WOOLPERT

DESIGN | GEOSPATIAL | INFRASTRUCTURE

INTEGRATING TECHNOLOGIES FOR 3D UTILITY LOCATING AND MAPPING

Presenter: Michael A. Twohig, Woolpert

Lessons Learned:

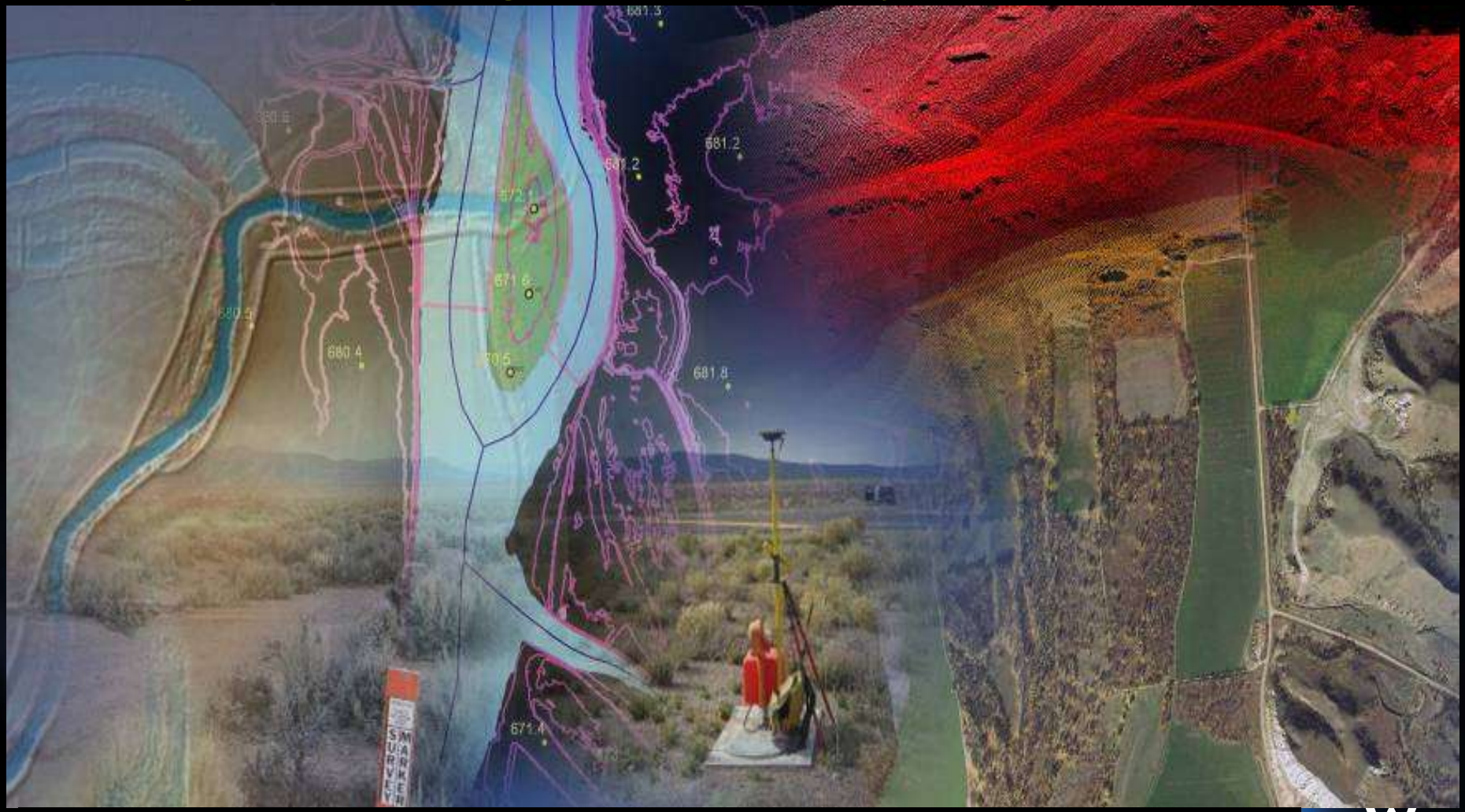
The Key to Damage Prevention

1. Good decision making

2. Communication

3. Appropriate application of utility locating technologies

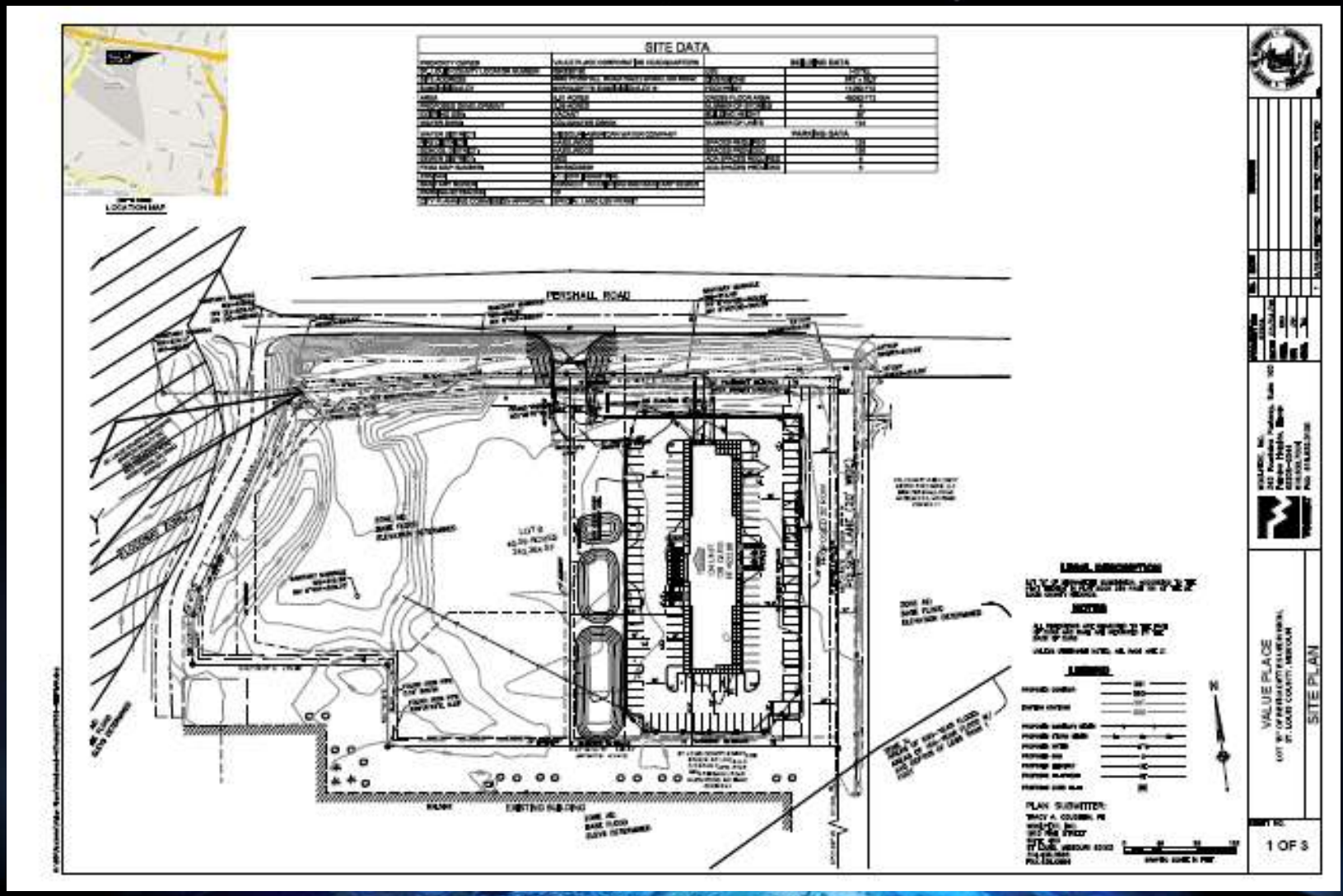
The SUE process will remain the same for the foreseeable future but new technologies have emerged to change the industry.



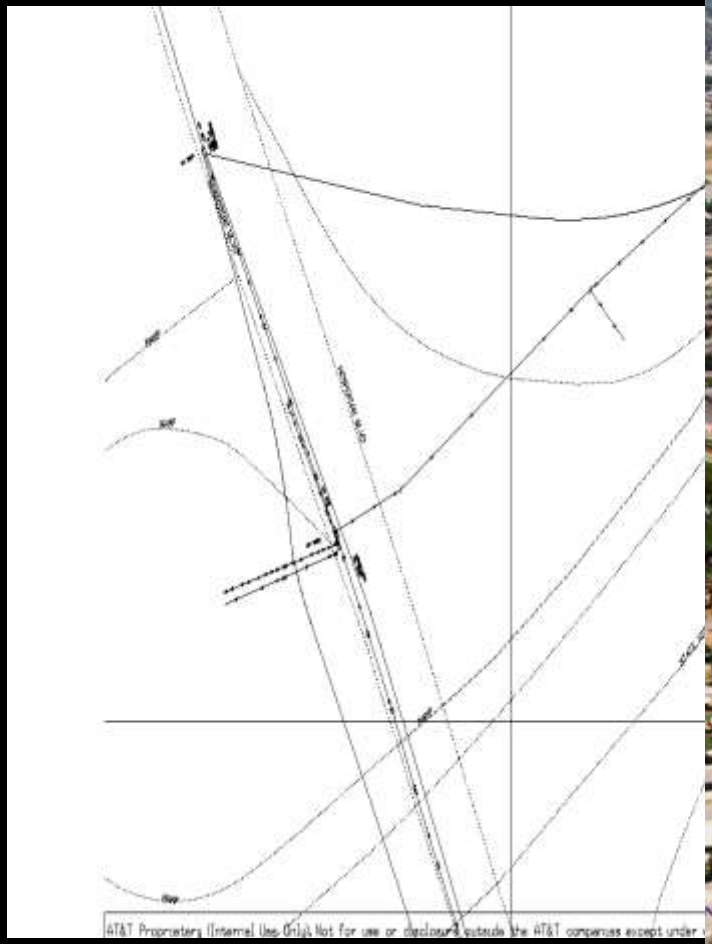
State Licensure. Example; Florida Surveyors or Mappers (Section 472 F.A.C)

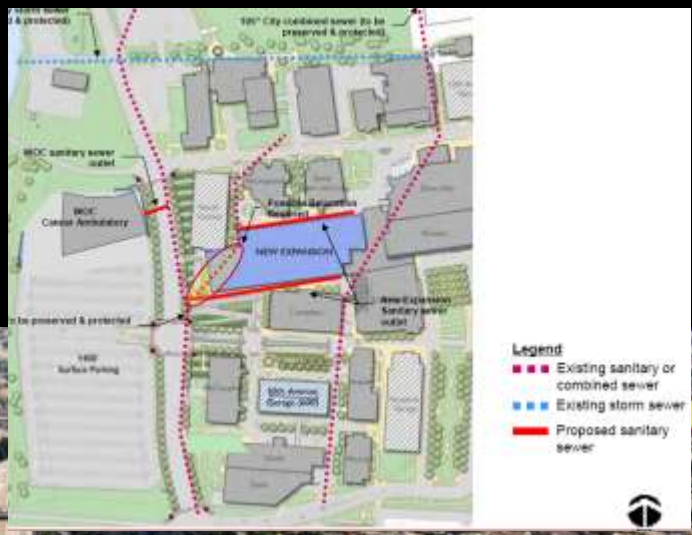
The Original Utility Investigation

We have been surveying and mapping in 2D for centuries, typical Topographic Plan



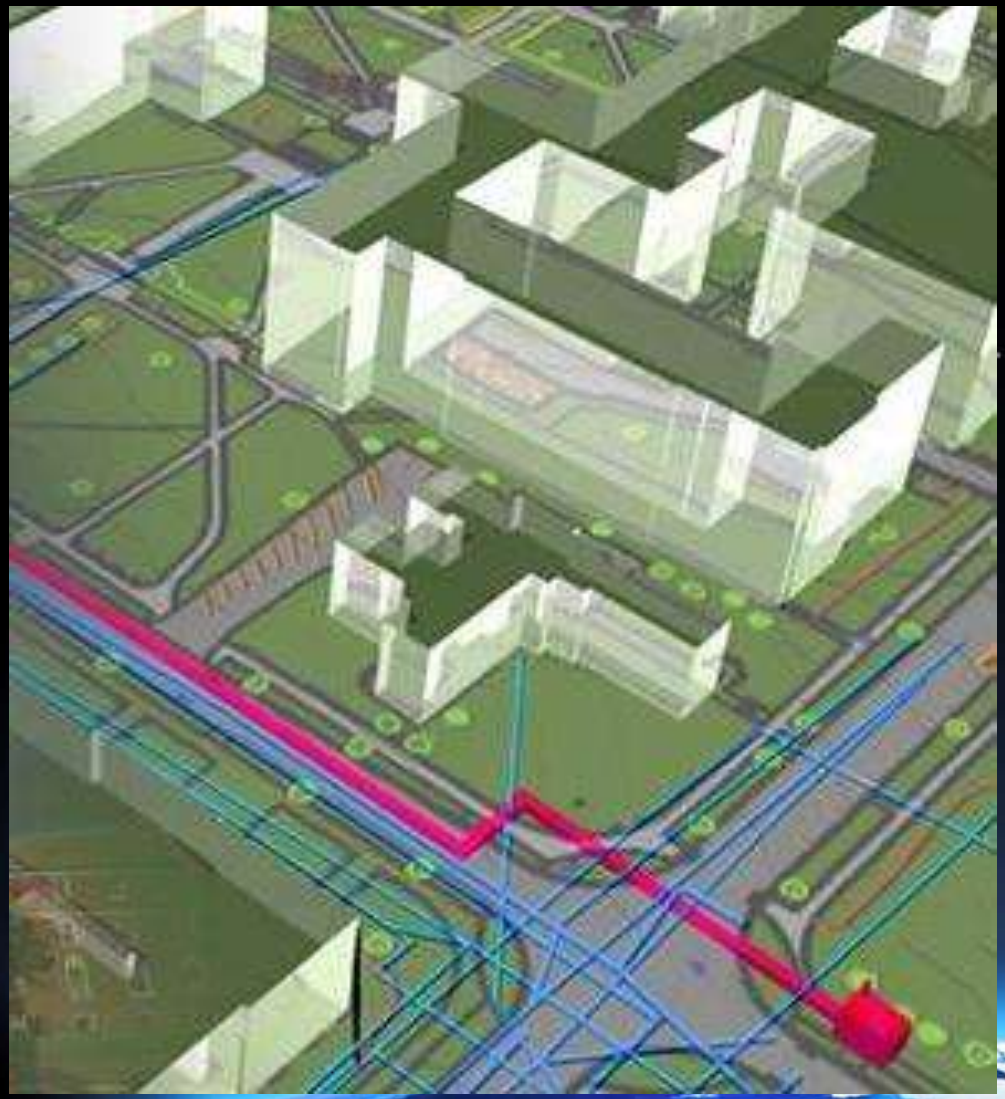
Geographic Information System Sample of “GIS” as built by a major telecom company.





How do you relate this information to a Site Plan?

Wish List/ The Black Box



How do we build a 3 D model Above *and* Below ground

Integrating technologies, 3 D Laser Scanning, Survey and locating technologies

Virginia One Call System
XXXF. S 556)

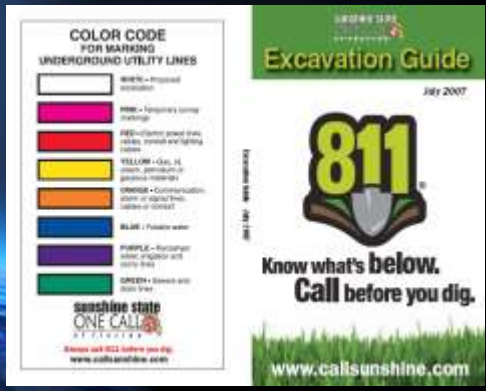
Courtesy Of Virginia One Call System

Damage Prevention vs. SUE

- Damage Prevention
  - Focus on a toll free call to local One Call Center
  - Mark the utilities before excavation
  - Typically just days before ground breaking

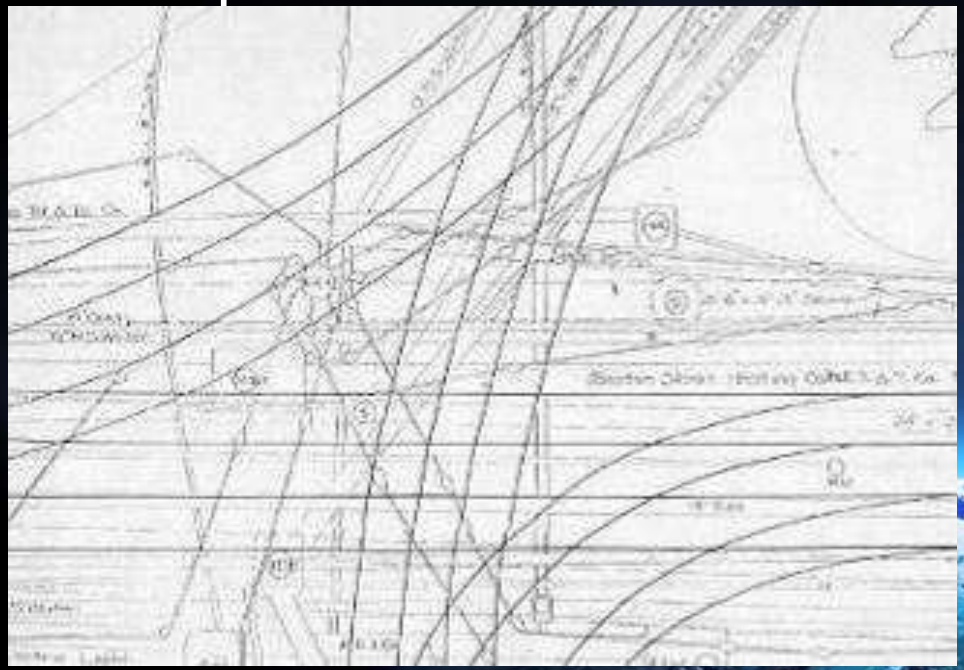
- Subsurface Utility Engineering (SUE)
  - Engineering tool used in the design phase of a project
  - mitigates the risk associated with construction projects
  - Typically months in advance of construction

OSHA Standards 29 CFR 1926.651b
The Contractors Role



Subsurface Mapping Challenges

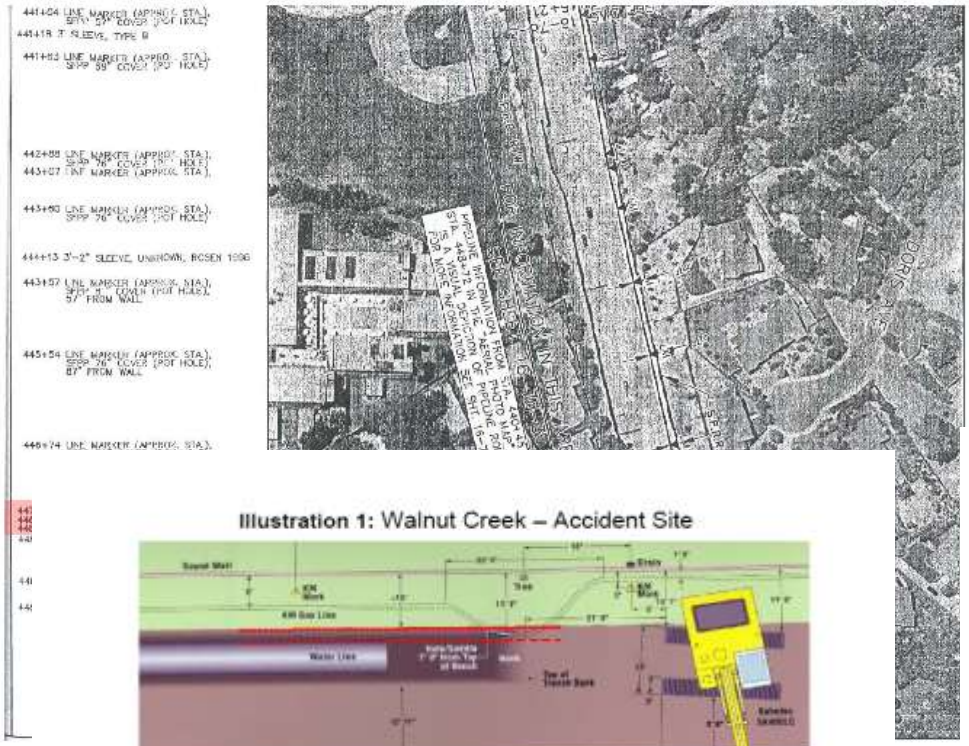
- Existing Buried Infrastructure is dense and very complex
- Systems Buried Daily
- Other utilities are abandoned in place



Utility Location Problems

- Despite major efforts by public and private entities, utility damage is still prevalent nationwide
- Applying today's guidelines and standards can prevent accidents

Walnut Creek, California- November 2004
Cause “Inadequate Line locating”



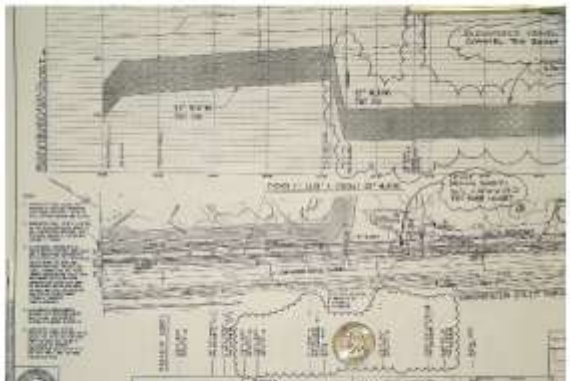
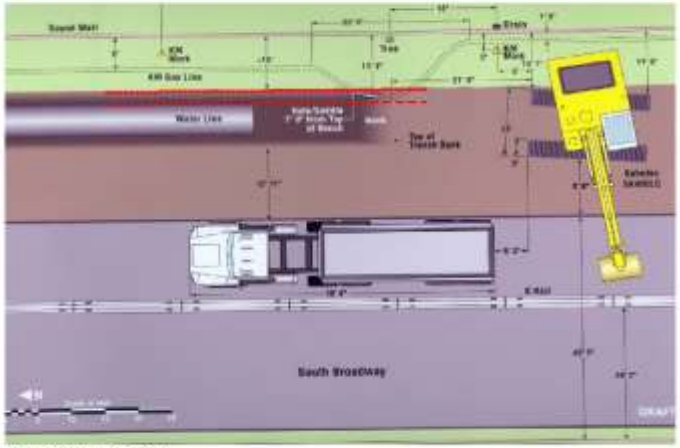


Illustration 1: Walnut Creek – Accident Site



Drawing Courtesy of CalOSHA

Photo A: Kinder Morgan LS 16 pipeline with through-wall puncture.

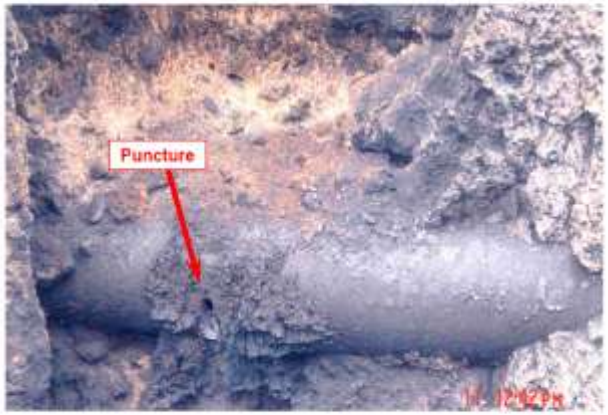


Photo Courtesy of CalOSHA

Refer to California Department Of Forestry and Fire Protection SFM Case #277

Environmental and Geotechnical Site Investigations also pose a serious risk to buried facilities.

- Virtually every major project today uses drillers to perform environmental and geotechnical investigations to identify the site characteristics in the design phase.

- These drilling operation frequently break utilities due to utility locating problems.

Broken water line

Even Small Construction Crews Cause the Major Utility Breaks

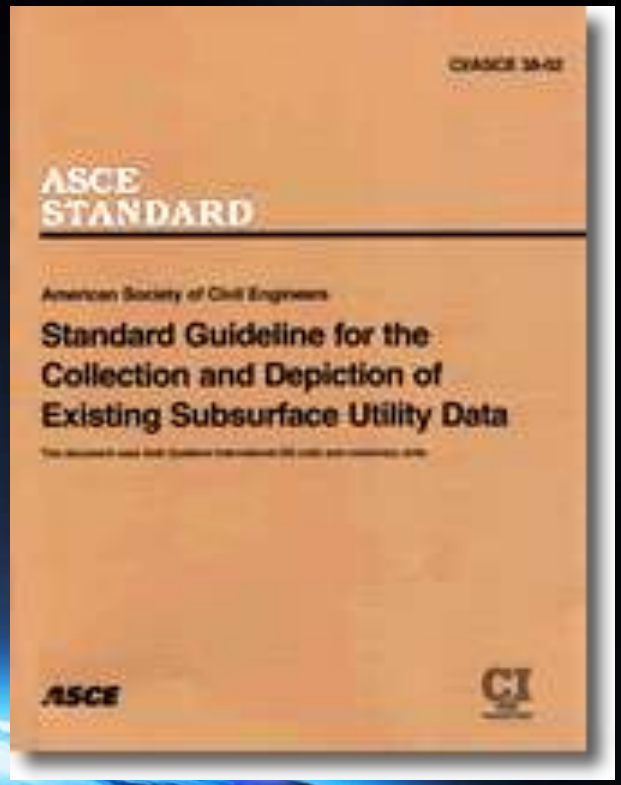
Why do we need 3 Dimensional data??
Subsurface Utility Locations

- We need to communicate what Level Of Accuracy is shown for underground utilities depicted on our designs
- (ASCE 38-02 Utility Quality Levels) (***Reliability of the data***)
- Designers are now working in 3 and 4 D environments.
- We face new challenges with underground utilities due to Machine Controls

Subsurface Utility Engineering
CI / ASCE 38-02 2002 Publication

- ASCE Standard
  - Written in 2002
  - Beginning point to solving utility location problems
  - Guideline for all utility mapping project for engineers and surveyors
- Many engineers recommend SUE to project owners to mitigate utility location problems

ASCE American Society of Civil Engineers



Review of the ASCE/CI 38-02 Standard

- Technical portions of the standard
  - Definitions
  - Collections and Depiction Tasks and Their Assignments
  - Quality Levels for Utility data
  - Deliverables Formatting
  - Costs and Benefits

How does SUE Work?
SUE Quality Levels (ASCE)

- **ASCE 38-02 Quality Level D**
  - **<u>Used in for planning stage of project</u>**
  - Gather all available records from public and private owners and compile a plan showing all known facilities

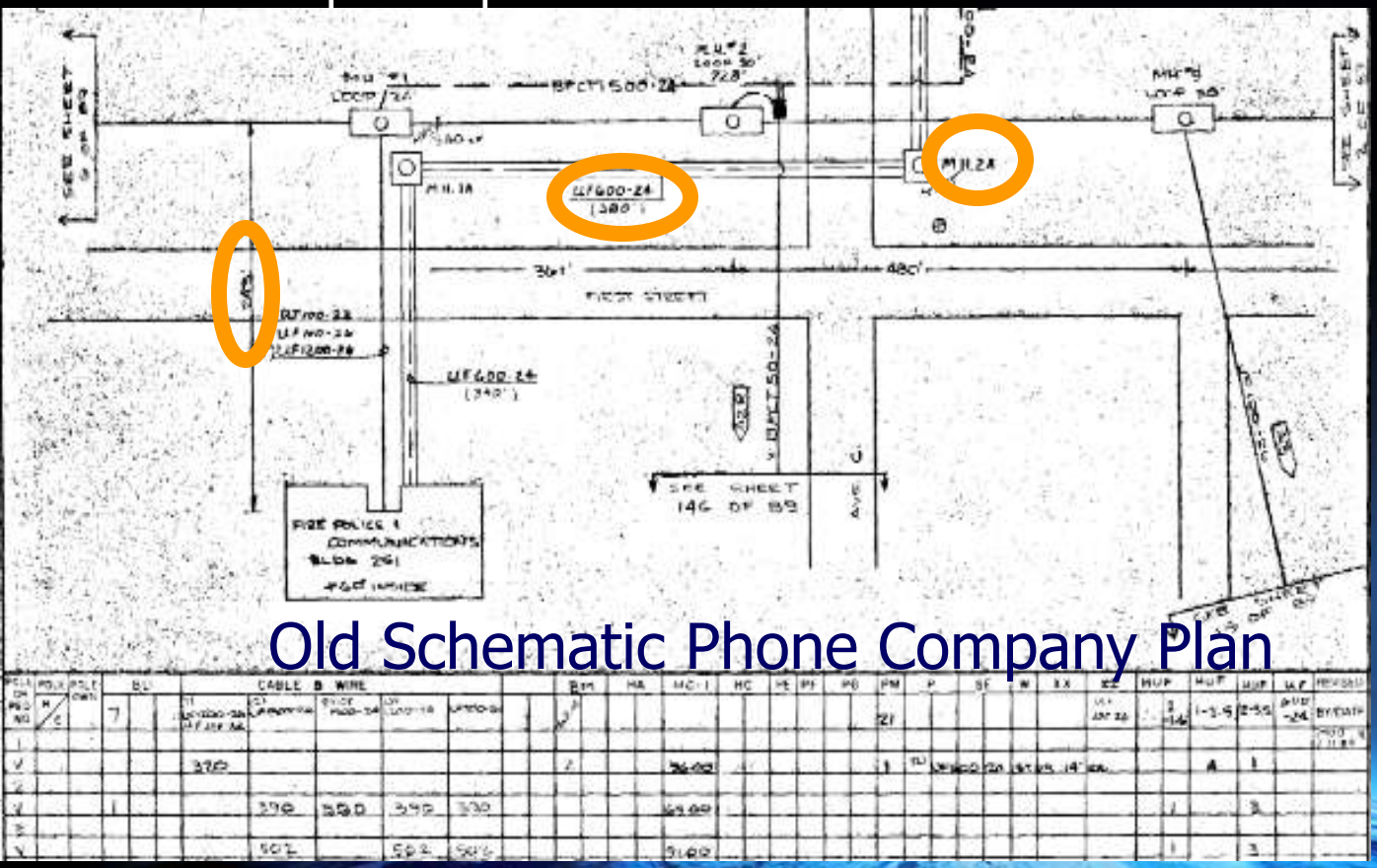
- **ASCE 38-02 Quality Level C**
  - **<u>Used in route selection stage (preliminary Design Phase)</u>**
  - Survey and locate all surface utility features and compile a plan showing all known facilities while correlating all below ground facilities

SUE Quality Levels (ASCE)

- **ASCE 38-02 Quality Level B**
  - Used in Design phase typically 15% to 25%
  - Designate the location of buried facilities using Geophysical Locating Technologies (pipe Locators, GPR, Acoustics, X ray and CCTV Technologies.
- **ASCE 38-02 Quality Level A**
  - Used in Final Design Phase 25% to 95%
  - (Test Holes) expose, measure and record exact location of buried facilities at critical locations (X,Y and Z)
  - Pipe type, conditions assessment, soil contaminants and ground water information is also possible through Level A Vacuum Holes

Record Utility Research

- **ASCE 38-02 Quality Level D**
  - Gather all available records from public and private owners
  - Compile various old utility plans or “As-Builts” into single composite plan



Old Schematic Phone Company Plan

Research comes from:

- Utility Owners
- Cities
- Towns
- County records
- GIS systems
- Past construction projects

Survey Locating Beginning of Field Work

- **ASCE 38-02 Quality Level C**
  - Surveying surface utility structures
  - Correlating data with the records from utility owners

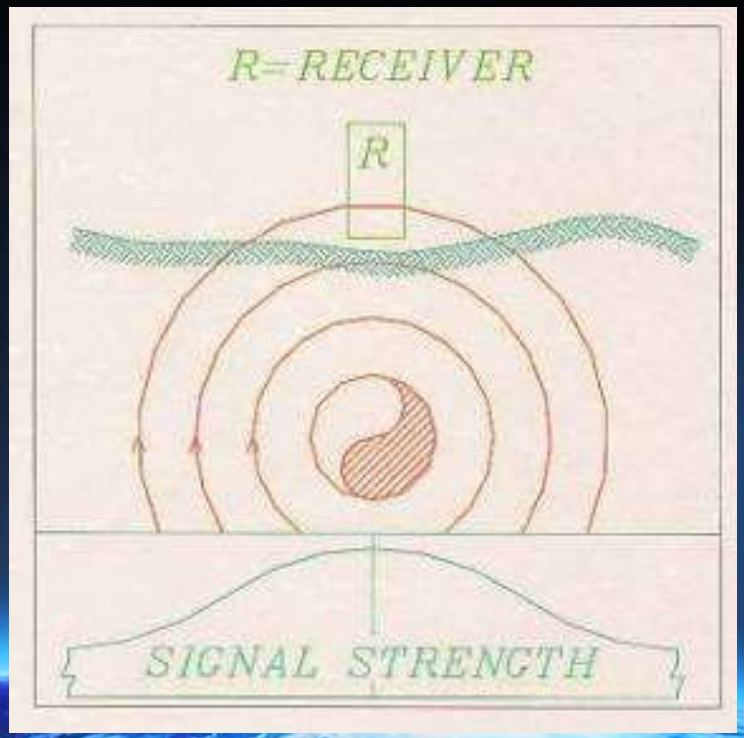
Electronic Locating Systems/Utility Investigation

- **ASCE 38-02 Quality Level B**
  - **Applying electronic technologies to determine approximate location of buried systems**

Sometimes referred to as Geophysical Investigation

Utility Designation (Line Tracing)

- **ASCE 38-02 Quality Level B**
  - Most utilities are traced or designated by
  - hand-held locators
  - These Systems designed to locate metallic utilities



Most utilities today are located using these types of hand held locators.

EM Technologies, Terrain Conductivity
ASCE 38-02 Quality Level B

Electrical Resistivity ASCE 38-02 Quality Level B

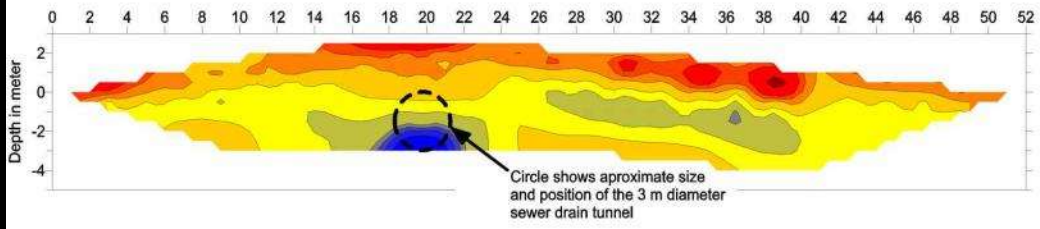
Location of
Field Test

Inactive Railroad Bridge
Over the Susquehanna River,
Harrisburg, Pennsylvania

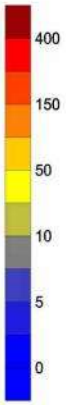
Electrical Resistivity Side Scanning Using the AGI SuperSting Resistivity Meter

A 28-electrode AGI SuperSting Array with a 3-meter electrode spacing was oriented parallel to the bridge pier and water flow and approximateh 2 meters from the pier. Modeling results indicate that adjacent subsurface structures can be mapped using electrical resistivity to image the size, depth and orientation of the target structur and surrounding earth materials.

Detection of a Sewer Pipe



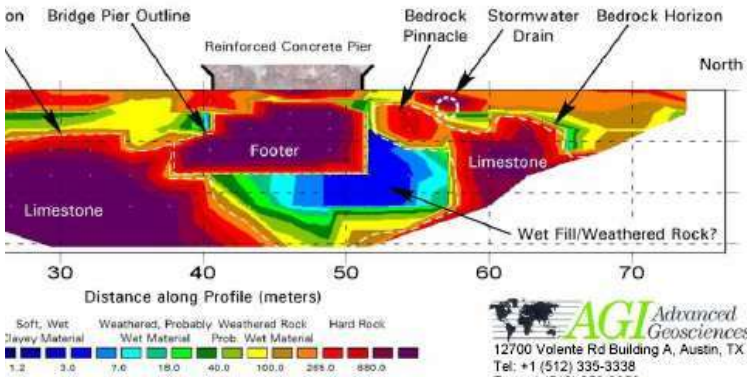
Objective:	The objective was to detect a buried sewer pipe of 3 meter diameter. The pipe appears conductive most likely because of steel reinforcement in the concrete pipe and possibly also because of the content of the pipe
Survey date:	September 18, 1998
Survey site:	Le Bourget, France
Method:	Dipole-dipole electrode array
Instrument:	Sting/Swift, 27 electrodes at 2 meter spacing
Processing:	Inversion and topographic correction using the Res2Dinv software
Units:	Meter and Ohmmeter



Courtesy of LRPC, Le Bourget, France

AGI Advanced Geosciences, Inc.
Tel: +1 (512) 335-3338
Fax: +1 (512) 258-9958
E-mail sales@agiusa.com
Web site http://www.agiusa.com

Resistivity/Depth Cross-Section



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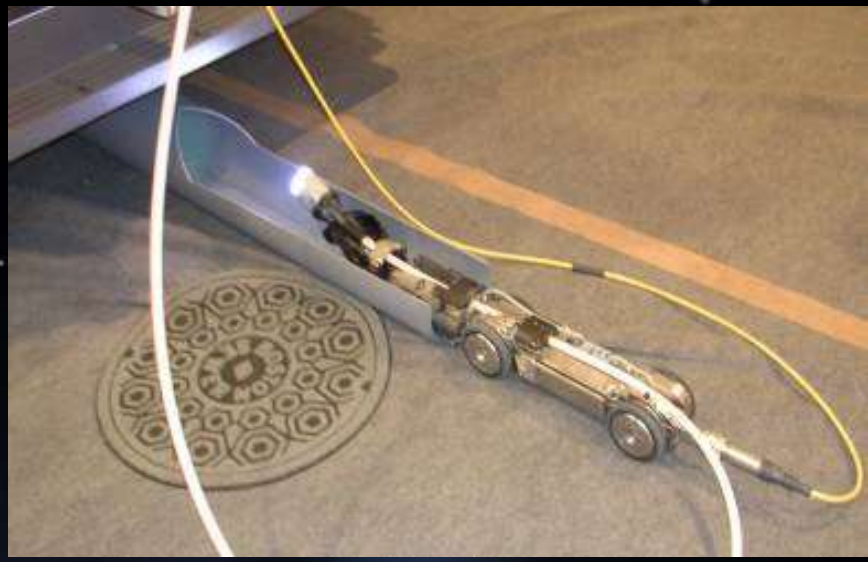
E-mail: sales@agiusa.com
Website: http://www.agiusa.com

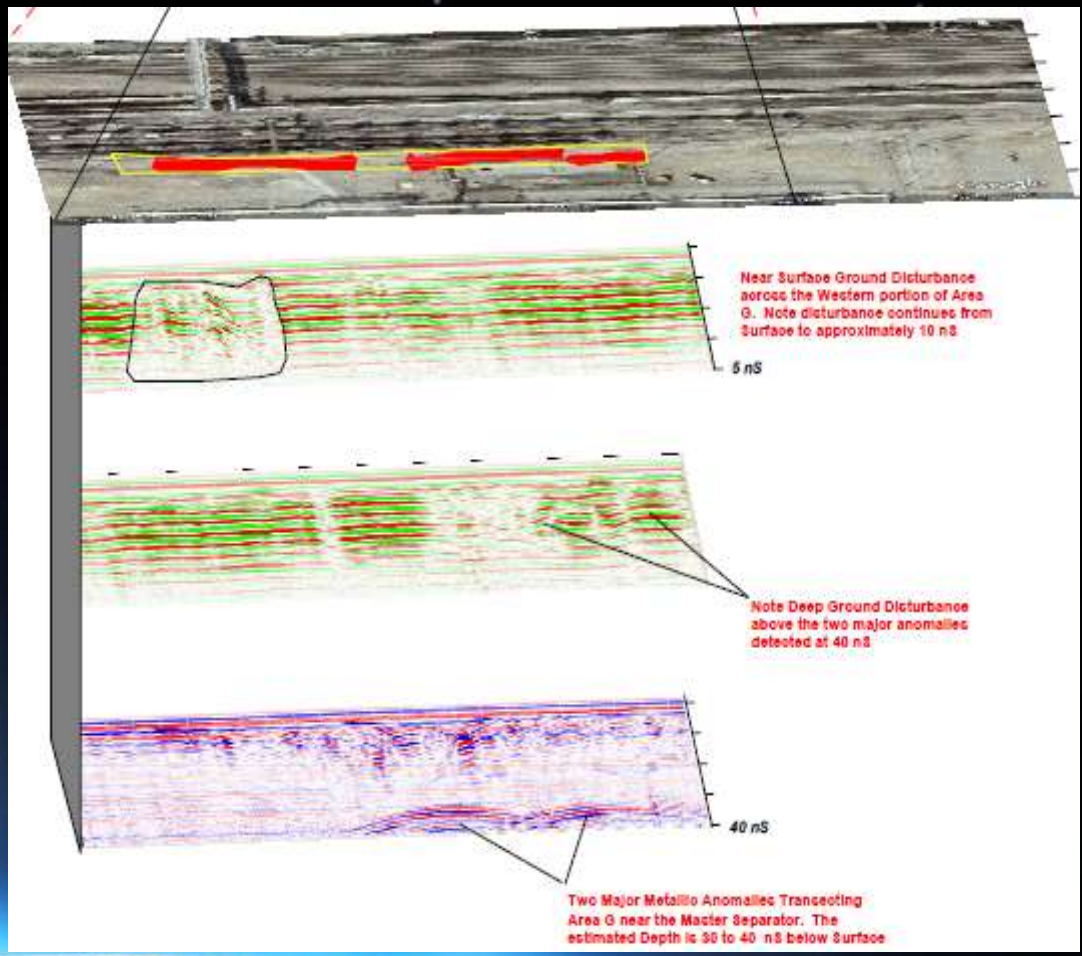
CCTV and Pipe Inspections
ASCE 38-02 Quality Level B
Pipe Line Condition Assessment Surveys

- Sewer and drain Locations
- Non Metallic lines can be problematic for locating technicians
- Assets management tool
- Equipment:
  - Robotic tractors with cameras
  - Manhole Inspection Cameras
  - Digital recording with GPS link



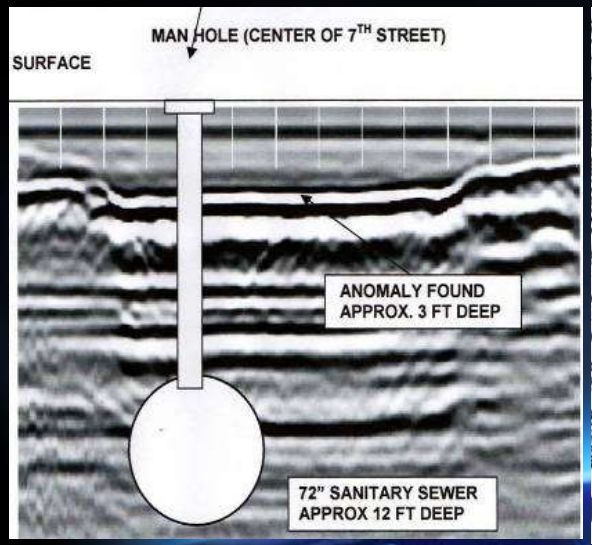
Ground Penetrating Radar (GPR)
Multi Array Antennas ASCE 38-02 Quality Level B

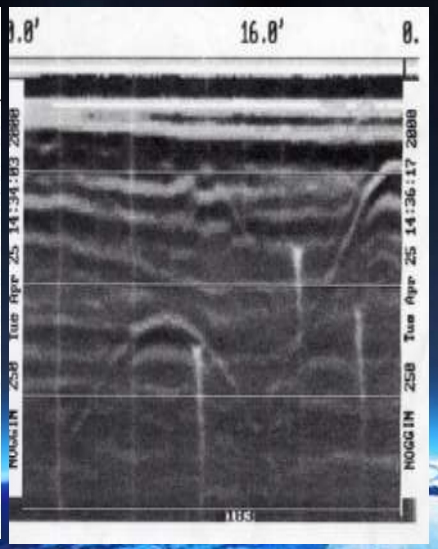
Multi Antenna Systems



Ground Penetrating Radar (GPR) Pros and Cons, ASCE Quality Level B

- Most widely used locating technology to trace non-metallic lines (water, gas telephone, sewer, drain and product lines) Excellent results in dry sandy soils.
- Not suited to areas with heavy clay and/or moisture content in soils
- Cannot always identify metallic or non-metallic lines
- Locate lines YES, Not Always Identify—there is a difference.





Multi Antenna GPR for Utility and Pavement Analysis

TerraVision by GSSI

Collect 3D Data in a Single Pass

Automatic Pipe Recognition

Very User-Friendly

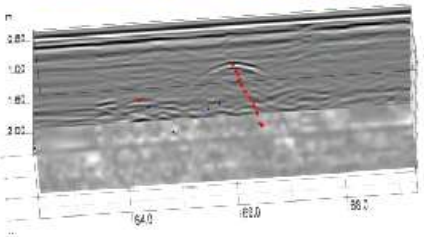
Applications

Rapid utility mapping in 3D

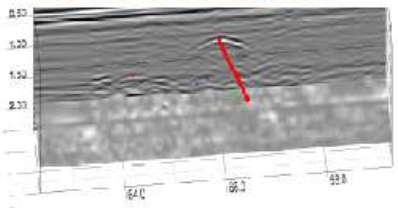
High-speed airport runway/ taxiway inspection

Archaeology

Automatic Target Recognition



Automatic Pipe Recognition



Features

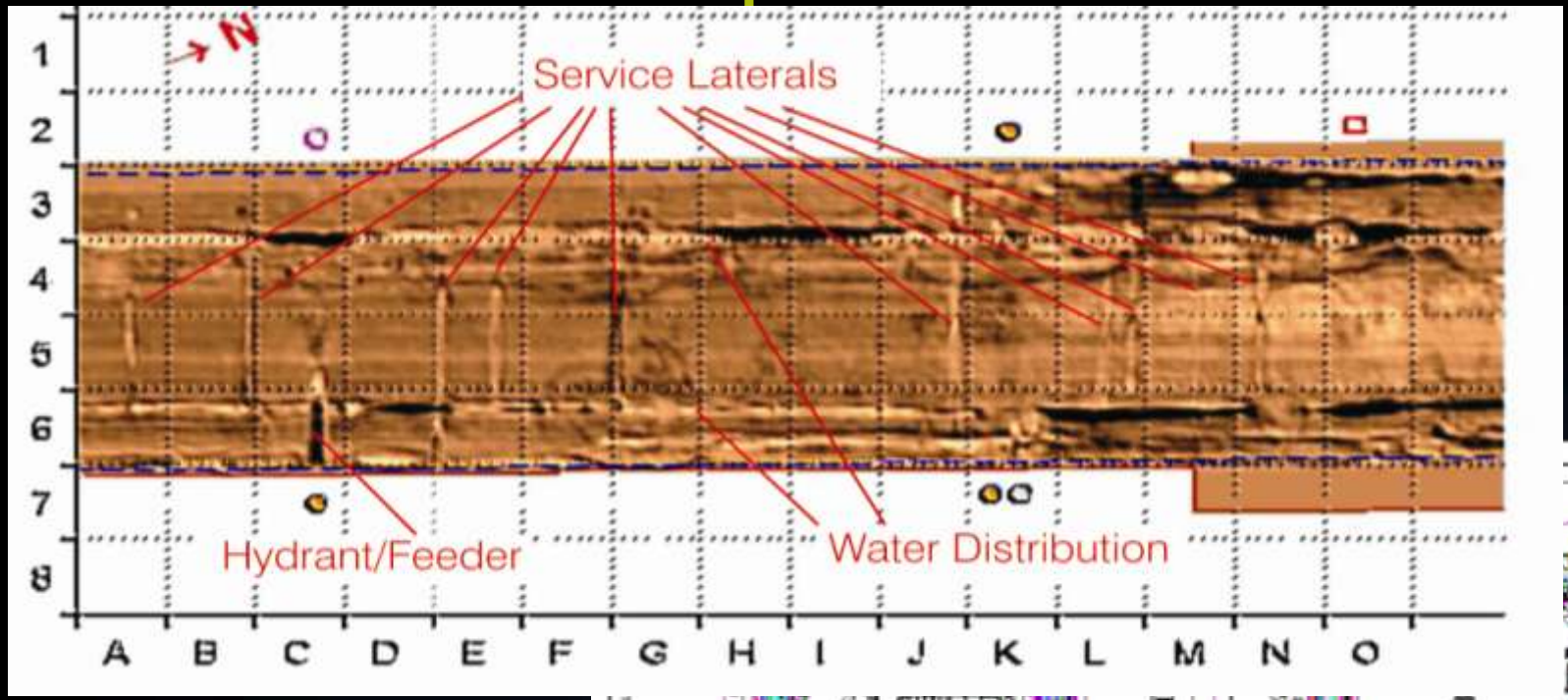
- 14 antenna array
- 6-foot wide survey path
- Data collection speed 5 mph and 10 mph
- See pipes and geological features in 3D
- Process a mile of data in under 10 minutes
- Post-processing done in the field
- GPS compatible

GSSI

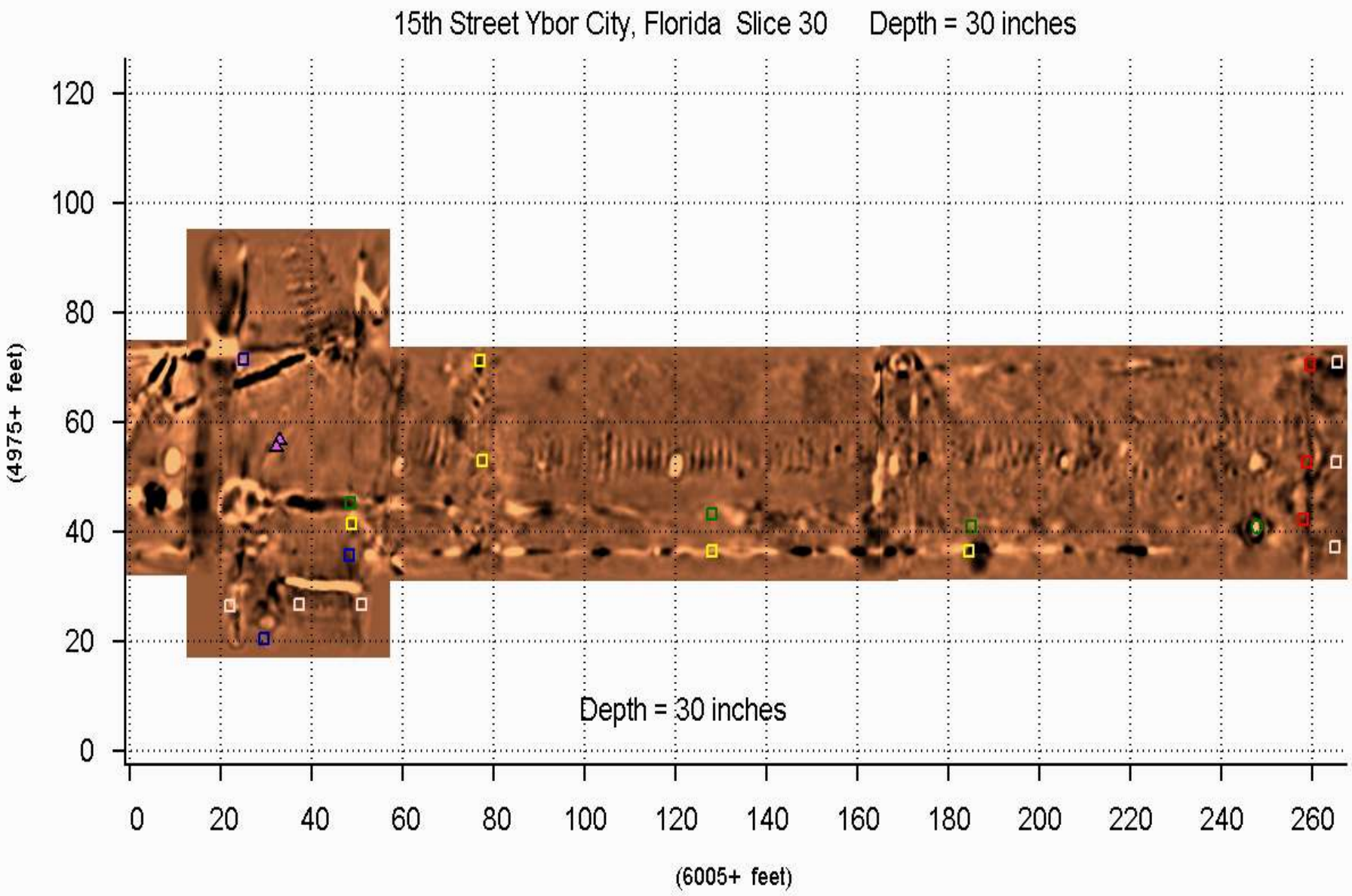
Geophysical Survey Systems, Inc.
www.geophysical.com

- GPR has numerous applications including the inspection of below ground site conditions, looking for pipes, voids and buried objects.
- Runway/Roadway
- Pavement Analysis.

Sample of results.



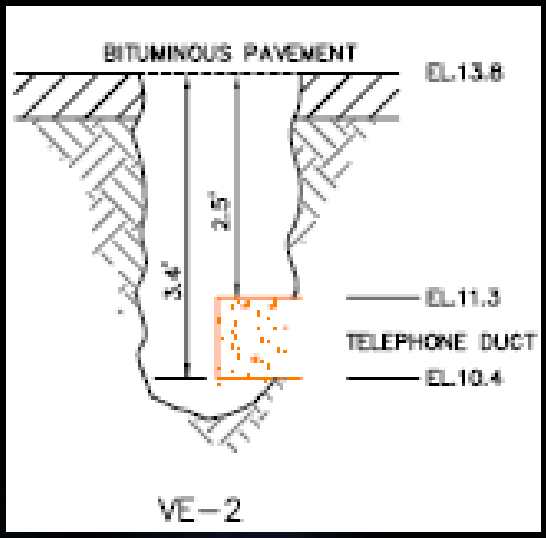
Utility Data: From 2D to 3D, Whitten Technologies

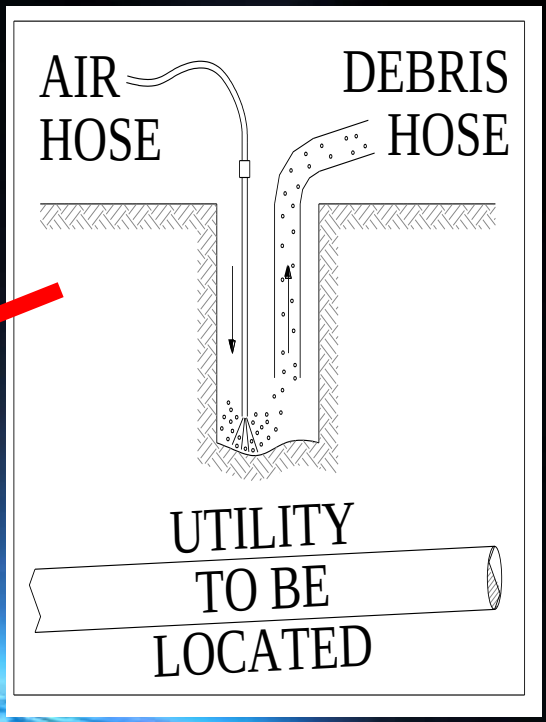

15th Street Ybor City, Florida Slice 30 Depth = 30 inches
120
100
80
60
40
20
0
(4975+ feet)
Depth = 30 inches
0
20
40
60
80
100
120
140
160
180
200
220
240
260
(6005+ feet)

Vacuum Excavation (non destructive excavation)

<u>Quality Level A</u> (Exact X, Y and Z Data)

Exposing facilities at critical points and areas or at points of conflicts are resolved utilizing non-destructive-vacuum-excavation





Why Vacuum Excavation ?

- **Air Or Hydro Excavation**
  - **Safe (when used properly)**
  - **Efficient**
  - **Minimum surface disruption**
  - **Less of an impact to traffic and pedestrians**
  - **Cost effective**
  - **Highly accurate data available**

Verifying Electronic Locations

- Any interference in designation phase requires vacuum excavation
- Best method for obtaining critical depths is by utilizing the vacuuming process
- Provides the accuracy needed for final designs

Exact X, Y and Z

Electronic Interference

Vacuum Excavation Rail Projects

Believe it or Not! This guy was locating a sewer line.

USE OF Global Positing Systems GPS in Survey is now very common.

New Taxiway “MIKE” Project in Logan International Airport, Boston MA.

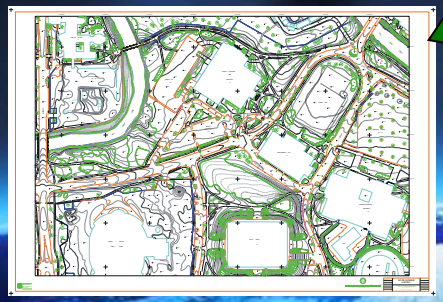
- Project team all working with the project survey control network

Surveying Services (Data Management)
Utility Asset Management Systems (GIS)

- Using a survey total station or GPS ensures all information is precise and accurate
- Recover/establish survey horizontal and vertical control network
- Locate all the results from the site investigation

Field data Collection

File transfer



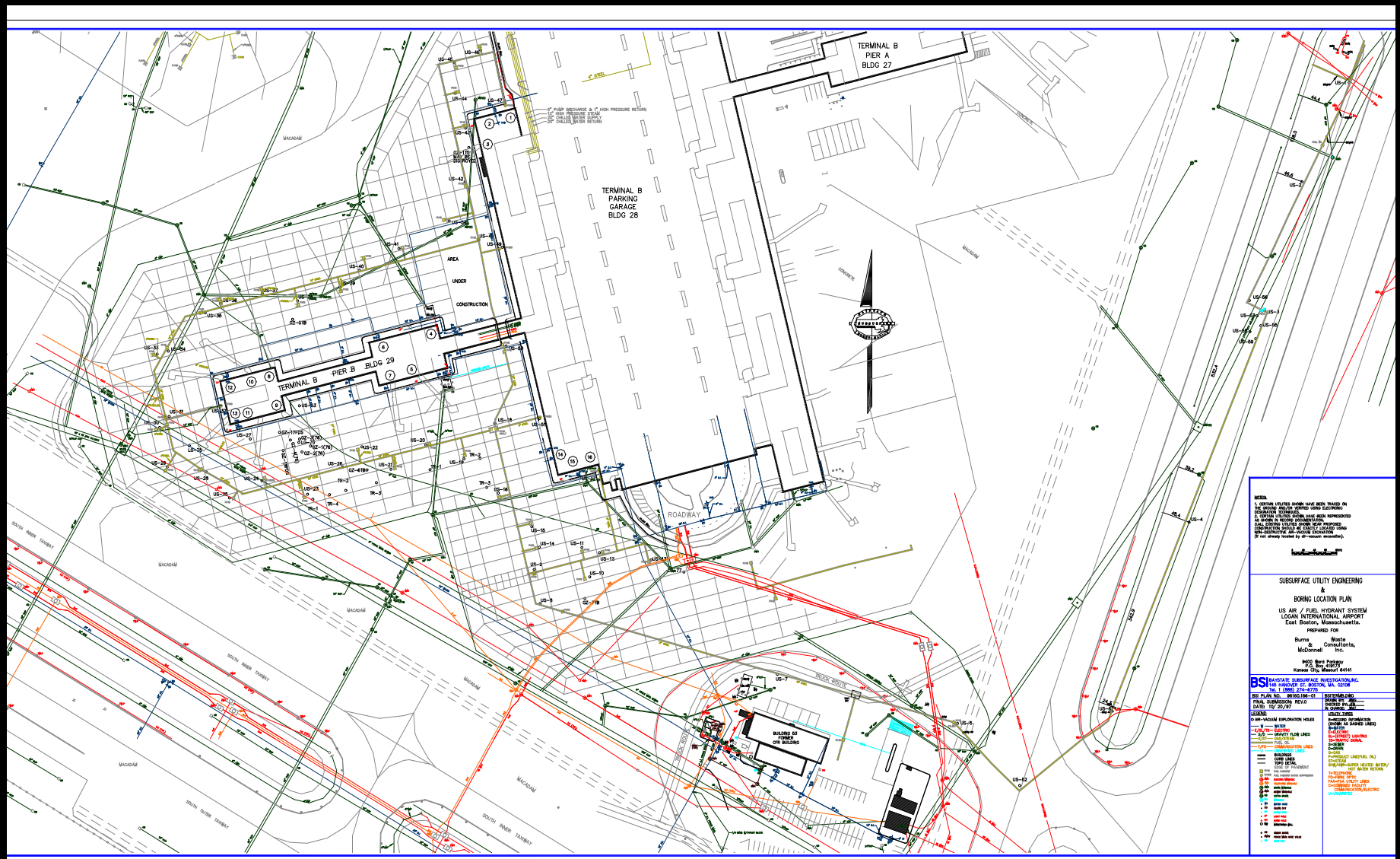
Tabular Data

Spatial Data

CADD Data

GIS Data

Boston's Logan Airport



Mapping Underground Electrical Lines

Merging the data into delivery formats New Taxiway Project 2008.



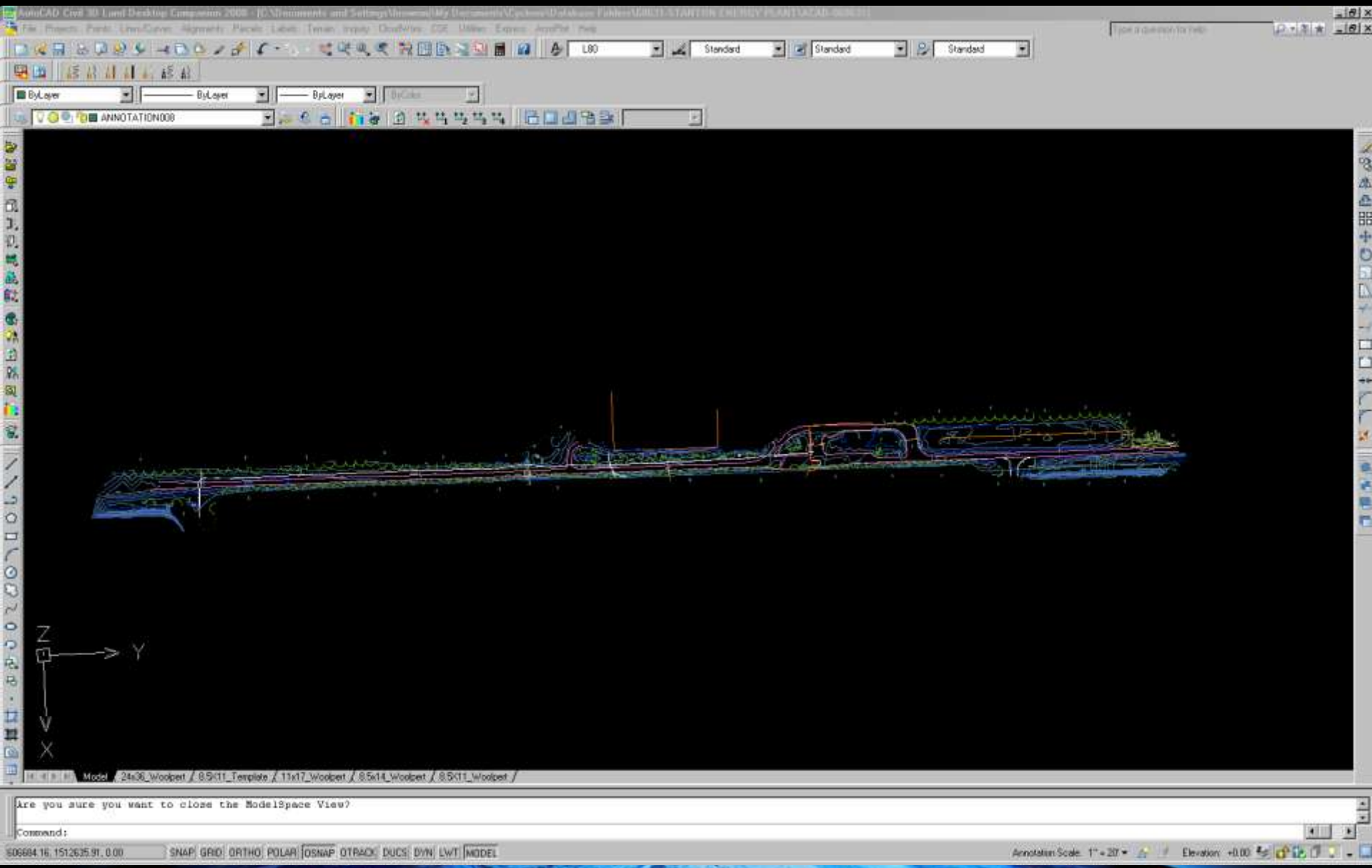






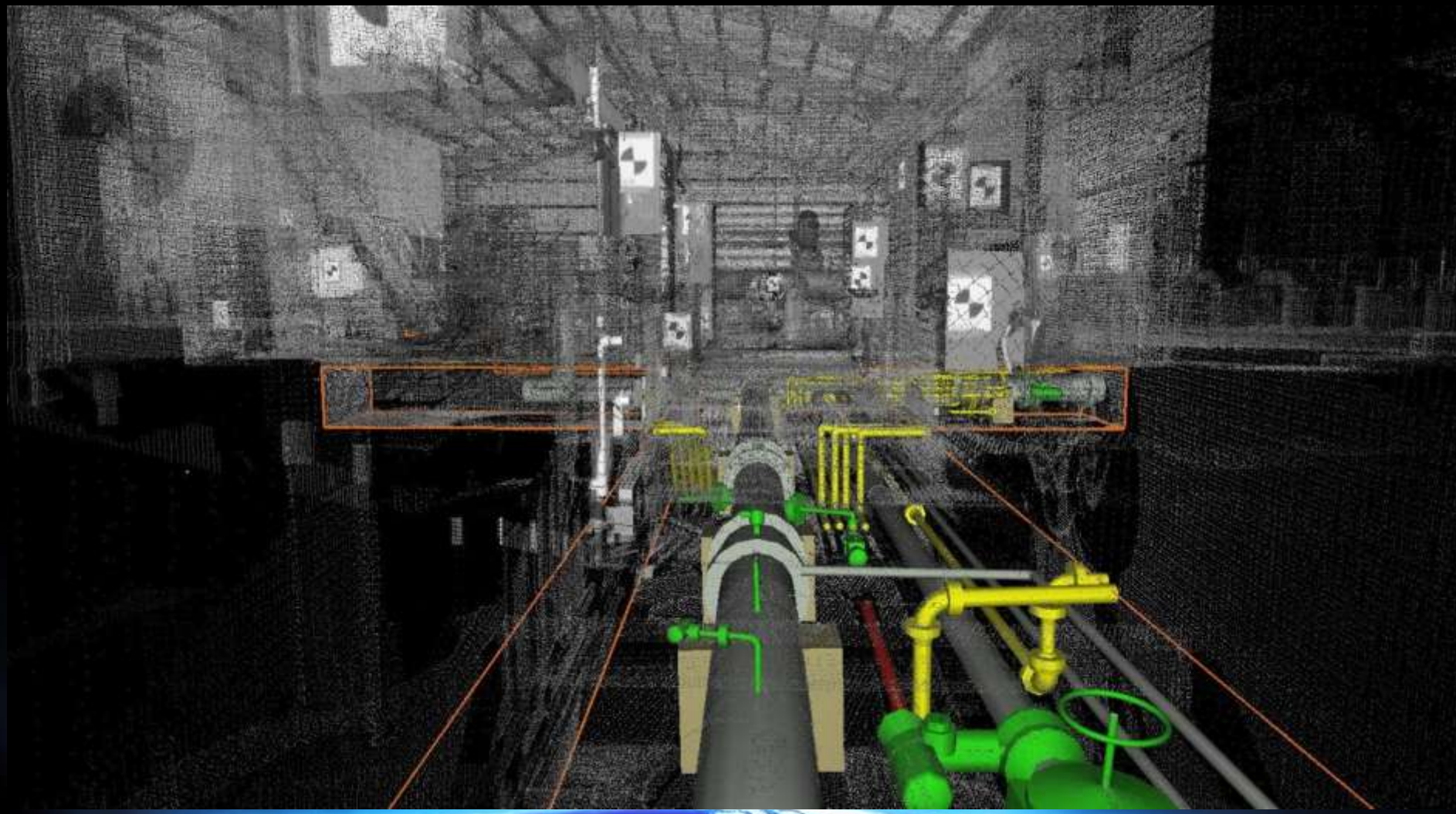
3 D Laser Scanning for Route Surveys (terrestrial)

3 D Laser Scanning for Route Surveys (terrestrial)

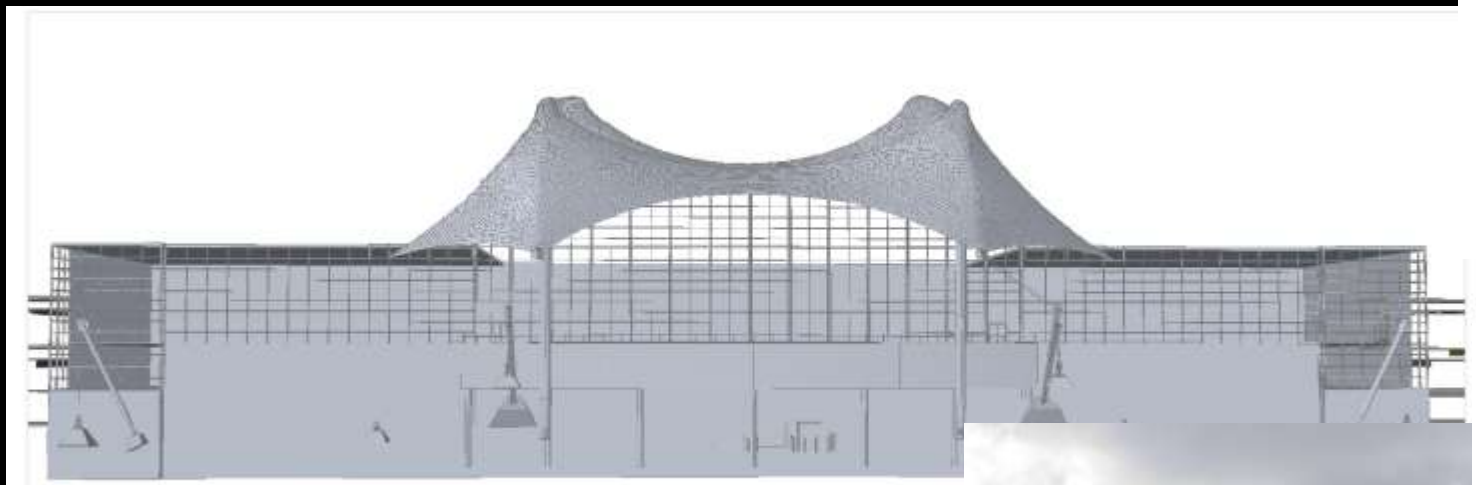


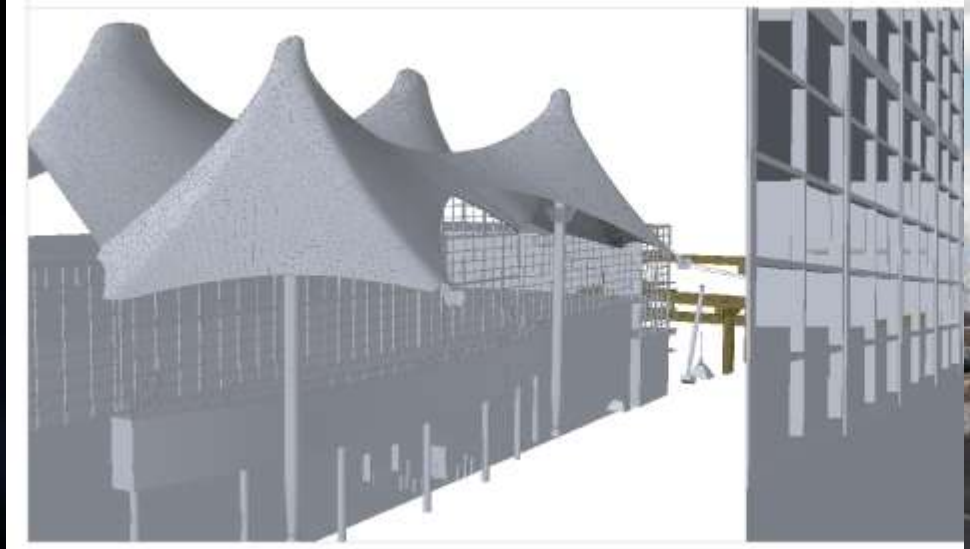
3 D Laser Scanning for Route Surveys (terrestrial)

3 D Laser Scanning for utility infrastructure

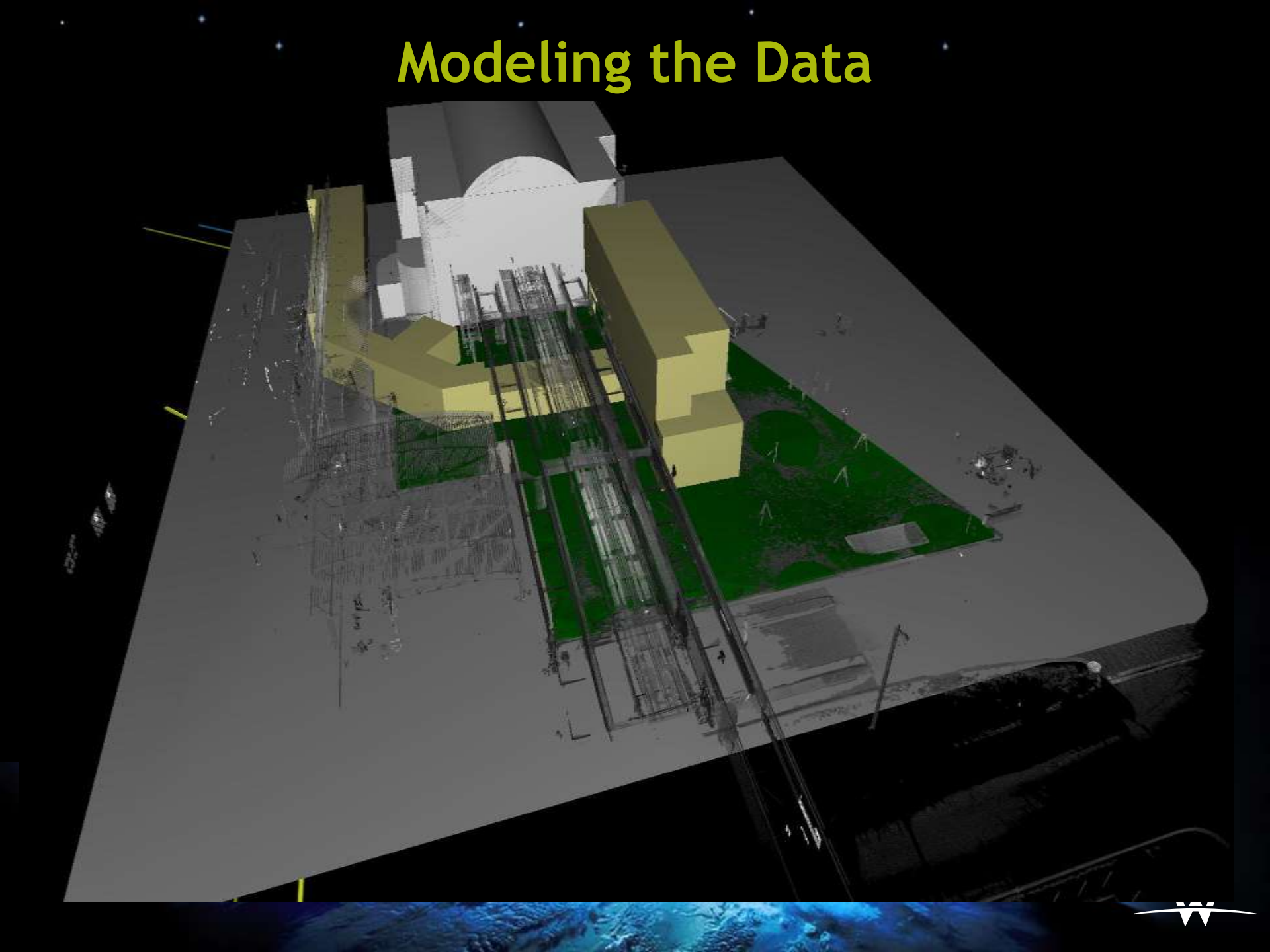


Modeling the 3 D Data

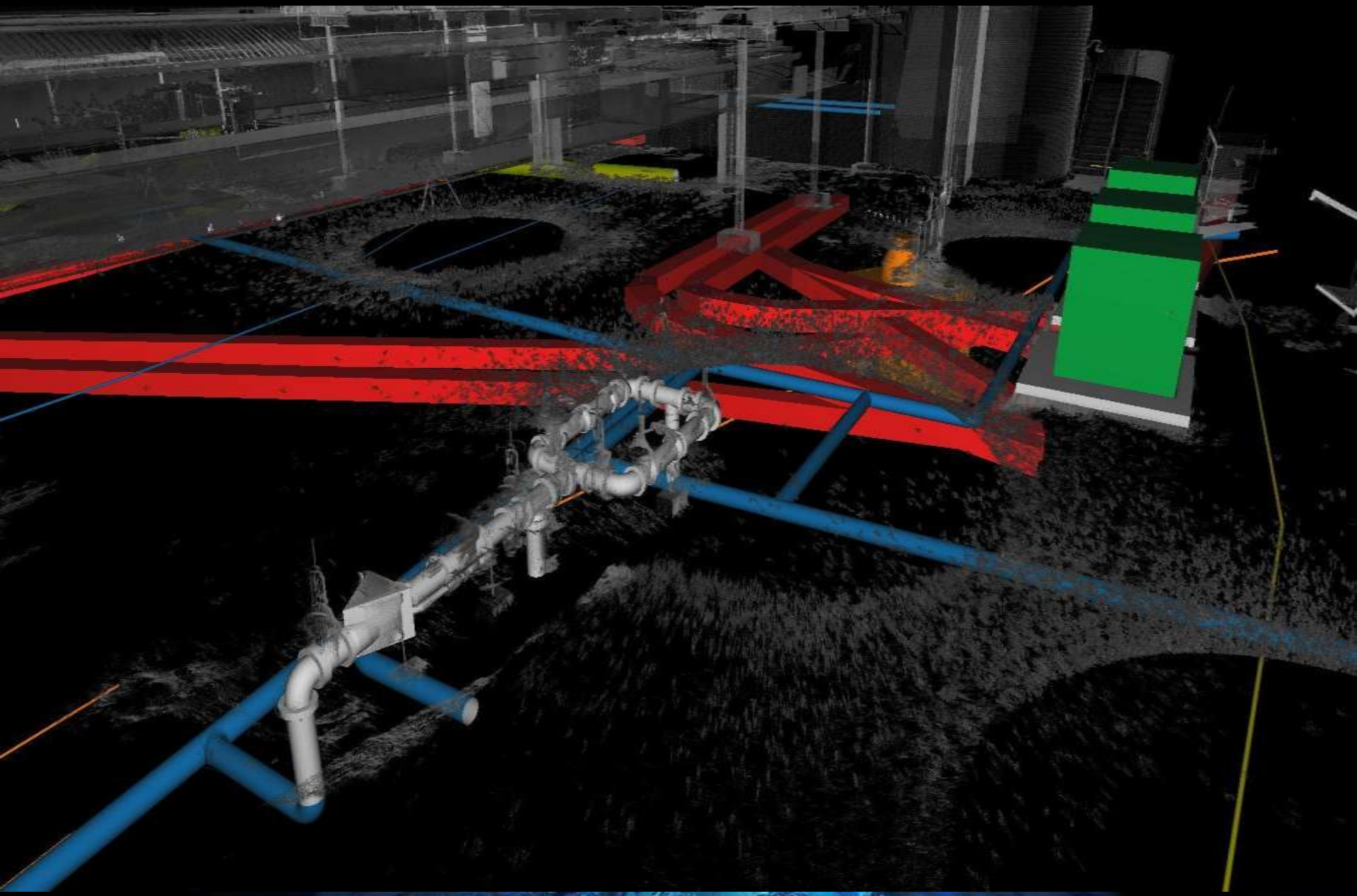




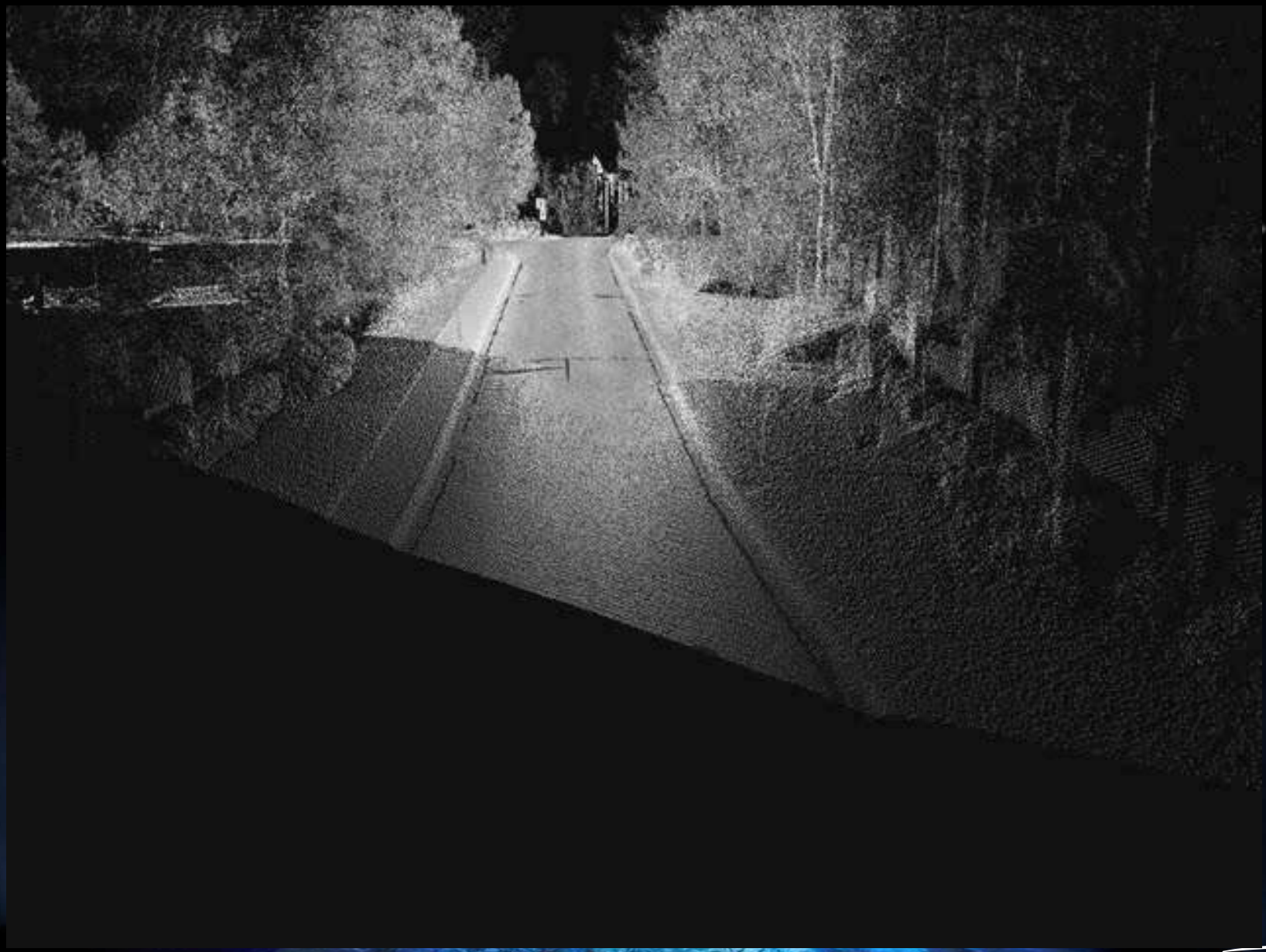
Modeling the Data



Modeling the Data

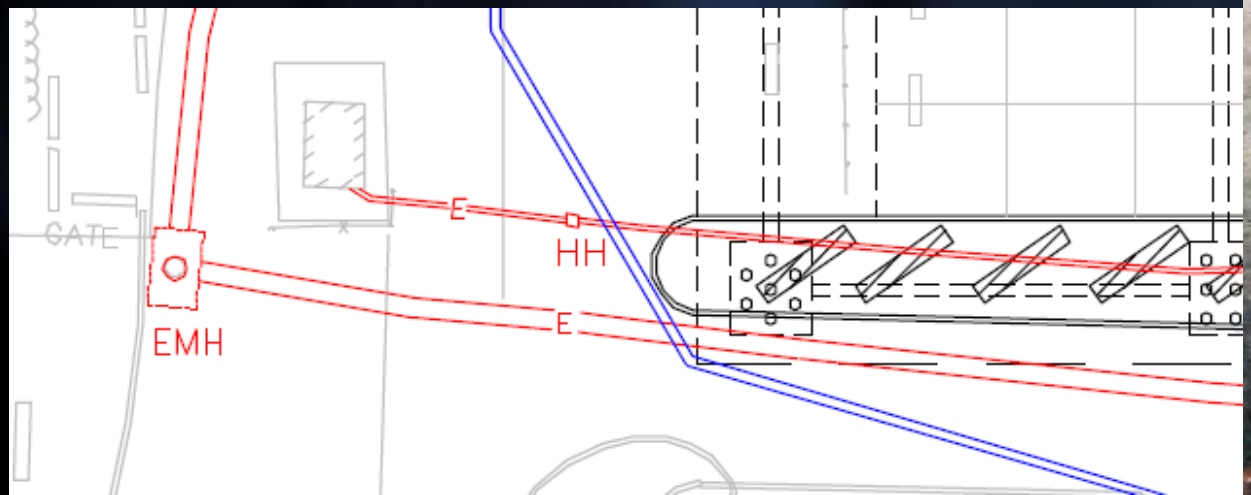


Mobile Lidar Sample



Risk Management/ Risk Avoidance/Risk Allocation

- **Risk Management**
- You can only manage the risk with regard to existing utilities if you know where they are located
- **Risk Avoidance**
- Avoid Design conflicts that are in conflict with Existing Utilities
- Design work clear of buried infrastructure
- Avoid having staging areas over buried utilities
- Avoid encountering “Differing Site Conditions”



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