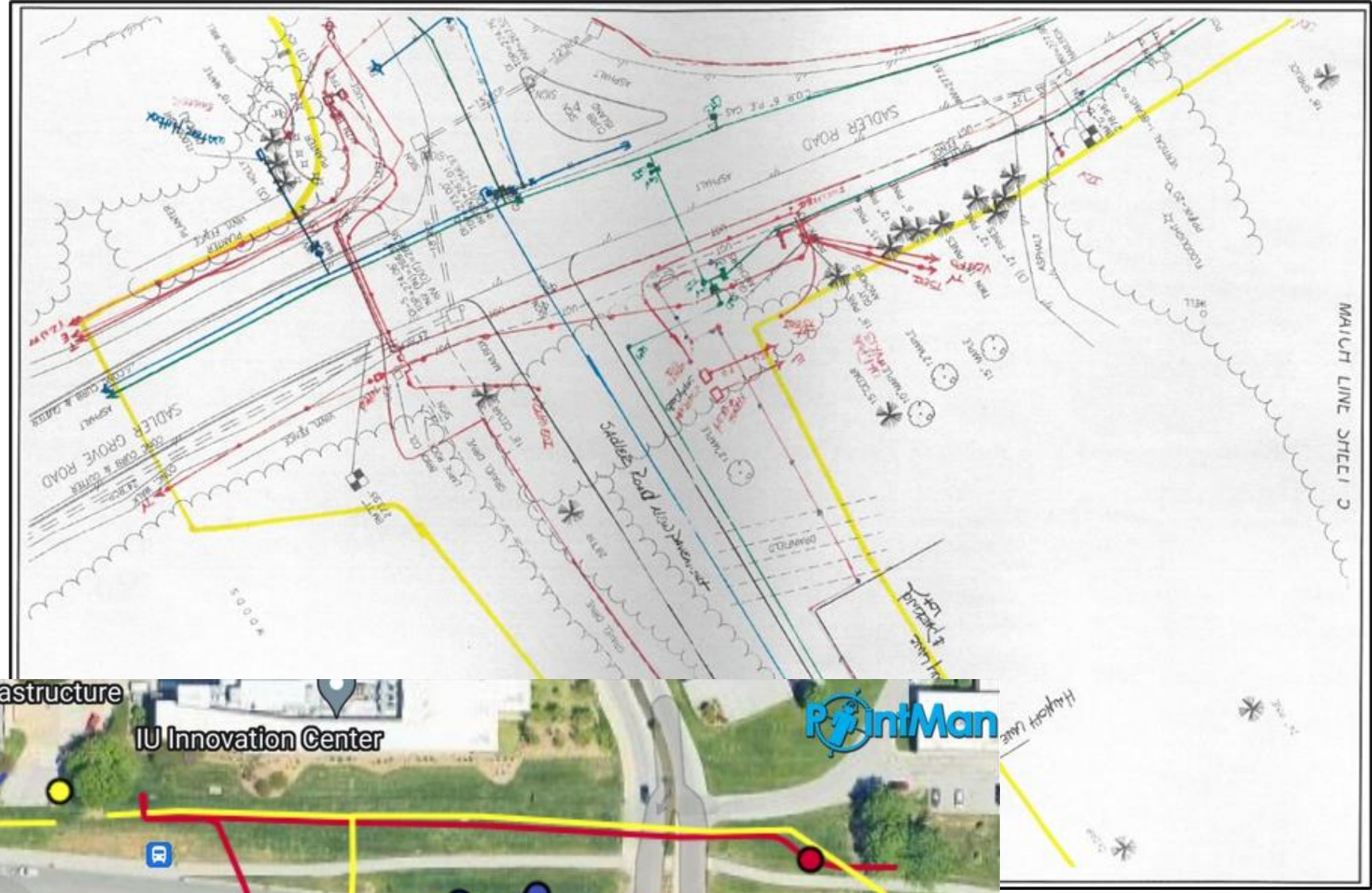
EXISTENCE AND APPROXIMATE HORIZONTAL LOCATION OF UTILITIES

FIELD WORK

1. Conduct electronic sweep for presence of both known and undocumented utilities
2. Target (paint) horizontal locations using electromagnetic locating and other geophysical tools
3. Generate Field Sketches
4. Survey (x, y of utility & z of ground elevation)

NOTE: Some electromagnetic equipment provide depth readings, but the horizontal locations (x ,y) of the utilities are the only data provided that is professionally certifiable at this stage.

FIELD SKETCH: Paper and/or Digital



UTILITY LOCATING EQUIPMENT AND TECHNOLOGY

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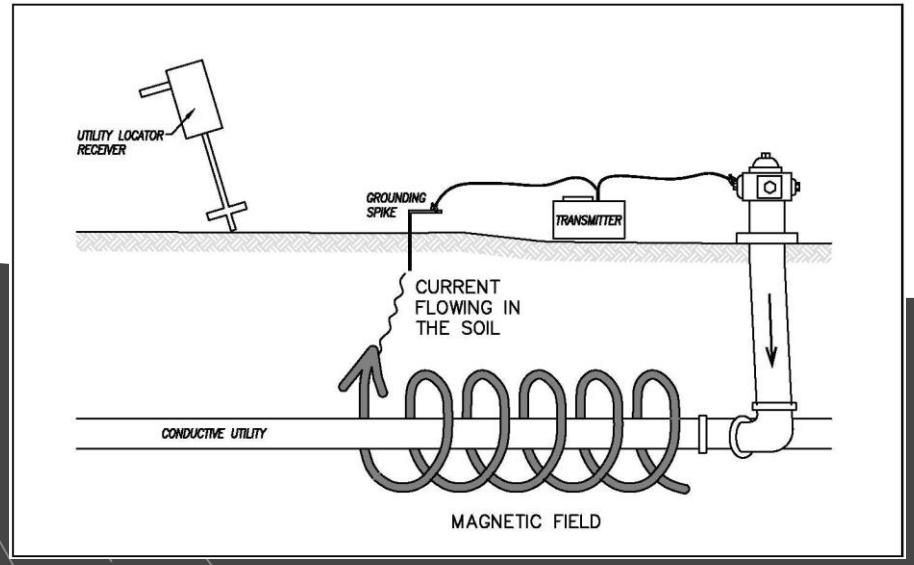


UTILITY LOCATING EQUIPMENT AND TECHNOLOGY

EM – Electromagnetic - Conductive and Inductive

UTILITY LOCATING EQUIPMENT AND TECHNOLOGY

Acoustic Pipe Locator

UTILITY LOCATING EQUIPMENT AND TECHNOLOGY

Ground Penetrating Radar

Ground-penetrating radar (GPR) is a geophysical method that uses radar pulses to image the subsurface.

This nondestructive method uses electromagnetic radiation in the microwave band (UHF/VHF) frequencies of the radio spectrum and detects the reflected signals from subsurface structures.

UTILITY LOCATING EQUIPMENT AND TECHNOLOGY

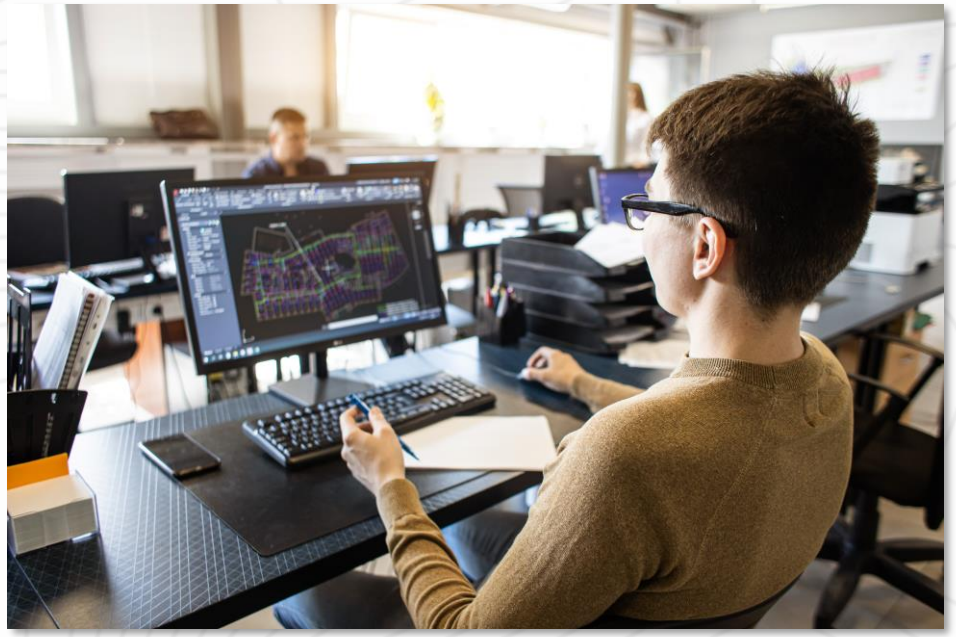
Metallic Snakes and Sondes

Insert a conductive metallic snake or sonde through a non-conductive pipe.

infra**map**

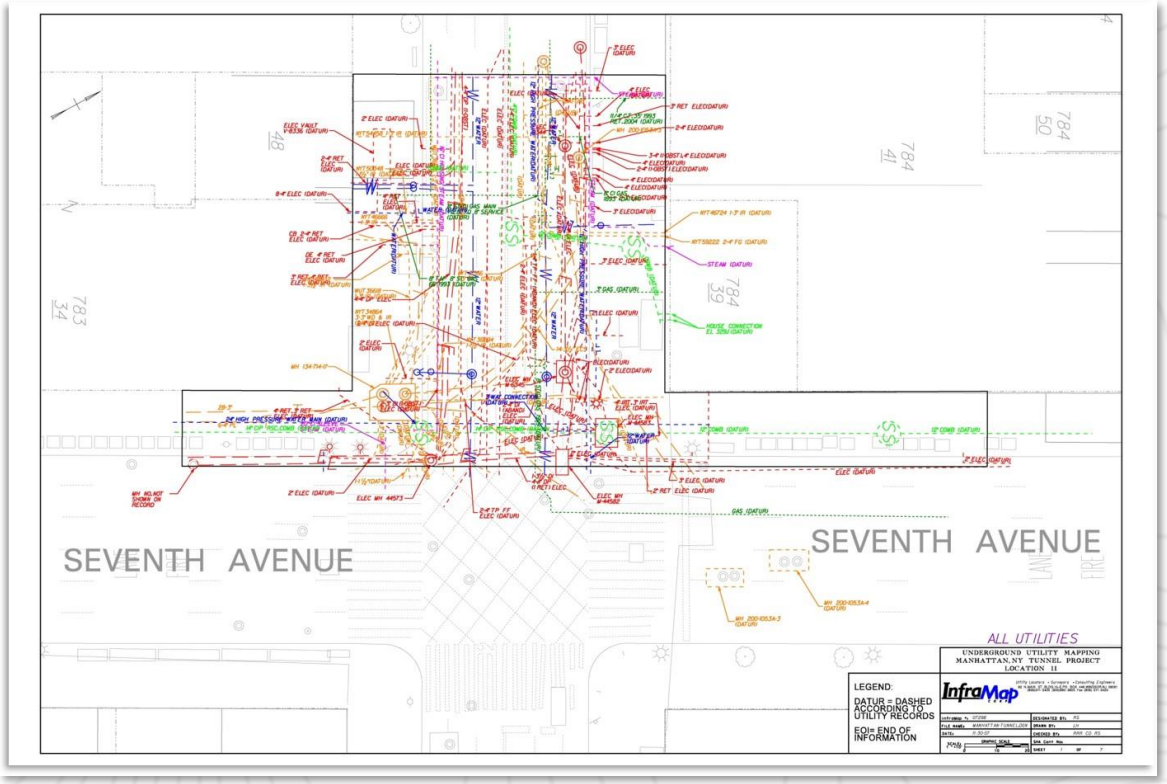
Quality Level B: Designating

EXISTENCE AND APPROXIMATE
HORIZONTAL LOCATION OF UTILITIES



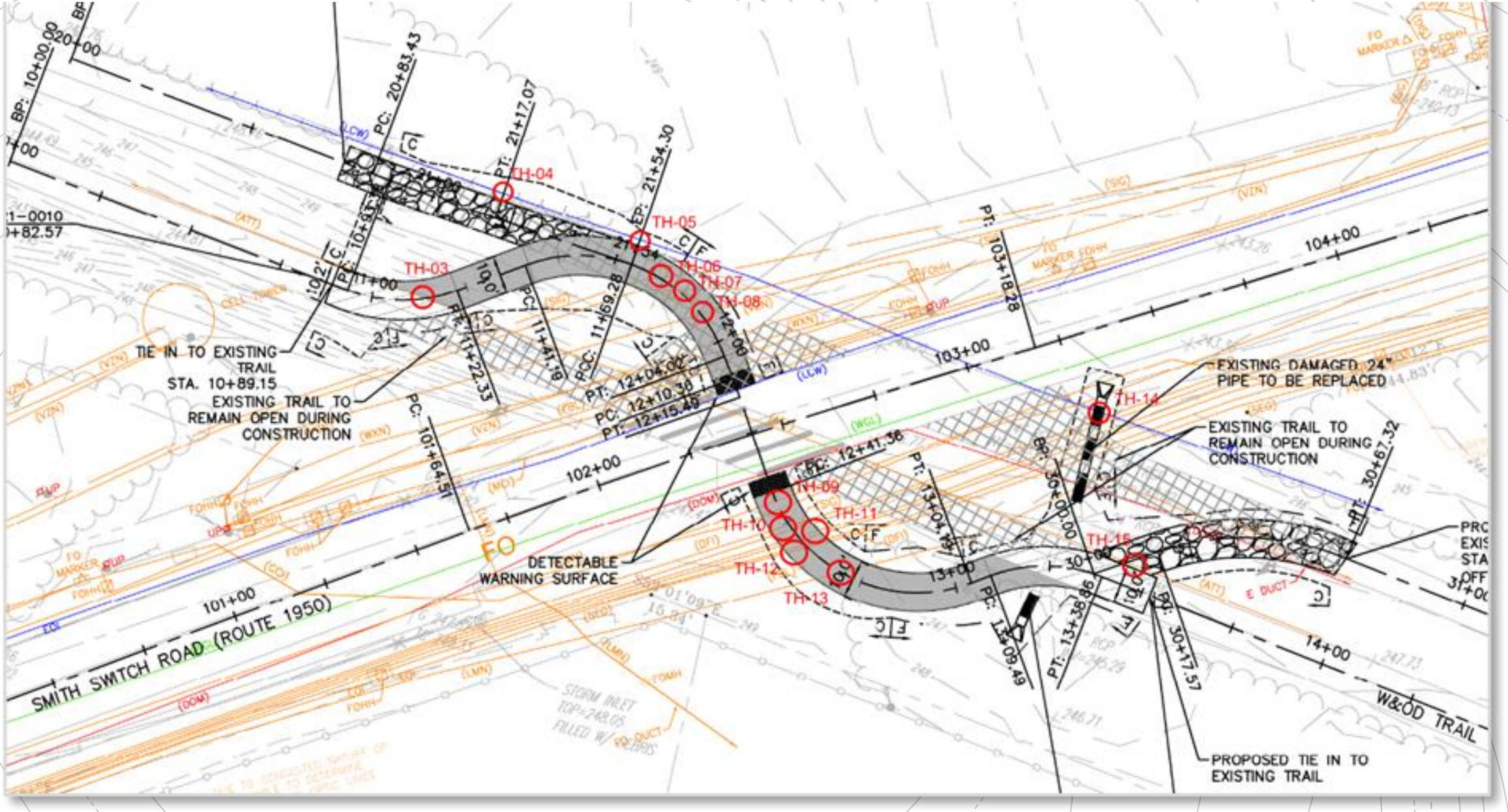
CADD PROCESSING

1. Process survey data in requested format (.dgn, .dwg, .ORD, etc.) into Existing Utility File
2. Convert Quality Level C and D linework into Quality Level B where horizontal location was able to be confirmed in the field
3. Maintain QLD where necessary



NEXT STEPS

1. Deliver existing utility file to designer
2. Perform utility conflict analysis and finalize QLA test hole locations



Utility Conflict Analysis / Test Hole Selection

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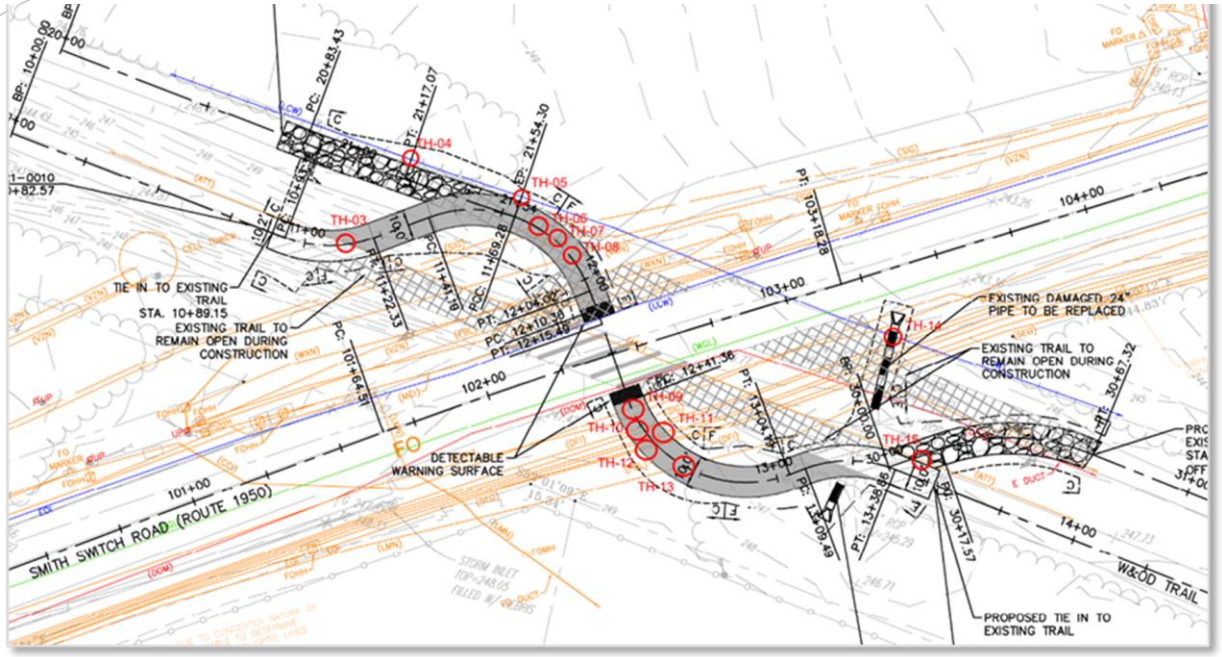
QUALITY LEVEL A – utility is directly exposed and measured to collect northing, easting, and elevation of utility at conflict location.

QLA TEST HOLES

DESIGNER CONSIDERATIONS FOR TEST HOLE SELECTION



- Typical test hole size is 24” x 24”
- When obtaining information on a duct bank (Top, bottom, sides), it is likely that multiple holes will be required at that one conflict point.
- When two or more utilities appear to be designated in close proximity to one another, it is rare that sufficient test hole information on multiple utilities is obtainable in one test hole.
  - IE, Assume 1 TH per utility conflict.
- Budget considerations: Test holes requiring temporary traffic control/ maintenance of traffic (MOT) may have significant cost implications
- Holes on QLD lines may require multiple attempts, trenching, and can ultimately be unsuccessful if horizontal location is never confirmed

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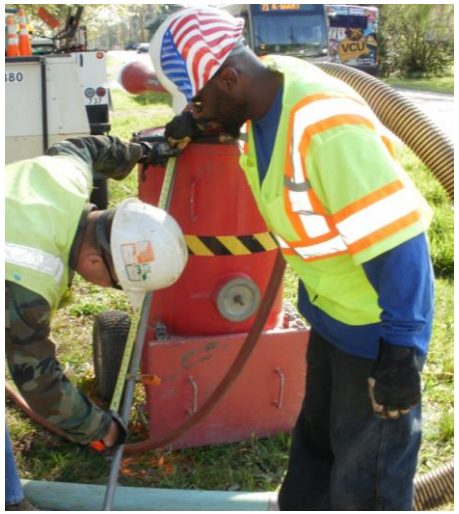
AIR VACUUM EXCAVATION PROCESS



- Excavate at conflict location
- Record exposed utility type, size, depth, configuration.
- Install survey marker (PK nail) at crown of utility.
- Survey to record x, y, z.
- Update existing utility file as necessary based on test hole results

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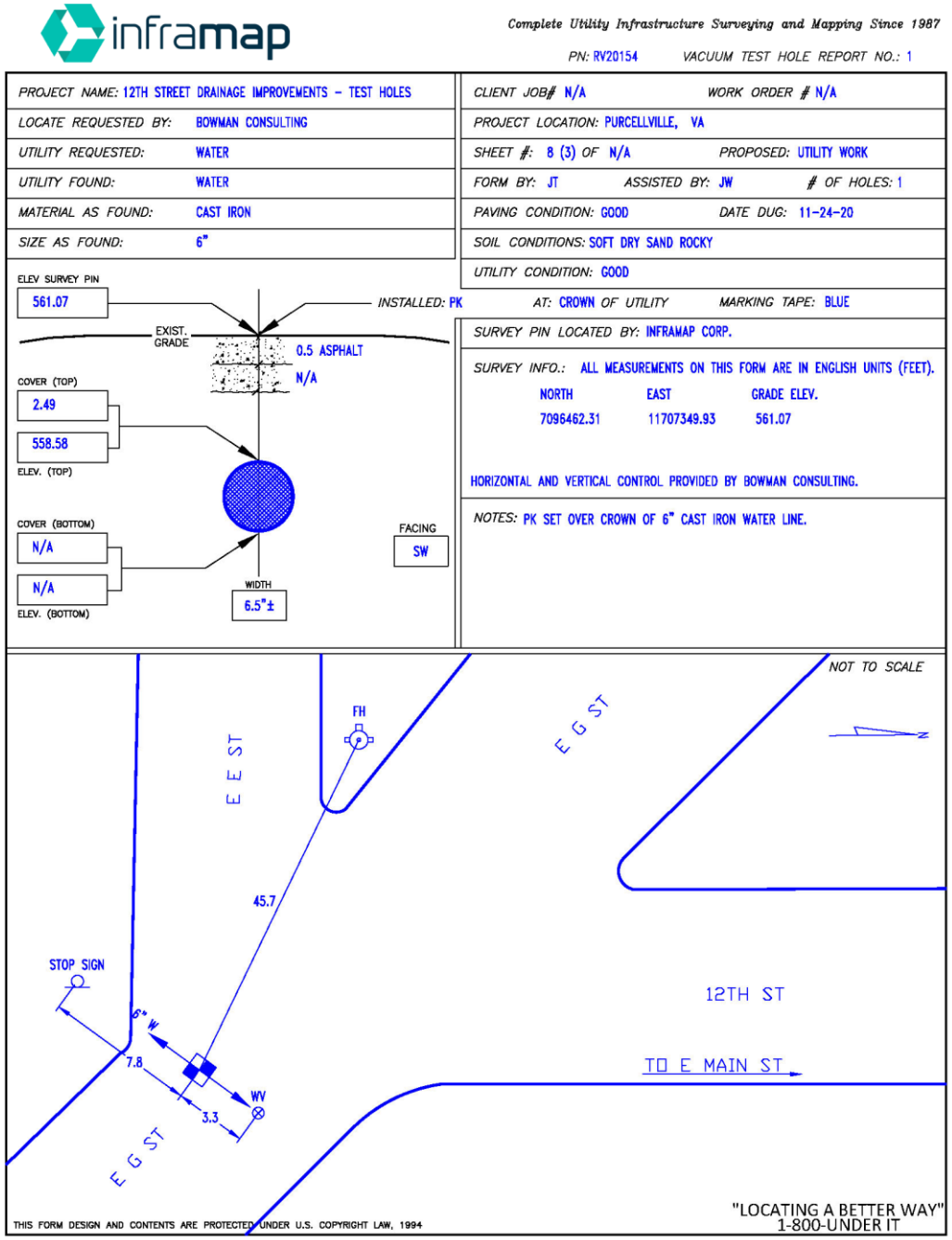
Test Hole Report:

- Utility type, size, material and condition
- Soil conditions and ground water information
- Pavement and sub-grade thickness reported
- Northings, eastings, elevations of utility at test hole location
- Photos of test holes as requested



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Complete Utility Infrastructure Surveying and Mapping Since 1987

PN: RV20154 VACUUM TEST HOLE REPORT NO.: 1

PROJECT NAME: 12TH STREET DRAINAGE IMPROVEMENTS – TEST HOLES	CLIENT JOB# N/A WORK ORDER # N/A
LOCATE REQUESTED BY: BOWMAN CONSULTING	PROJECT LOCATION: PURCELLVILLE, VA
UTILITY REQUESTED: WATER	SHEET #: 8 (3) OF N/A PROPOSED: UTILITY WORK
UTILITY FOUND: WATER	FORM BY: JT ASSISTED BY: JW # OF HOLES: 1
MATERIAL AS FOUND: CAST IRON	PAVING CONDITION: GOOD DATE DUG: 11-24-20
SIZE AS FOUND: 6"	SOIL CONDITIONS: SOFT DRY SAND ROCKY
	UTILITY CONDITION: GOOD
	INSTALLED: PK AT: CROWN OF UTILITY MARKING TAPE: BLUE
	SURVEY PIN LOCATED BY: INFRAMAP CORP.

ELEV SURVEY PIN 561.07 — EXIST. GRADE — 0.5 ASPHALT — N/A

COVER (TOP) 2.49 — ELEV. (TOP) 558.58

COVER (BOTTOM) N/A — ELEV. (BOTTOM) N/A

WIDTH 6.5"±

FACING SW

SURVEY INFO.: ALL MEASUREMENTS ON THIS FORM ARE IN ENGLISH UNITS (FEET).

NORTH	EAST	GRADE ELEV.
7096462.31	11707349.93	561.07

HORIZONTAL AND VERTICAL CONTROL PROVIDED BY BOWMAN CONSULTING.

NOTES: PK SET OVER CROWN OF 6" CAST IRON WATER LINE.

"LOCATING A BETTER WAY"
1-800-UNDER IT

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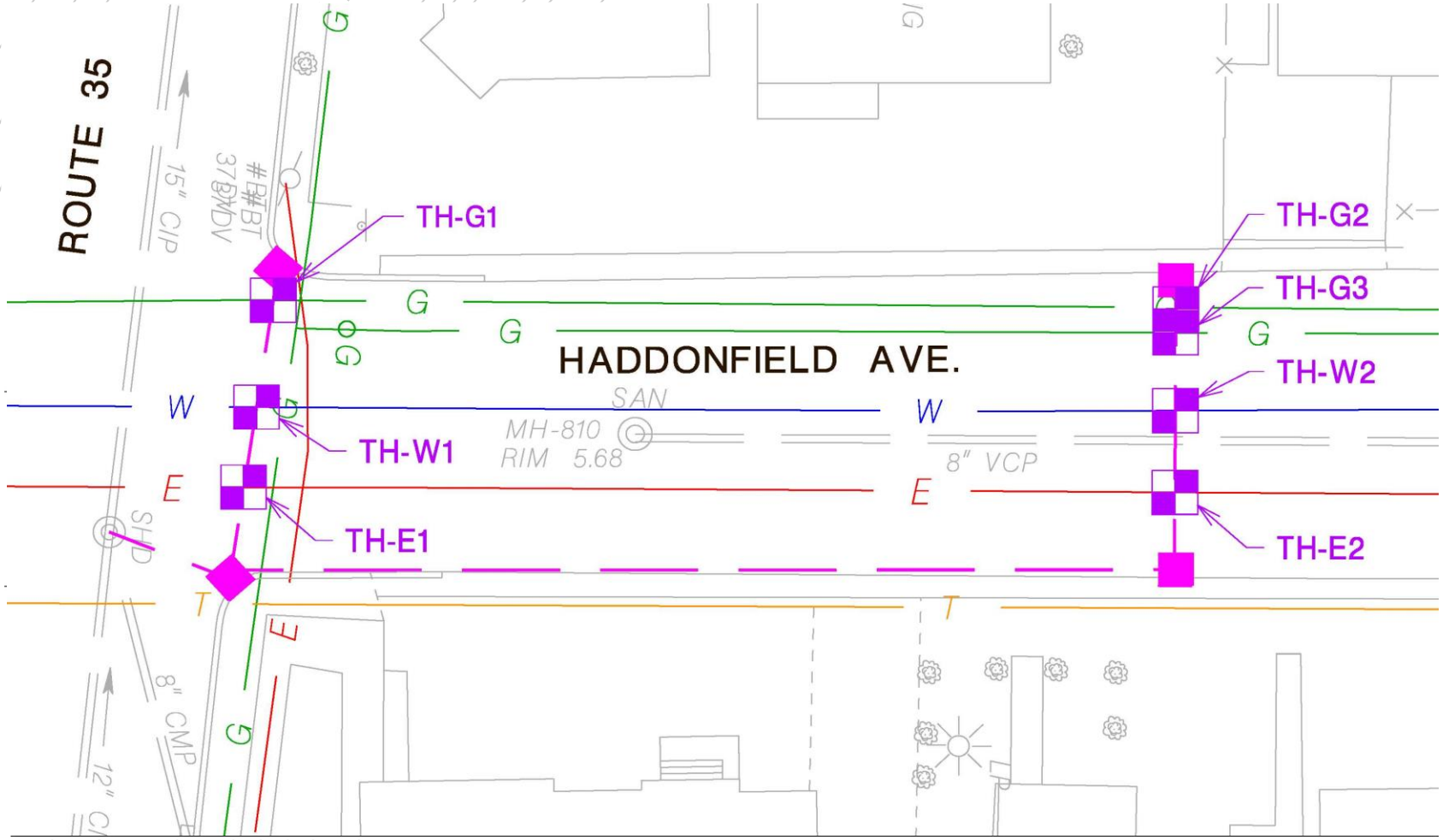
Project Example – Proposed Drainage Improvement



What's next for SUE and Design?

3D Deliverables for Existing Utilities & Clash Detection

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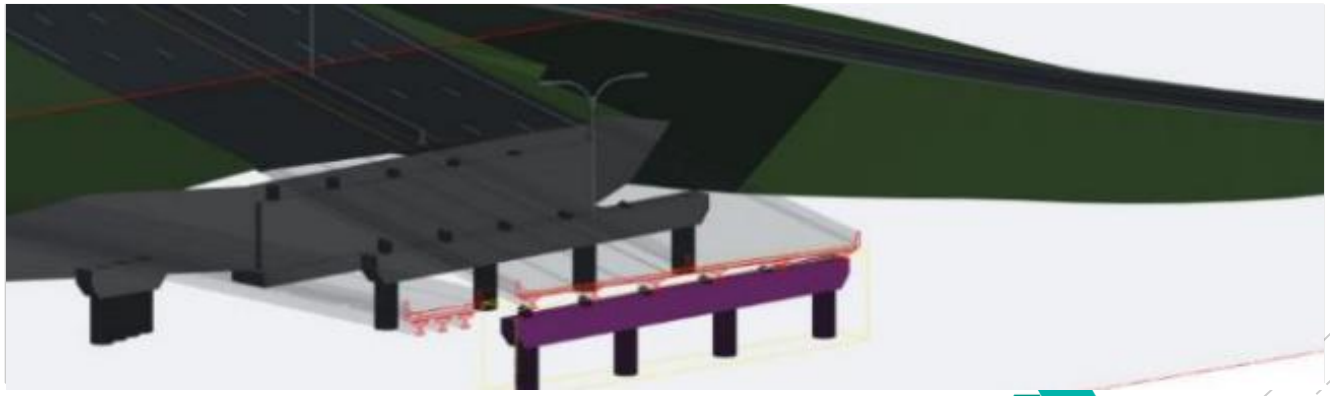
3D Existing Utility Deliverables

Modified QLB Data Collection and Designating Deliverables

- Proposed Design is already being completed in 3D, but existing utility networks are still being delivered at the 2D level
  - Only elevations provided are at locations where test holes are performed, making it difficult to generate a 3D model
  - Depths can be obtained and recorded during QLB designating phase but elevations aren't certified except for QLA locations
- Some state DOTs are moving forward with establishing guidelines for preparing these deliverables, with language to protect the engineers from liability, as roadway and drainage design is already being completed in 3-dimensions.
- The goal is to give the designers more information, with varying levels of confidence, to aid in their design and identify utility conflicts at earlier stages in project development.



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Thank you!

Jimmy Stewart, PE

jstewart@inframap.net

C: 804.387.5510

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