Southeastern Transportation Geotechnical Engineering Conference

Charlotte 2023

GPR Applications for Roadway and Bridge Projects

Edward (Ned) Billington, PG and C. Ryan Pastrana, PG

ESP Associates, Inc.

November 1, 2023

ESP

OUTLINE

- NCDOT Geophysics
- GPR Methodology
- Example Projects
- Closing

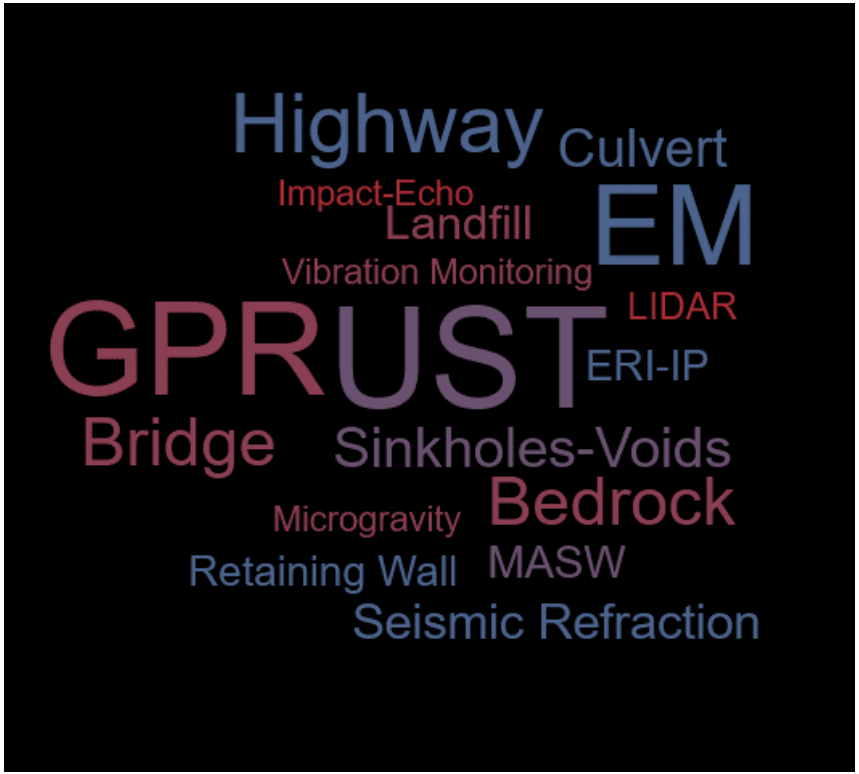
NCDOT GEOPHYSICS

Thanks to the NCDOT Geotechnical Engineering Unit for their long-term support of applying geophysics to engineering and environmental projects.

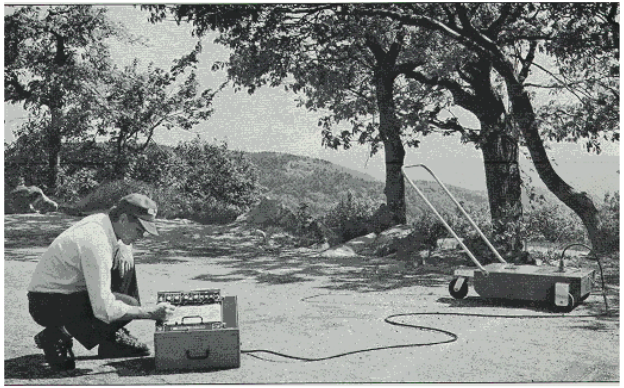
ESP

NCDOT GEOPHYSICS

- ESP has been providing geophysical services for the NCDOT since 2012
- Majority of work has been GPR and EM for abandoned USTs.
- Studies for sinkholes/voids and depth to rock are second most common, followed by buried waste and other applications.



GPR METHODOLOGY



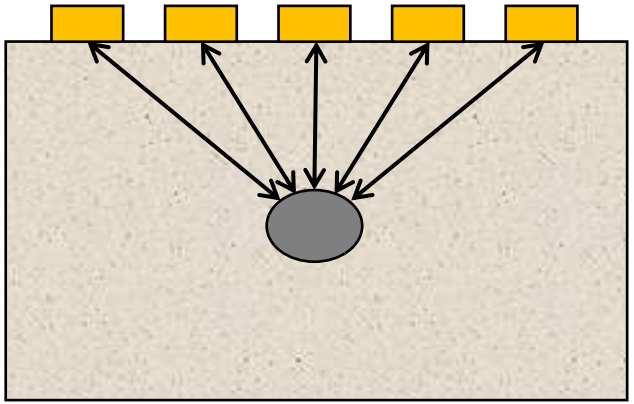
GPR METHODOLOGY

- Antenna transmits and receives high frequency radio waves
- Typical frequency range: 100 to 2600 MHz
- Depth range depends on antenna frequency, soil type and water content

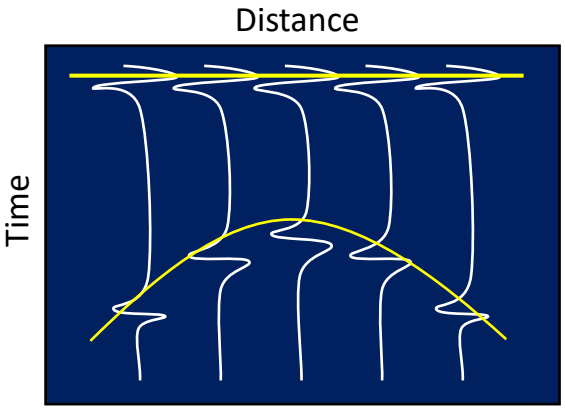
Noggin Cart with 250 MHz antenna

GPR METHODOLOGY

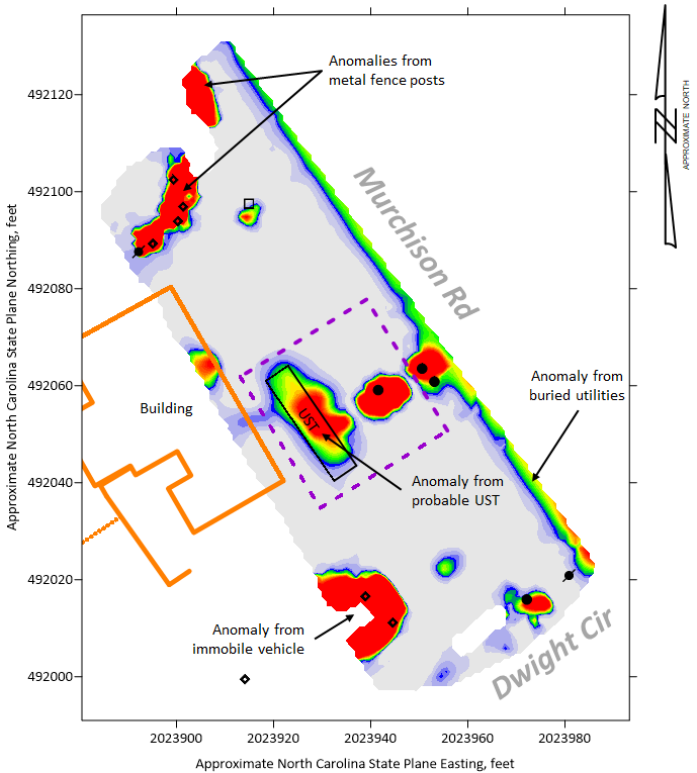
Antenna Position

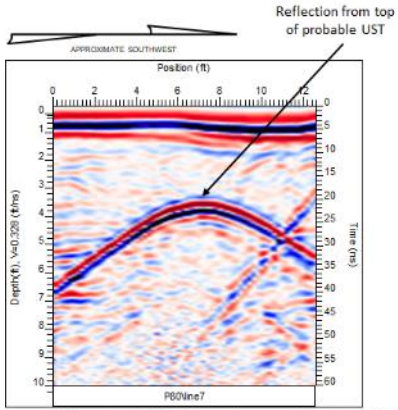


GPR Data

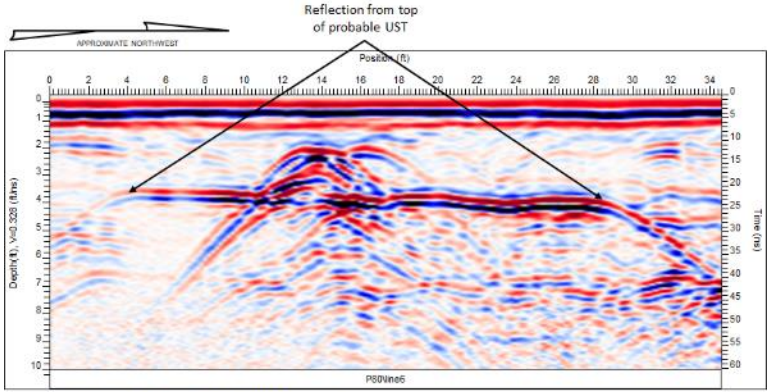


EXAMPLE 1 – ABANDONED USTS





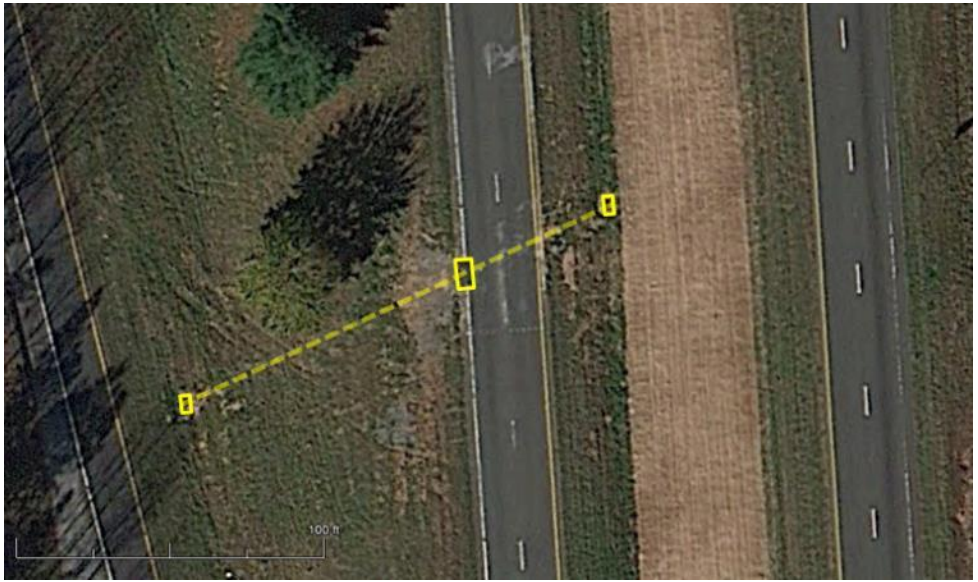
B. Example GPR Line 7 over short axes of probable UST7.



C. Example GPR Line 6 over long axis of probable UST.

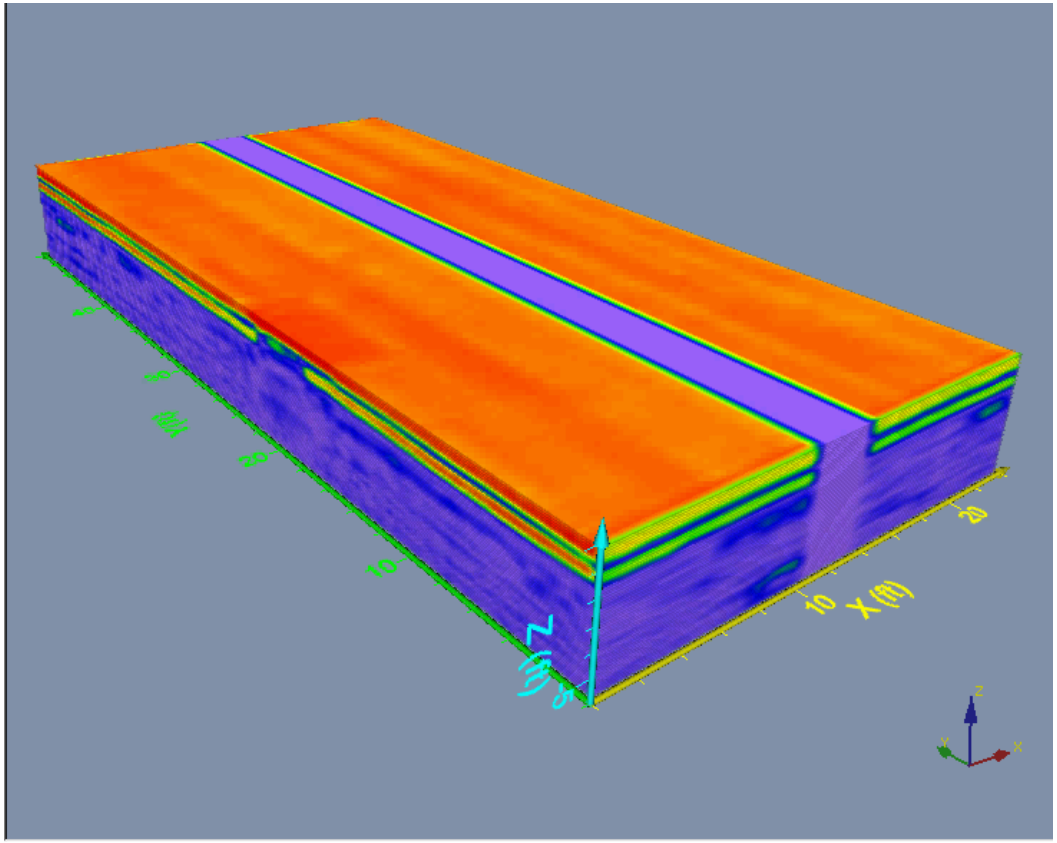
EXAMPLE 2 – HWY 321 VOIDS

EXAMPLE 2 – HWY 321 VOIDS



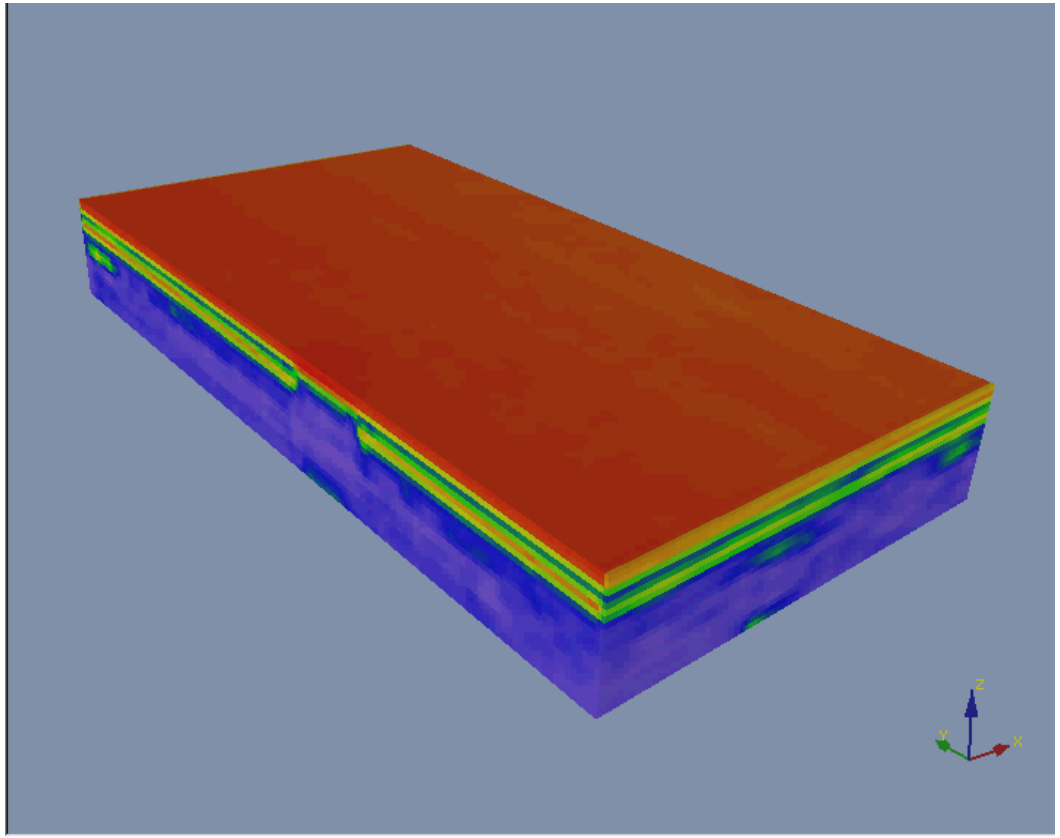
EXAMPLE 2 – HWY 321 VOIDS

2013 GPR DATA



EXAMPLE 2 – HWY 321 VOIDS

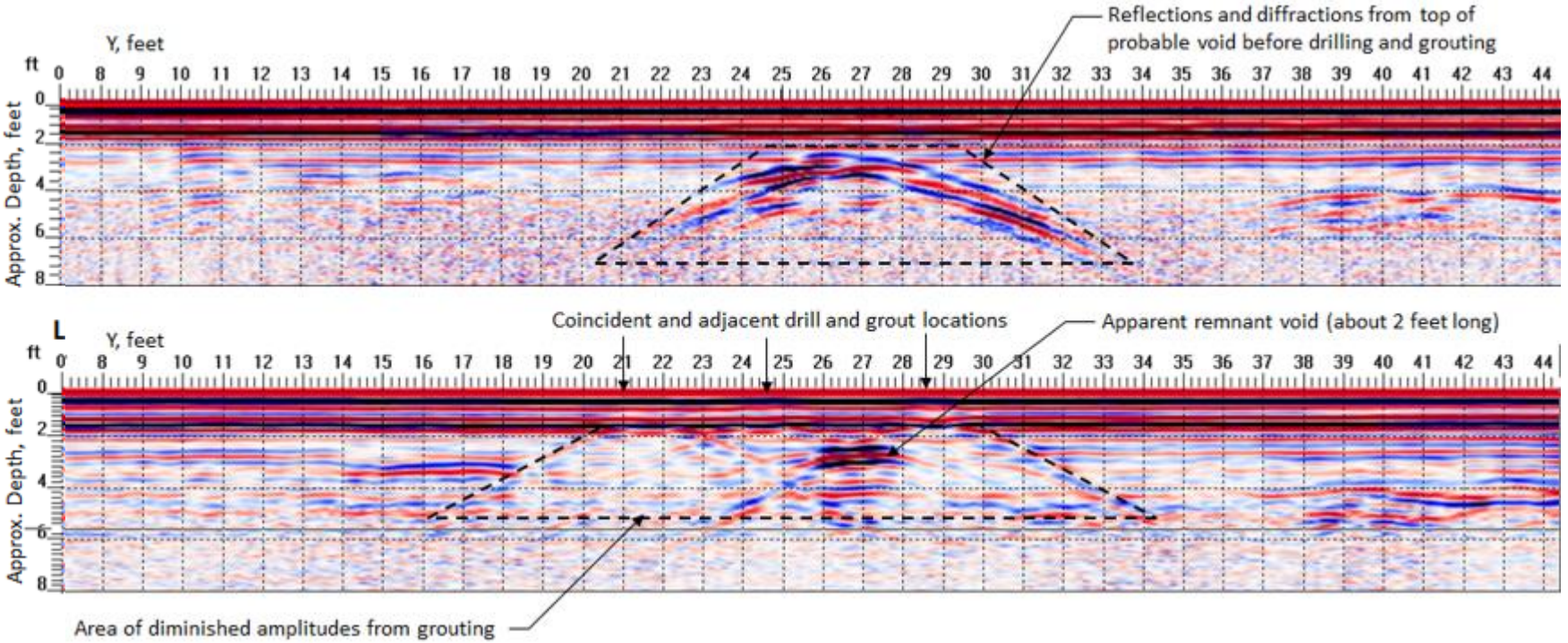
2014 GPR DATA



EXAMPLE 2 – HWY 321 VOIDS

2013

2014



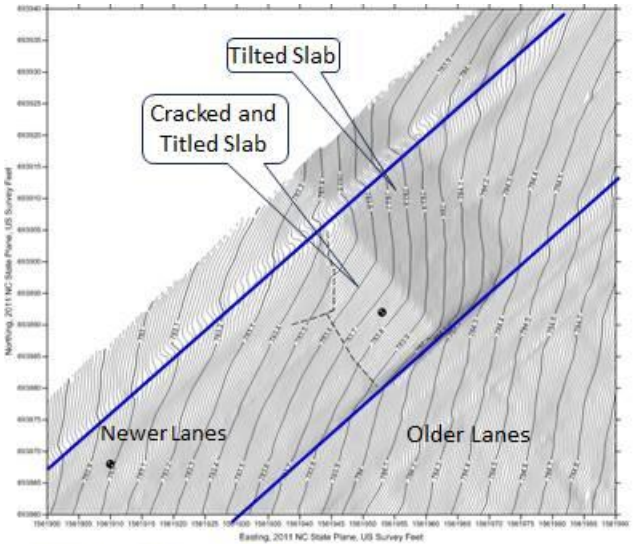
EXAMPLE 3 – I-85 SETTLEMENT

EXAMPLE 3 – I-85 SETTLEMENT

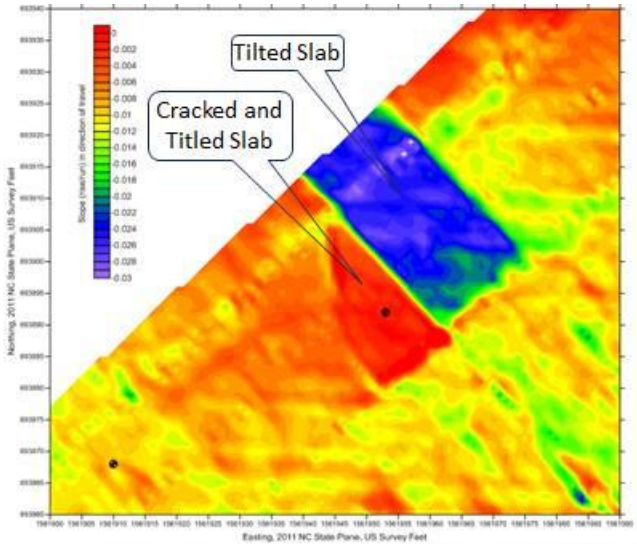
2013 GE IMAGE

- I-85 widened from 4 to 8 lanes through Salisbury in 2004-2008
- By 2013, the two outer SB lanes started showing settlement and cracking
- ESP provided investigations in 2014 and 2015 that included 3D GPR and roadway LIDAR.

EXAMPLE 3 – I-85 SETTLEMENT



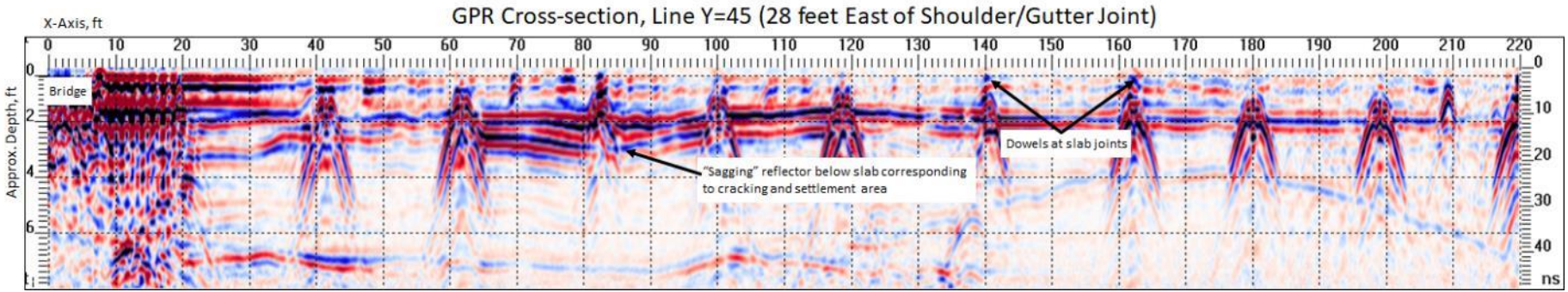
Roadway Topography



Slope of Roadway Surface, calculated for direction of travel

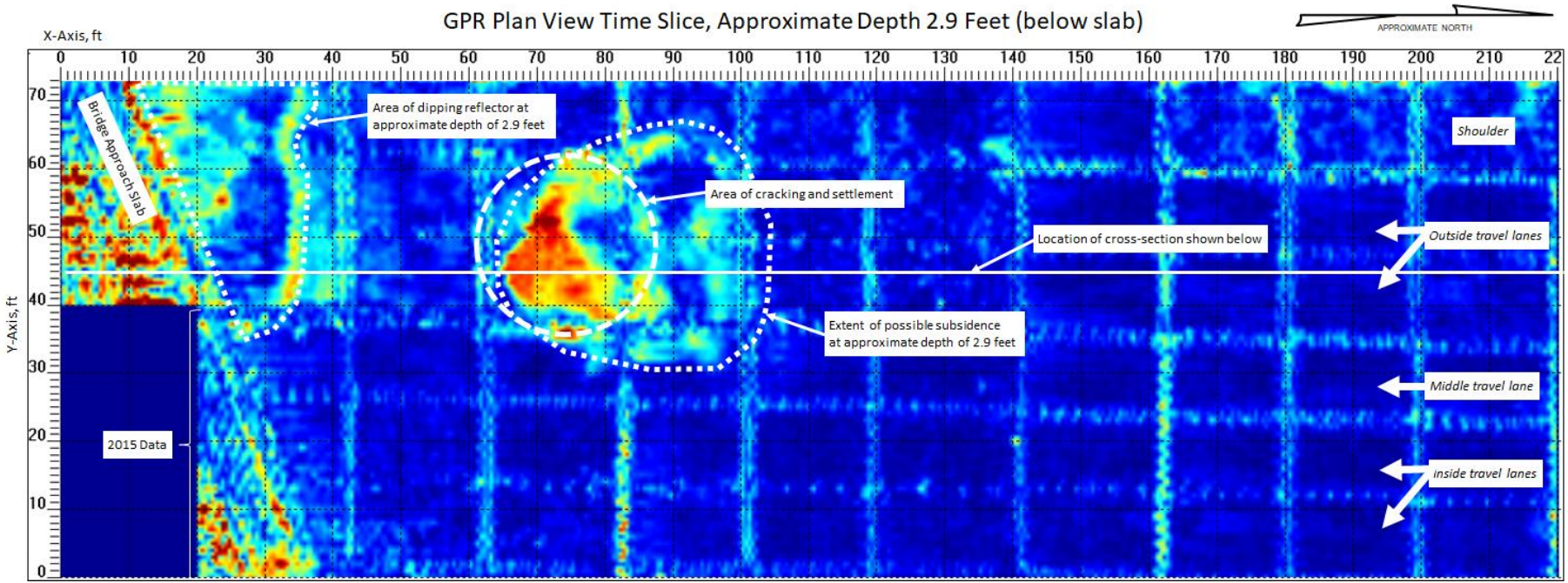
EXAMPLE 3 – I-85 SETTLEMENT

GPR 2D CROSS-SECTION



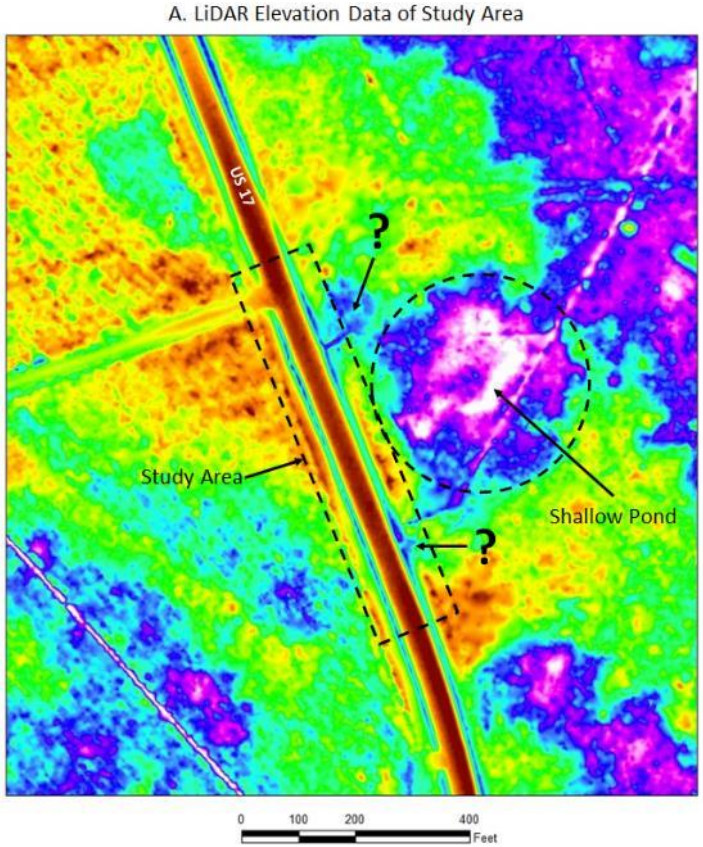
EXAMPLE 3 – I-85 SETTLEMENT

GPR TIME/DEPTHSLICE



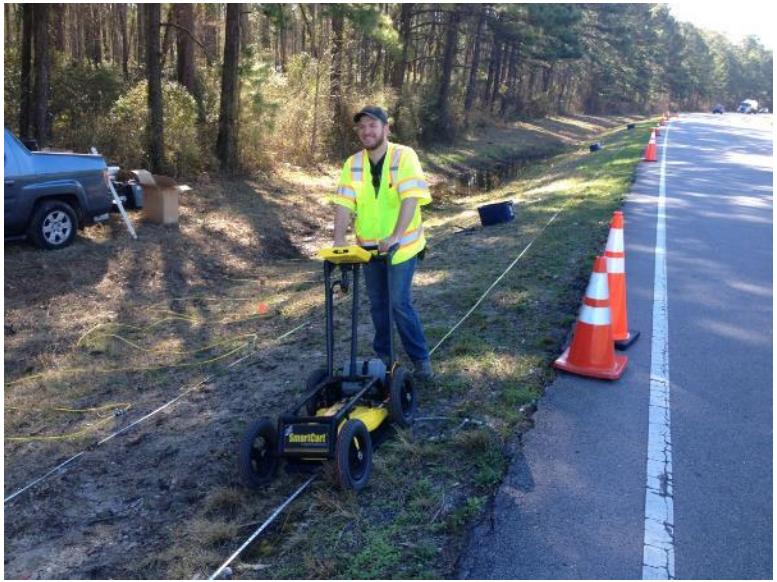
EXAMPLE 4 – HWY 17 VOIDS

EXAMPLE 4 – I-85 HWY 17 WILDLIFE CROSSING

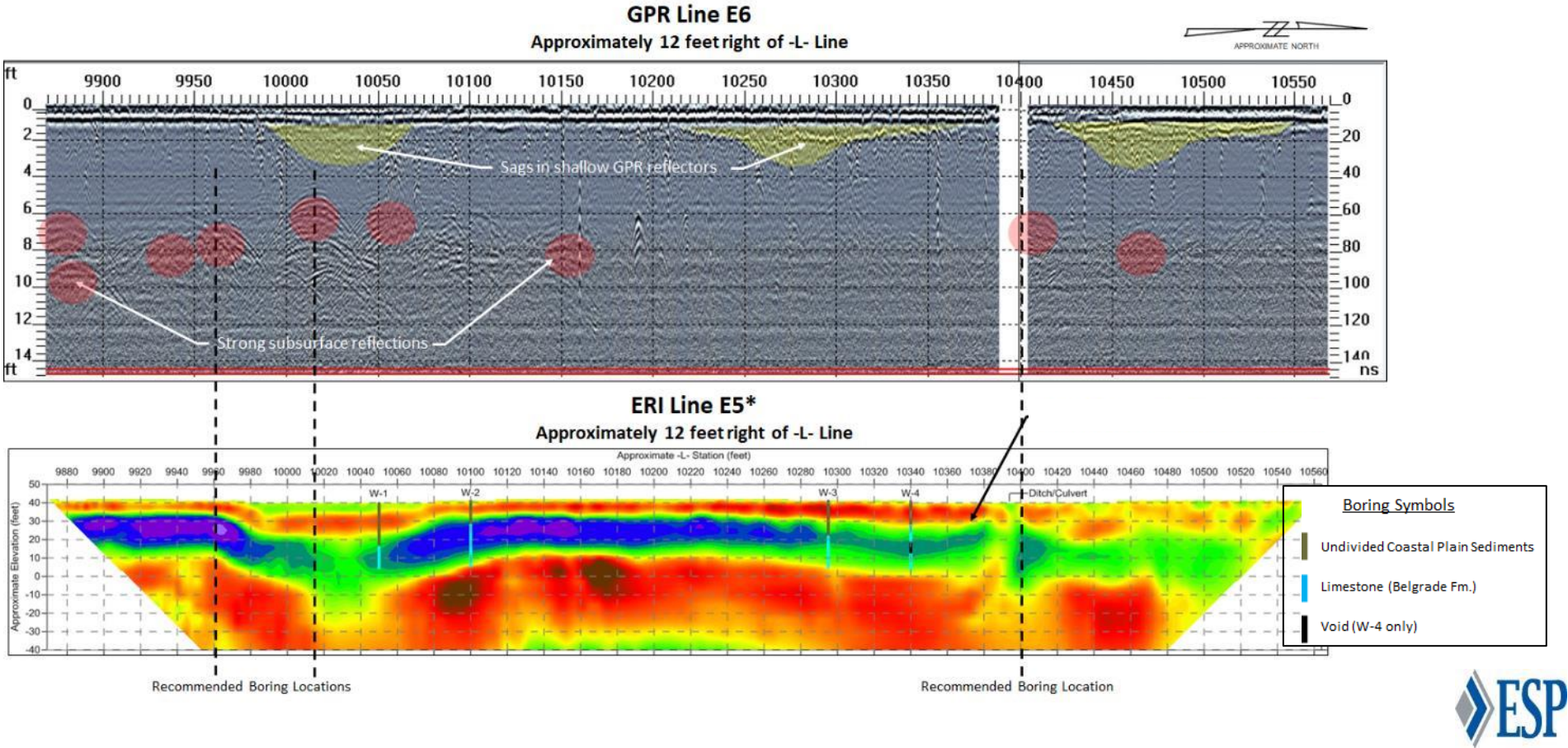


- NCDOT borings indicated a void in the area of a proposed wildlife crossing bridge.
- ESP provided geophysical services in 2015 that included 3D GPR and 2D ERI.
- Borings in 2016 encountered additional voids

EXAMPLE 4 – I-85 HWY 17 WILDLIFE CROSSING



EXAMPLE 4 – I-85 HWY 17 WILDLIFE CROSSING



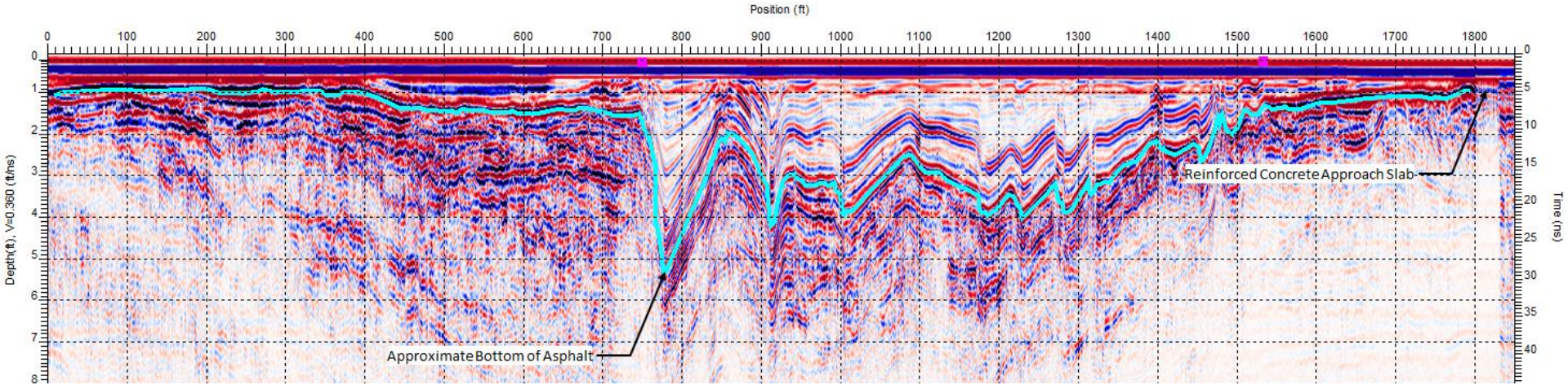
EXAMPLE 5 – ALL-AMERICAN FREEWAY

EXAMPLE 5 – ALL-AMERICAN FREEWAY SETTLEMENT STUDY

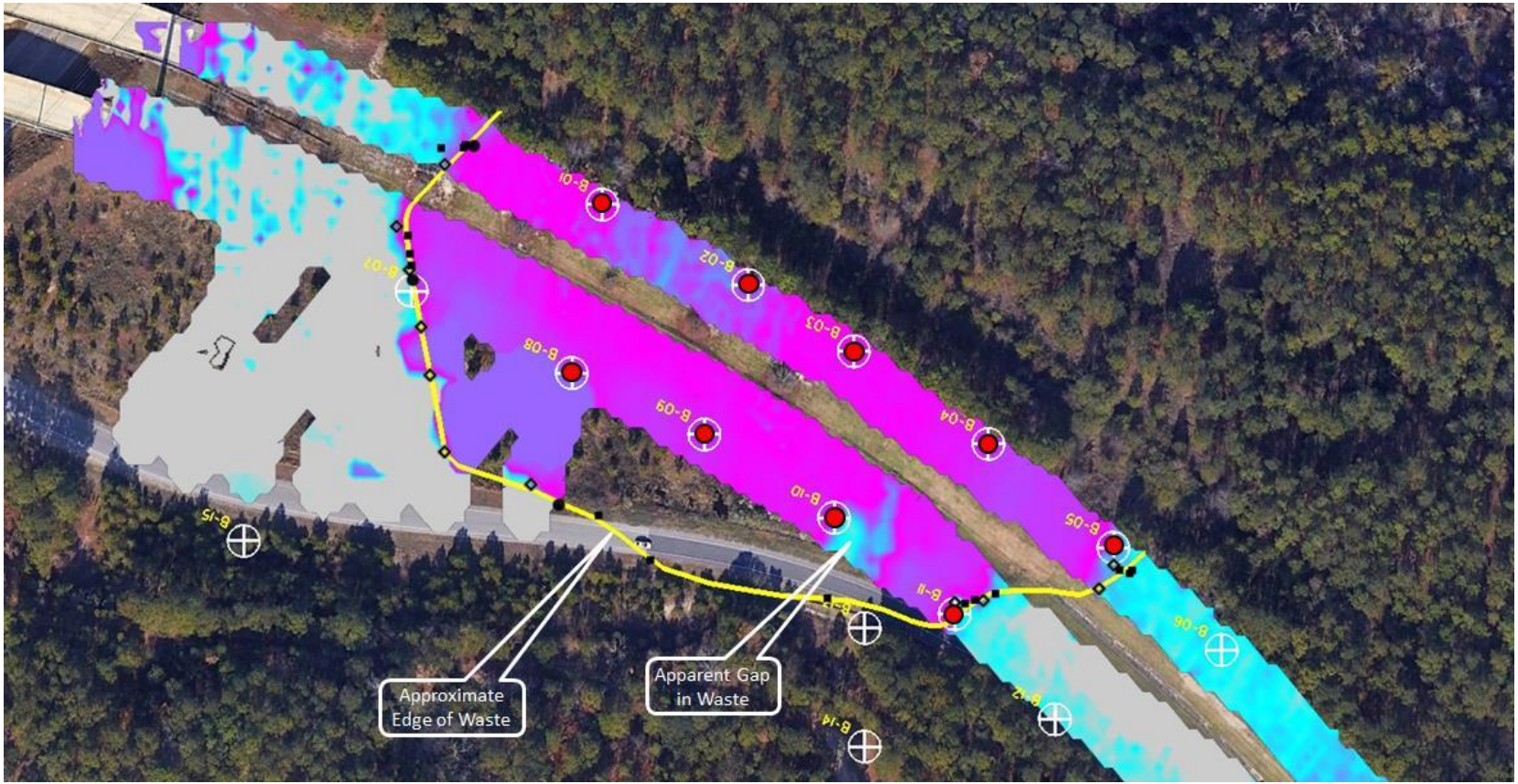
EXAMPLE 5 – ALL-AMERICAN FREEWAY SETTLEMENT STUDY

- In 2023, ESP collected geophysical data:
  - GPR for asphalt thickness
  - GEM-2 for lateral landfill limits
  - ERI/IP for vertical and lateral delineation

EXAMPLE 5 – ALL-AMERICAN FREEWAY SETTLEMENT STUDY



EXAMPLE 5 – ALL-AMERICAN FREEWAY SETTLEMENT STUDY



EXAMPLE 6 – OVERWATER GPR

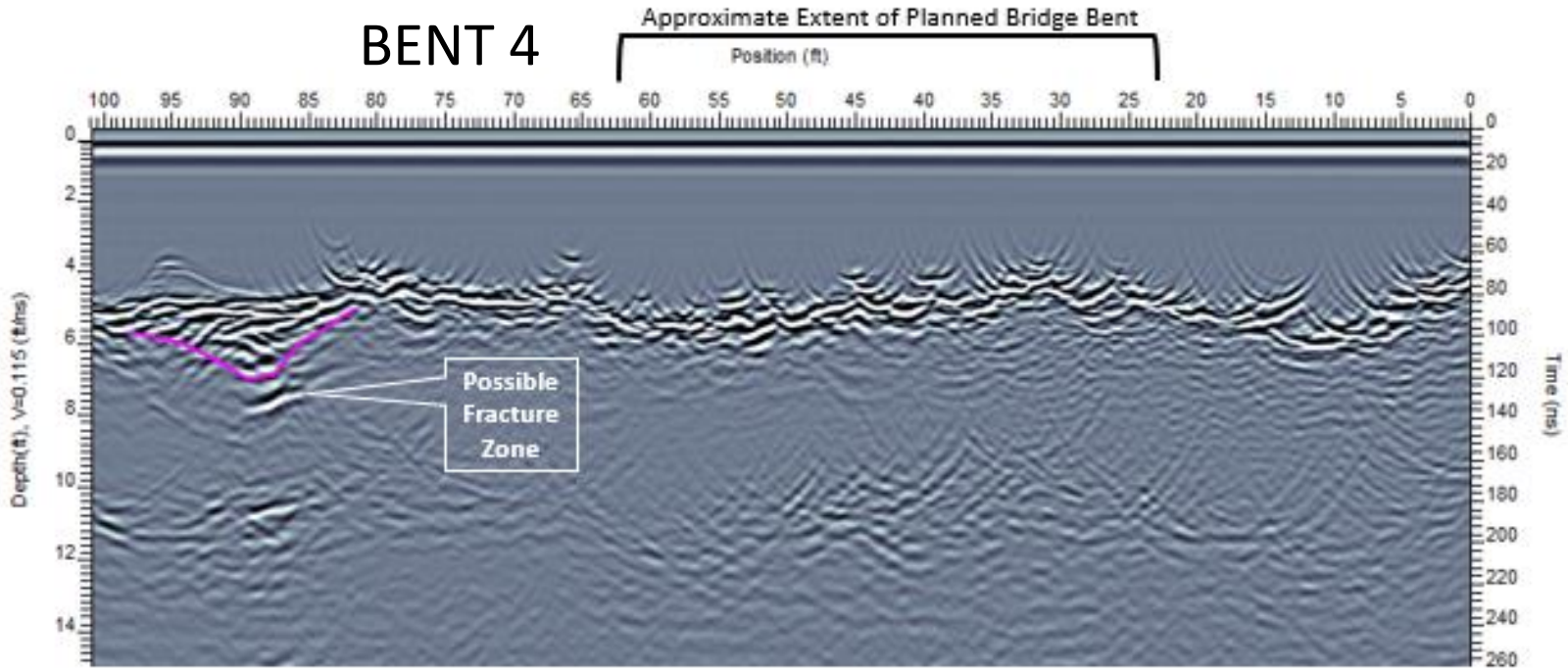
EXAMPLE 6 – OVERWATER GPR FOR HWY 48 BRIDGE REPLACEMENT

Highway 48 Bridge over Roanoke River

GPR data collected during moratorium

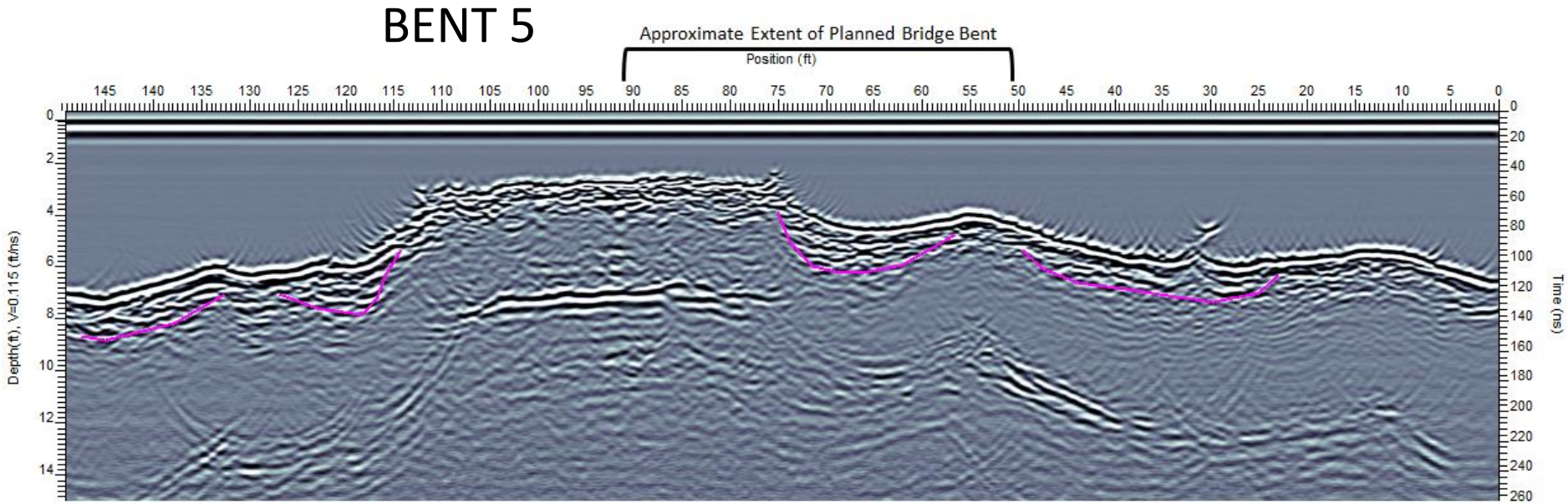
EXAMPLE 6 – OVERWATER GPR FOR HWY 48 BRIDGE REPLACEMENT

EXAMPLE 6 – OVERWATER GPR FOR HWY 48 BRIDGE REPLACEMENT



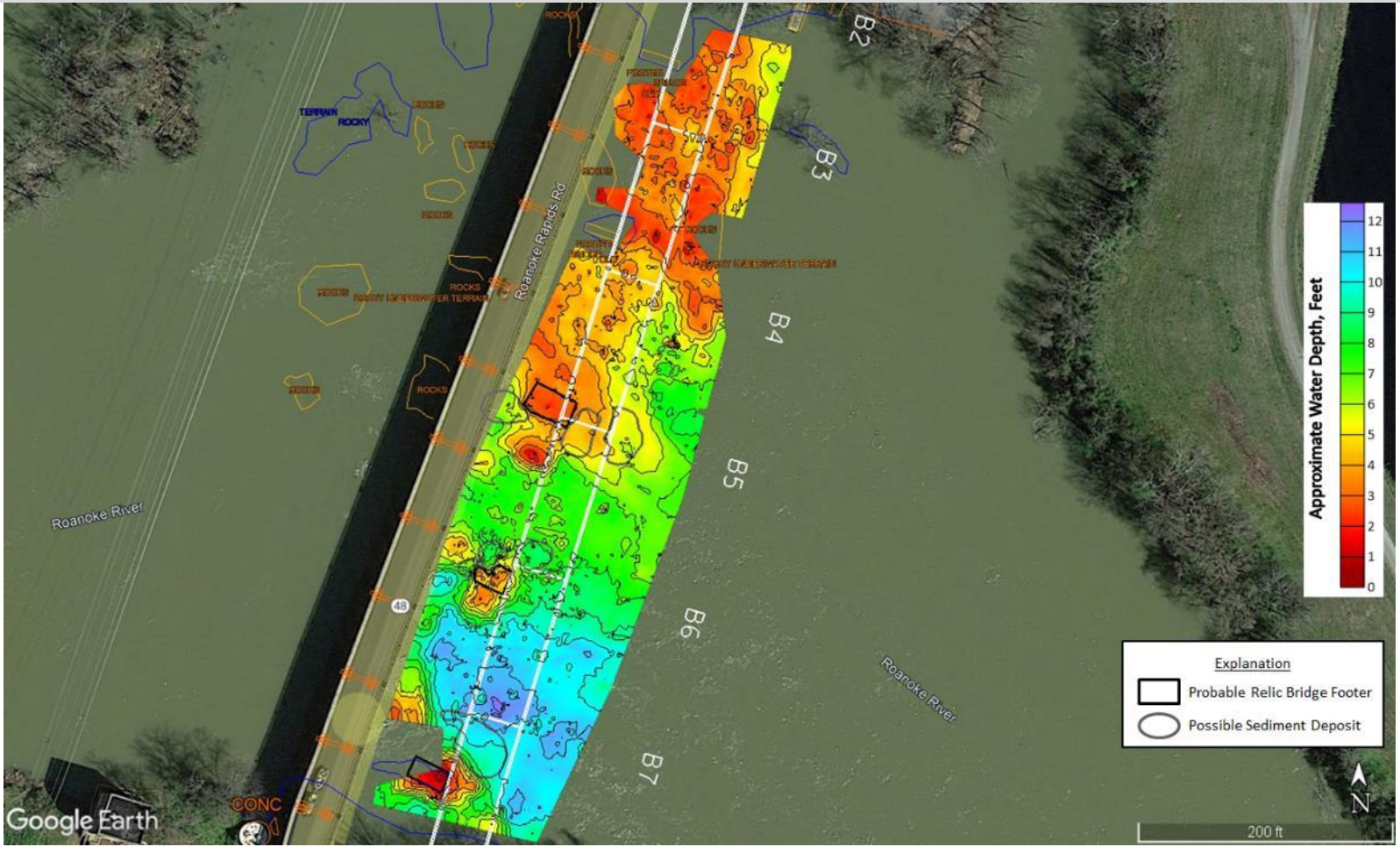
B. Remigrated 250 MHz GPR line 27 showing possible sediment deposit in possible weathered fracture zone..

EXAMPLE 6 – OVERWATER GPR FOR HWY 48 BRIDGE REPLACEMENT



B. Remigrated 250 MHz GPR line 3 showing possible sediment deposits.

EXAMPLE 6 – OVERWATER GPR FOR HWY 48 BRIDGE REPLACEMENT



COMMENTS

- After about 40 years of near-surface use, GPR remains versatile and effective, and continues to be improved.
- Current systems allow fast processing and display of 3D results, real-time integration with GPS positioning, multiple frequencies, and multi-antenna arrays.
- As with any geophysical technique, GPR is especially effective when used in combination with other geophysical techniques and when correlated with intrusive data.

Southeastern
Transportation
Geotechnical
Engineering
Conference

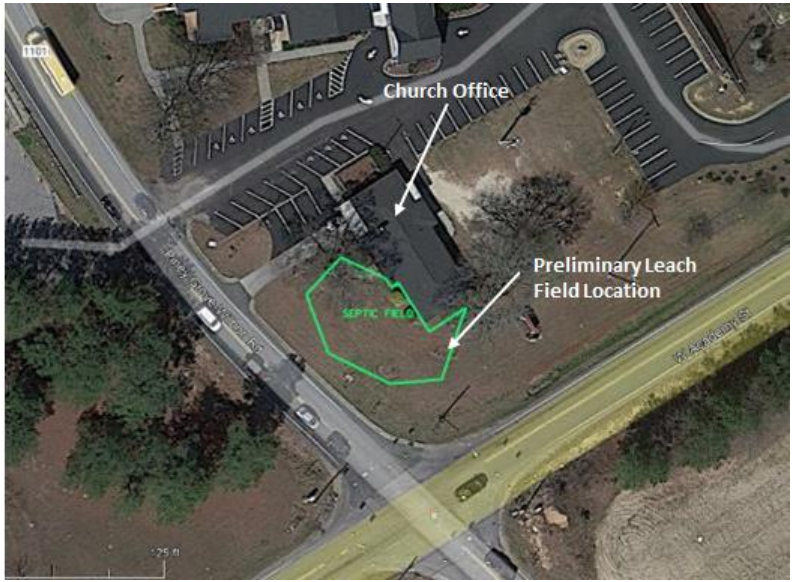
Charlotte
2023

ESP

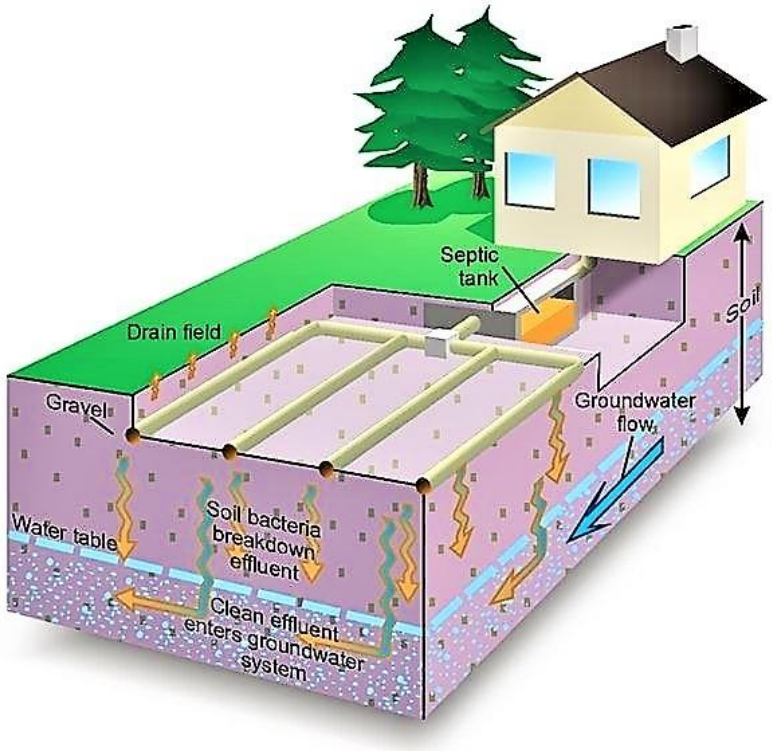
EXAMPLE 7 – SEPTIC LEACH FIELD

Intersection of NC 42 and Piney Grove-Wilbon Rd.

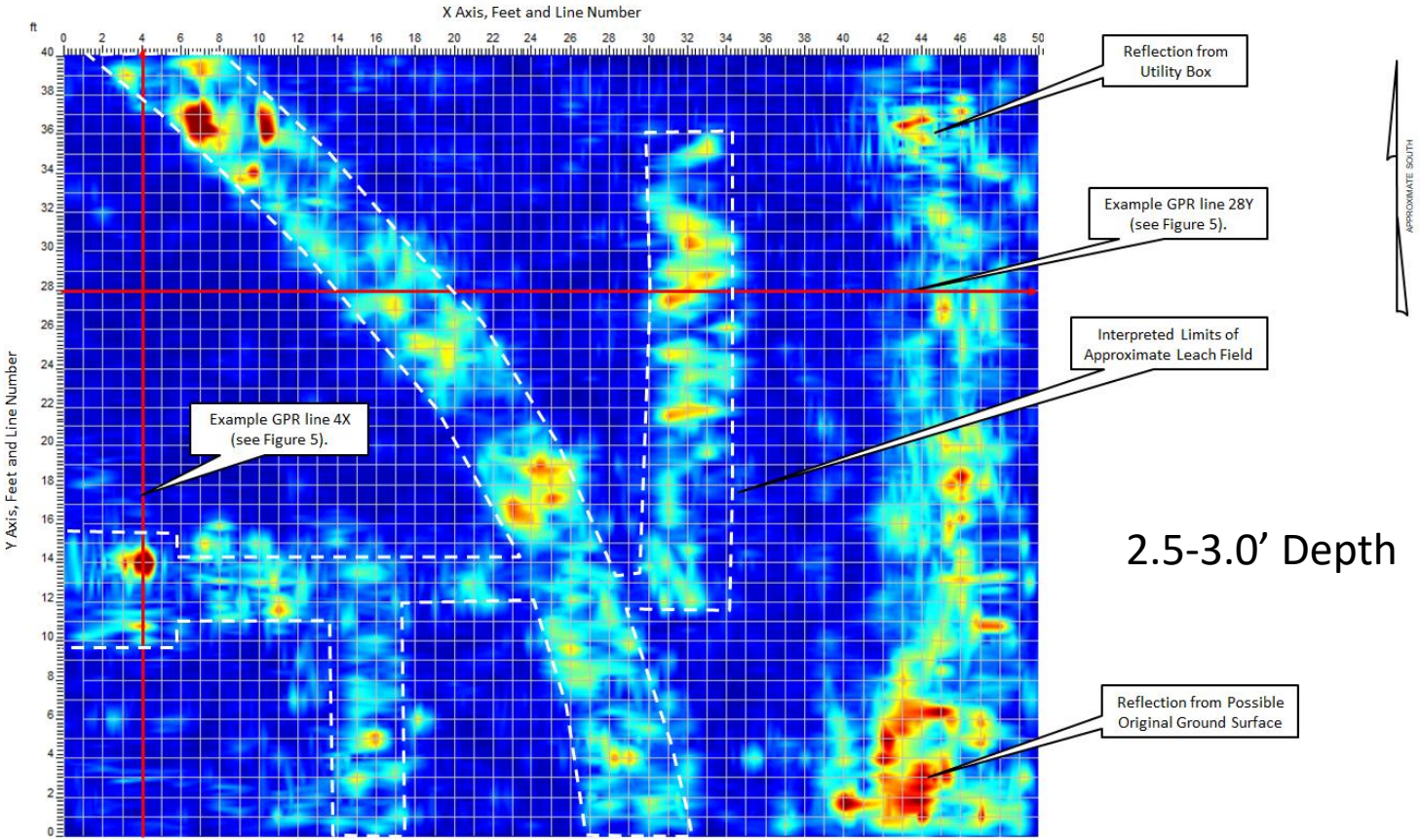
EXAMPLE 7 – SEPTIC LEACH FIELD



EXAMPLE 7 – SEPTIC LEACH FIELD



EXAMPLE 7 – SEPTIC LEACH FIELD



2.5-3.0’ Depth

EXAMPLE 7 – SEPTIC LEACH FIELD