

Ground Penetrating Radar (GPR) Archaeological Surveys



Marc Paalvast

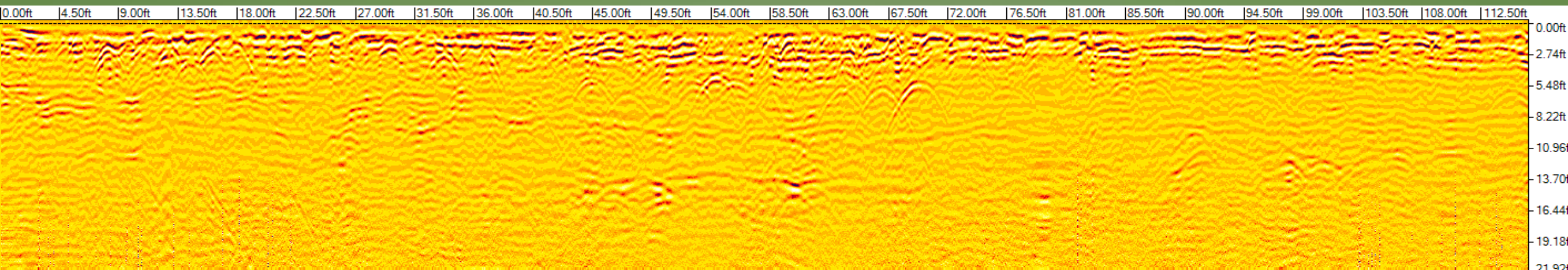
New Jersey Pinelands Commission
Cultural Resources Specialist

Funded by:



GPR for Archaeological Surveys - Outline

- Ground Penetrating Radar
 - What is it and how does it work?
 - What are the benefits for archaeology?
 - How can GPR be used for finding unmarked burials?
- St. Mary's in the Pines GPR Survey – Pleasant Mills, Atlantic County
- African Methodist Episcopal Cemetery GPR Survey – Tabernacle, Burlington county
- Whitesbog Historic Village GPR Survey – Browns Mills, Burlington County
 - In progress



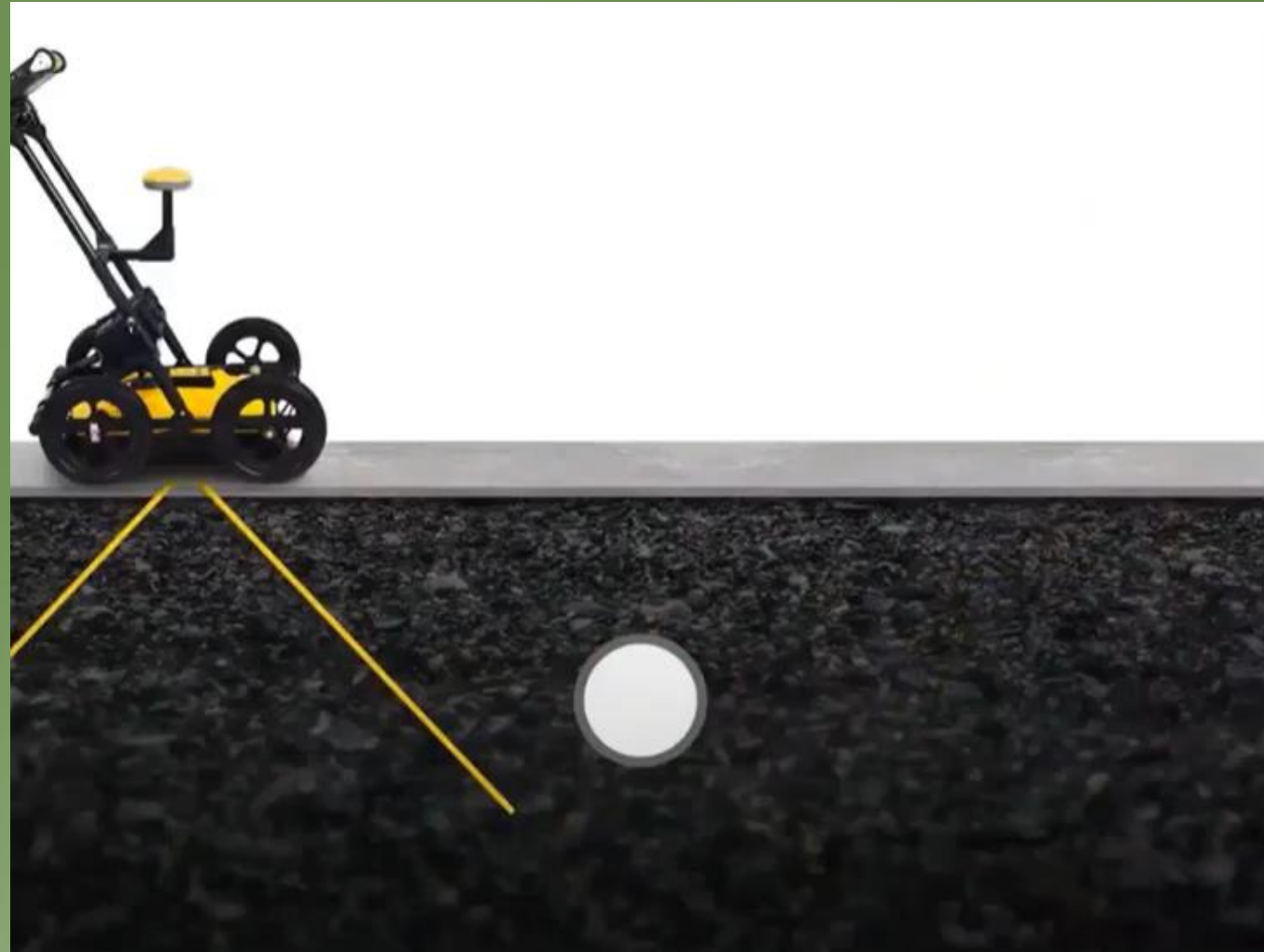
What is Ground penetrating radar (GPR)?

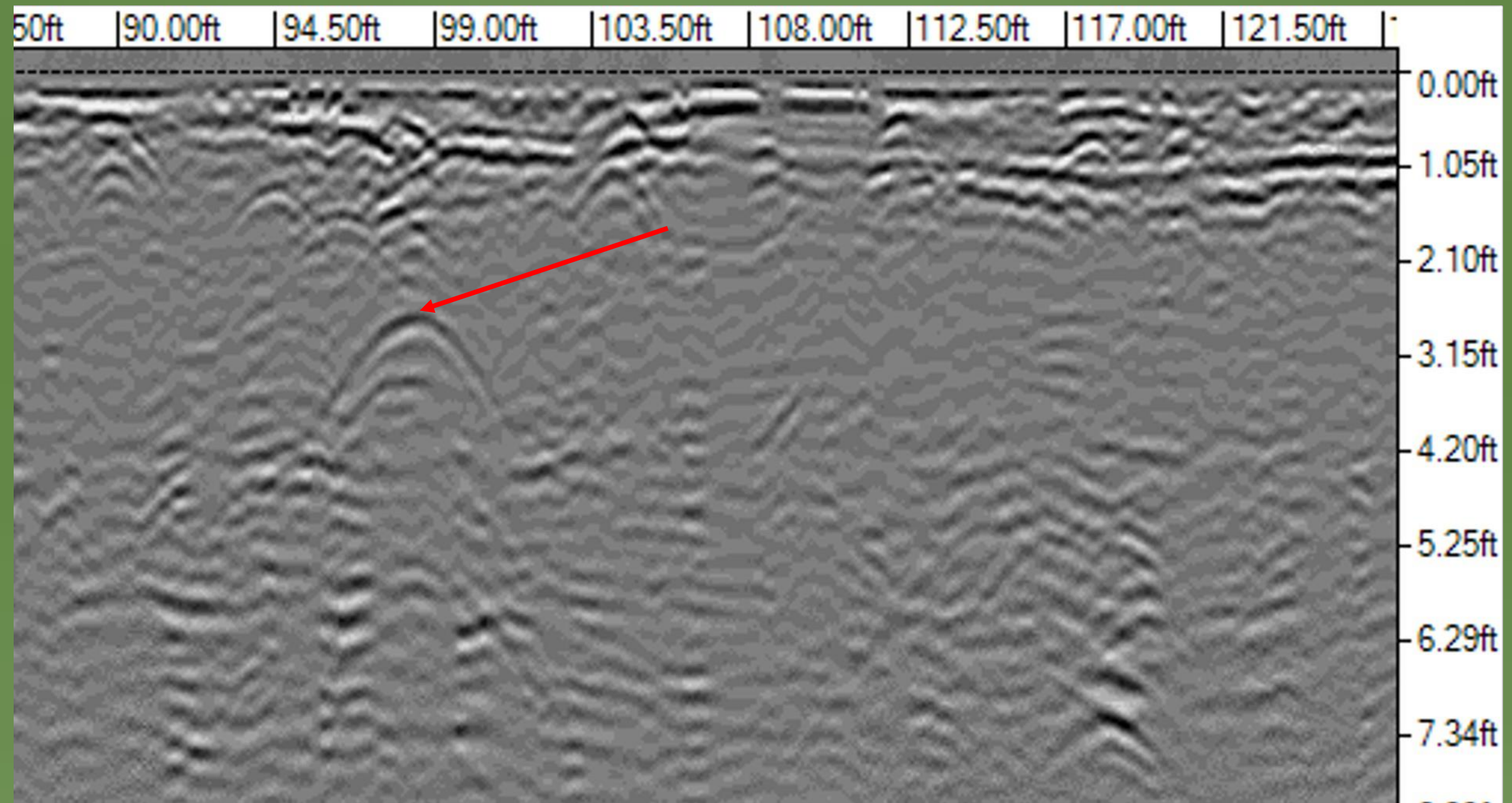
- A geophysical survey method that uses a wheeled device to send and receive electromagnetic waves to create images of the subsurface
- The device is rolled in linear transects much like a lawnmower

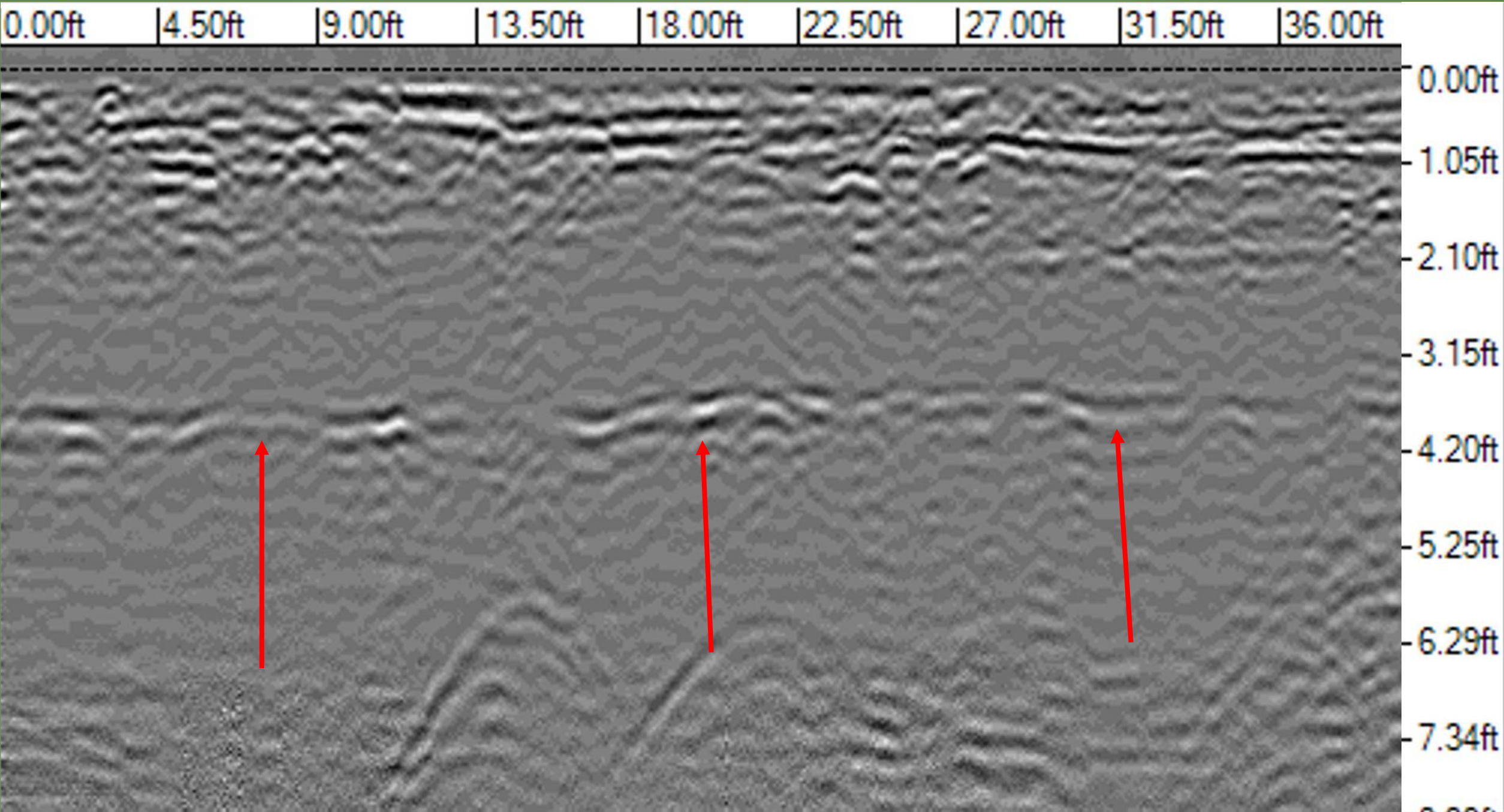


How does GPR work?

- Transmits high-frequency electromagnetic waves in the form of a large cone into the ground
- Waves are reflected back by subsurface objects or other changes in soils or sediments and recorded
- GPR does not produce lifelike images
- Reflections are usually in the shape of either hyperbolas or planes







Relative Dielectric Permittivity

- Stronger reflections are created by higher contrast in dielectric permittivity
- Lower numbers allow the GPR waves to pass through them easier
- Higher numbers absorb the waves
- How water soluble is the soil?
- Metal has a permittivity value of infinity. It does not let any of the electromagnetic wave through

Air	1	Frozen Soil/Permafrost	6
Snow Firn	1.5	Dry Salt	6
Dry Loamy/Clayey Soils	2.5	Syenite Porphyry	6
PVC	3	Wet Granite	6.5
Asphalt	3 - 5	Travertine	8
Glacial Ice	3.6	Wet Limestone	8
Dry Clay	4	Basalt	8 – 9
Dry Sands	4	Wet Basalt	8.5
Dry Granite	5	Tills	11
Limestone	4 – 8	Wet Concrete	12.5
Concrete	4 – 11	Volcanic Ash	13
Soils & sediments	4 – 30	Wet Sands	15
Coal	4.5	Saturated sand (20% porosity)	19 – 24
Frozen Sand & Gravel	5	Wet Sandy Soils	23.5
Shale	5 – 15	Dry Bauxite	25
Dry Concrete	5.5	Saturated Sands	25
Dry Limestone	5.5	Wet Clay	27
Dry Sand & Gravel	5.5	Peats (saturated)	61.5
Potash Ore	5.5	Organic Soils (saturated)	64
Sandstone	6	Sea Water	81
Dry Mineral/Sandy Soils	6	Water	81

What are the benefits of GPR?

- GPR is Non-invasive
- Archaeology is destructive by nature
 - Removes artifacts and features from their context while documenting
- Helps preserve the integrity of the site
 - Identifies potential artifacts and structural remains without physical excavation



What are the benefits of GPR?

- Developing research questions
- Planning excavations
- Avoidance



What are the benefits of GPR?

- See below obstructions that prevent manual excavations like concrete or pavement



GPR for finding unmarked burials

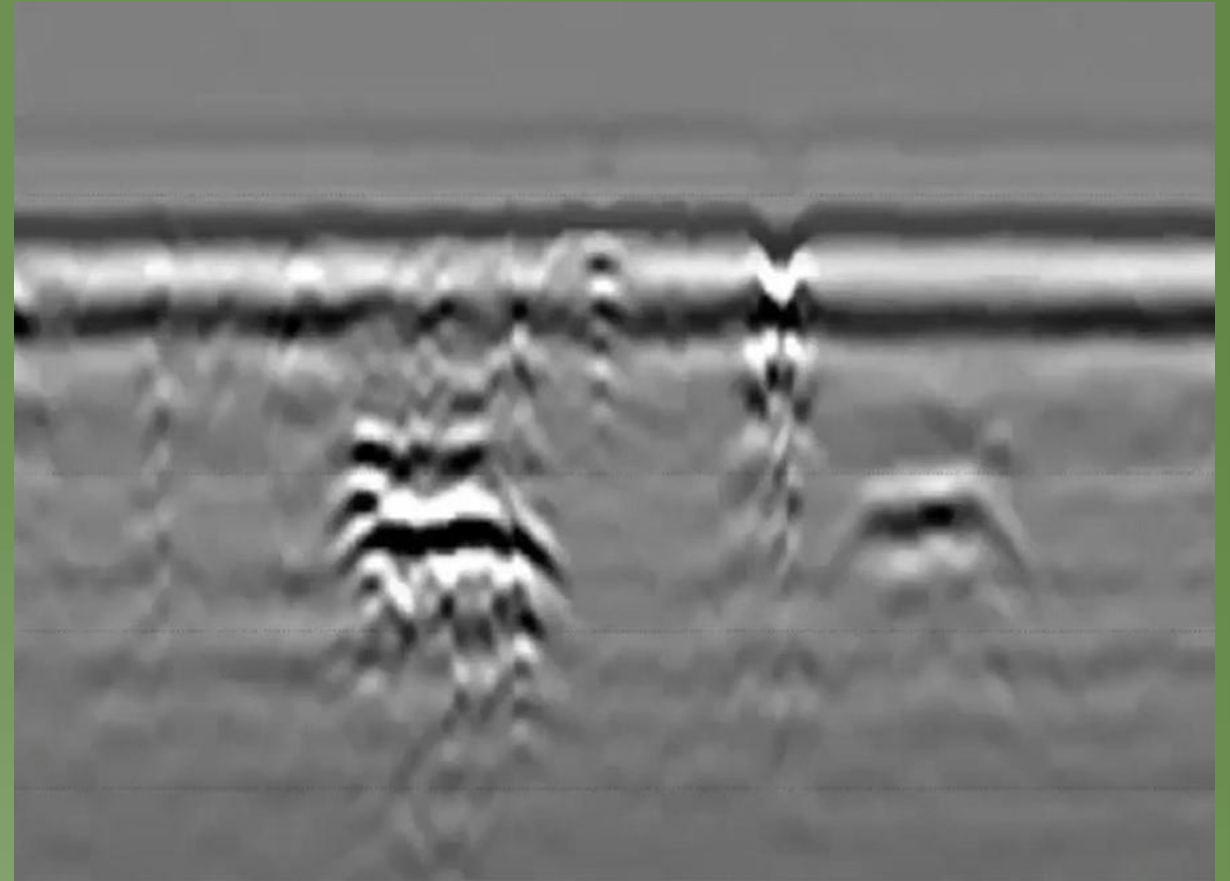
Purpose:

- Identification of unmarked burials
- Protection from accidental disturbance
- Recognition of the deceased



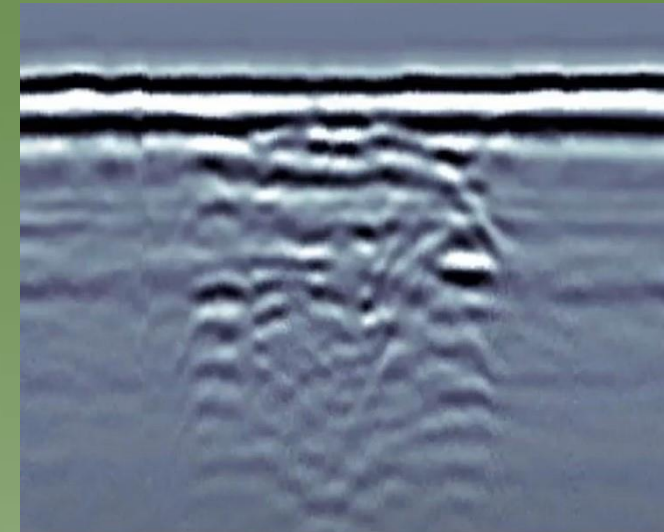
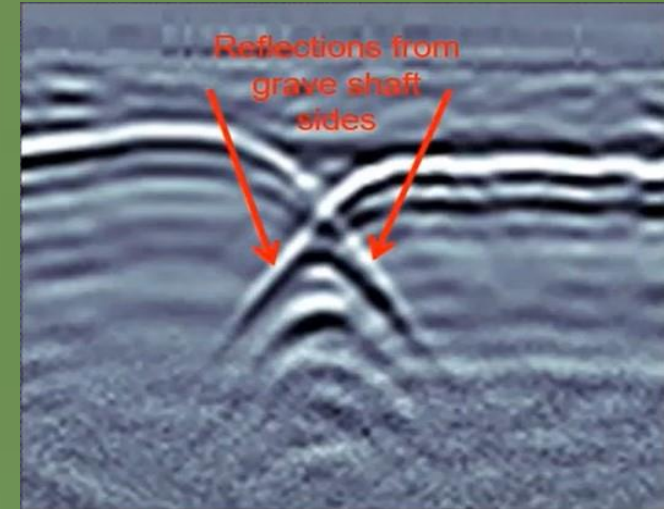
GPR for finding unmarked burials

- Fallen grave markers
- Caskets
 - Metal caskets create very strong reflections
 - Wooden caskets create weaker reflections
 - If intact, air inside casket will likely contrast and cause a visible reflection
 - If collapsed, weaker reflections from casket, human remains, or offerings



GPR for finding unmarked burials

- Grave shafts
 - Sides of grave shaft can be recorded as an X-shaped reflection
 - See breaks in soil stratigraphy (reflection planes)
 - See differences in natural soil and refilled grave shafts



GPR Equipment

- US Radar Q5 series cart mounted GPR unit
 - Tablet with Radar Controller software
 - 500MHz auto-calibrating antenna
- Pin Flags
- Tape Measures
- GPS
- Notebook
- Camera

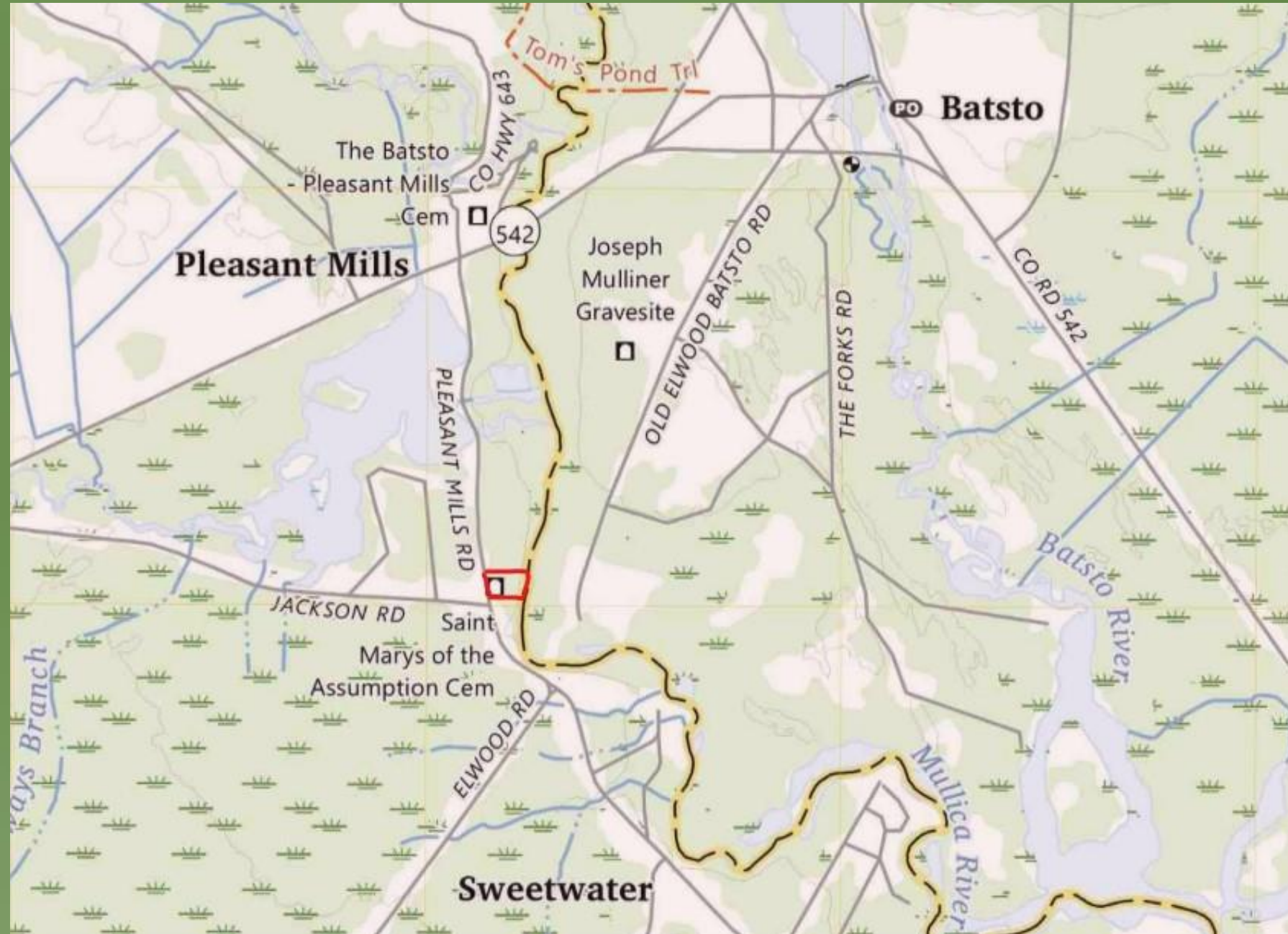


Pinelands Commission GPR Surveys

- St. Mary's in the Pines GPR Survey – Pleasant Mills, Atlantic County
- African Methodist Episcopal Cemetery GPR Survey – Tabernacle, Burlington county
- Whitesbog Historic Village GPR Survey – Browns Mills, Burlington County
 - In progress

St. Mary's in the Pines GPR Survey

Pleasant Mills,
Atlantic County



St. Mary's in the Pines - History



- 1826: Land donated by Jesse Richards, iron master at Batsto Iron Works
- 1827: Church building was erected
- 1830: Building was formerly dedicated
- 1860: Last church service was held
- 1900: Wildfire destroyed building



Watercolor by Carol Freas;
Courtesy of The Mullica in
the Pines Historical Society.

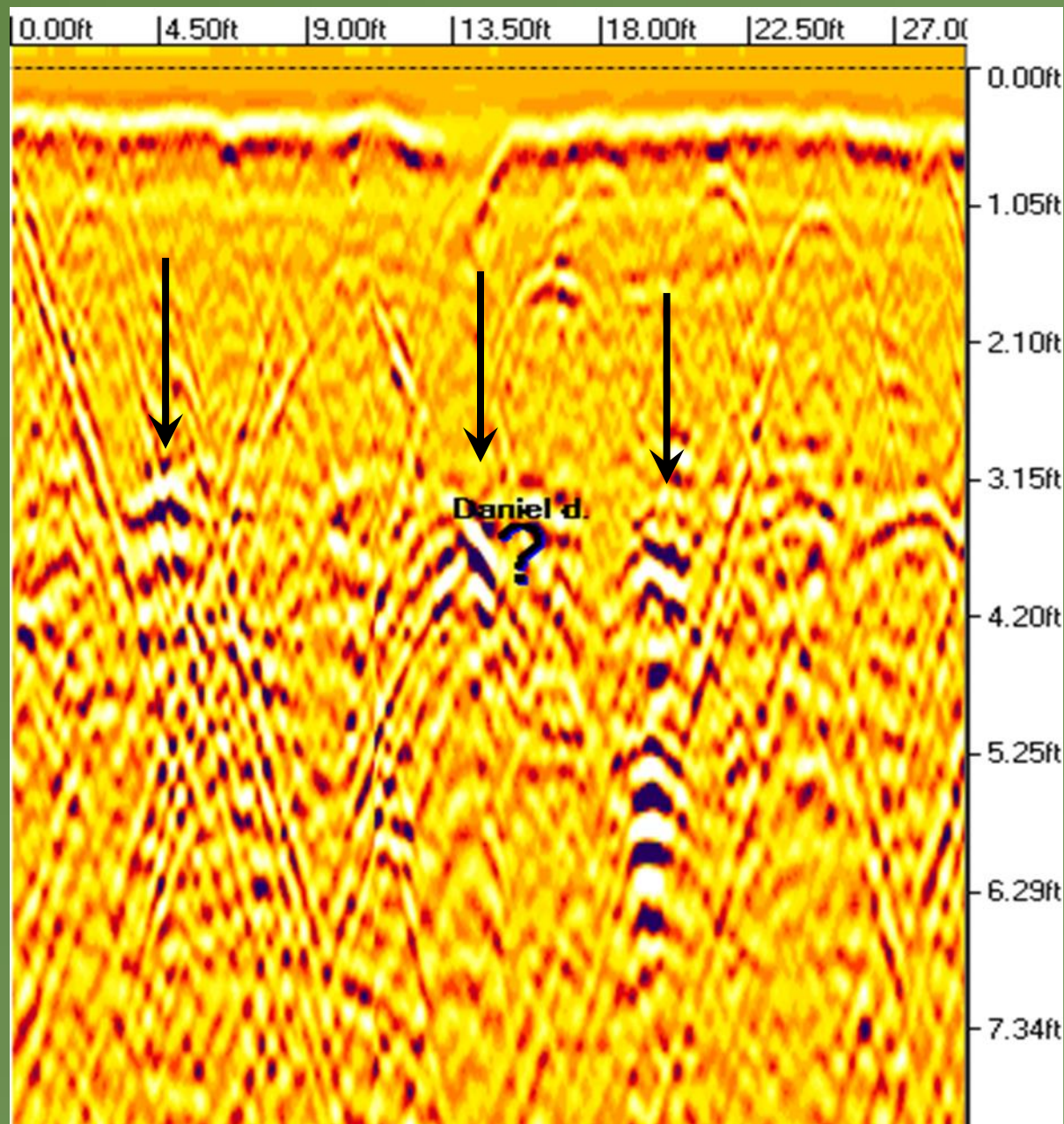
GPR Survey Methods – St. Mary's

- Fieldwork conducted on October 26 and 27, 2021
- A 70-foot baseline was established along the northern boundary
- Transects were oriented N to S and marked out at 5-foot intervals (total of 16)
- Test passes over marked burials

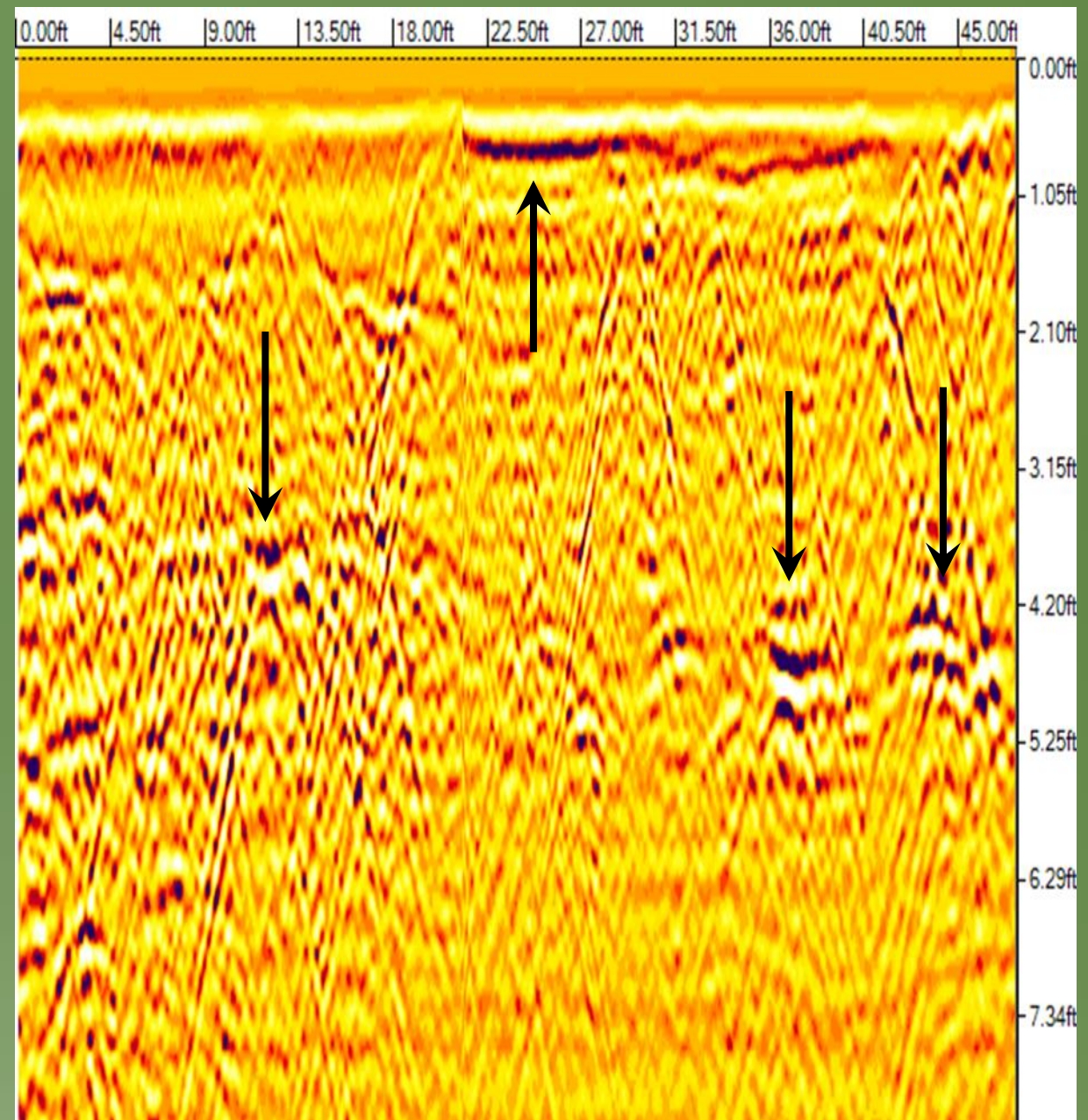








Reflection Profile – Test Transect 2



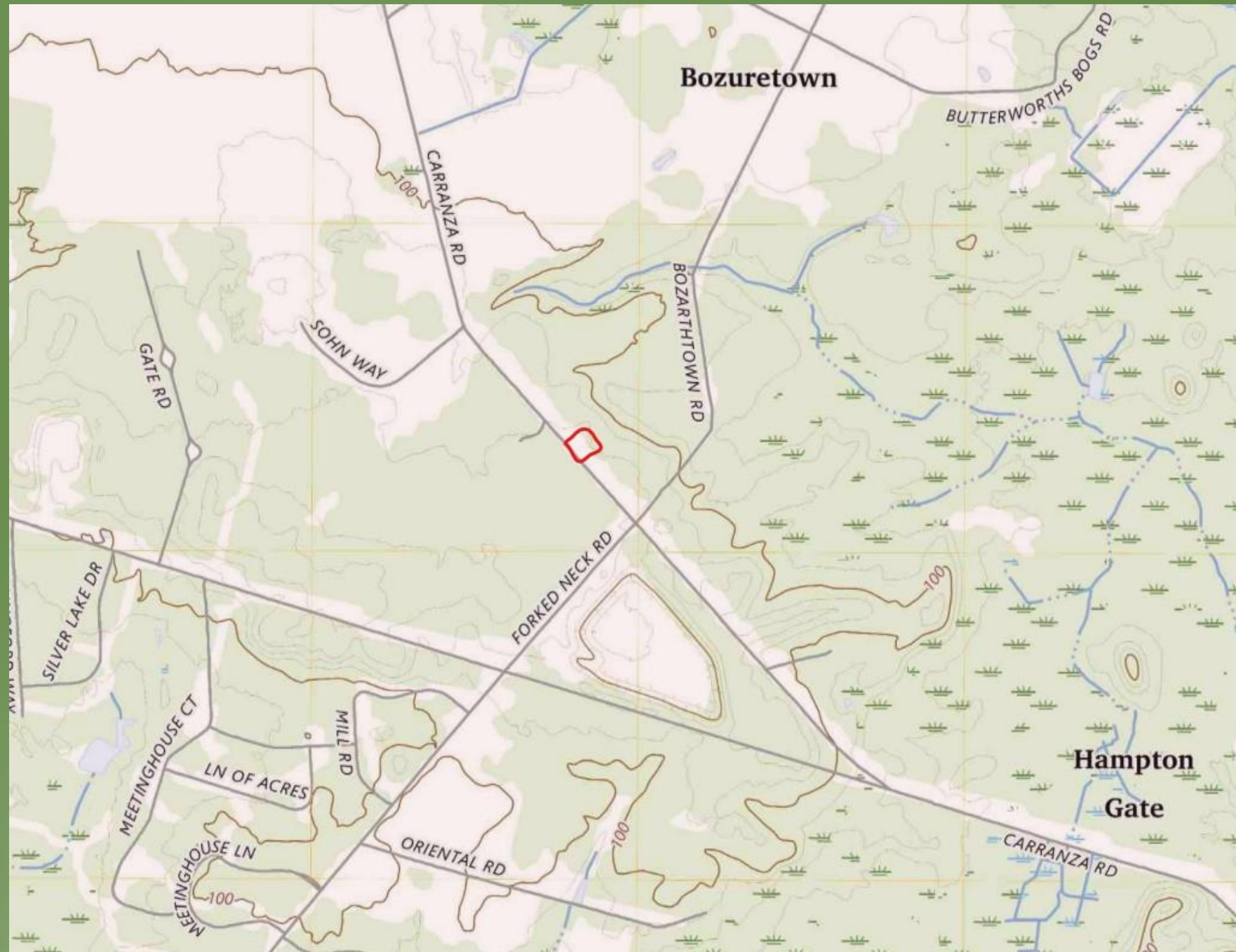
Reflection Profile – Transect 4

- Conclusions-
- 23 potential unmarked burials
- Some identified below church foundation which could represent burials or offerings
- Could be more outside of surveyed area



African Methodist Episcopal Cemetery GPR Survey

Tabernacle Twp.,
Burlington County



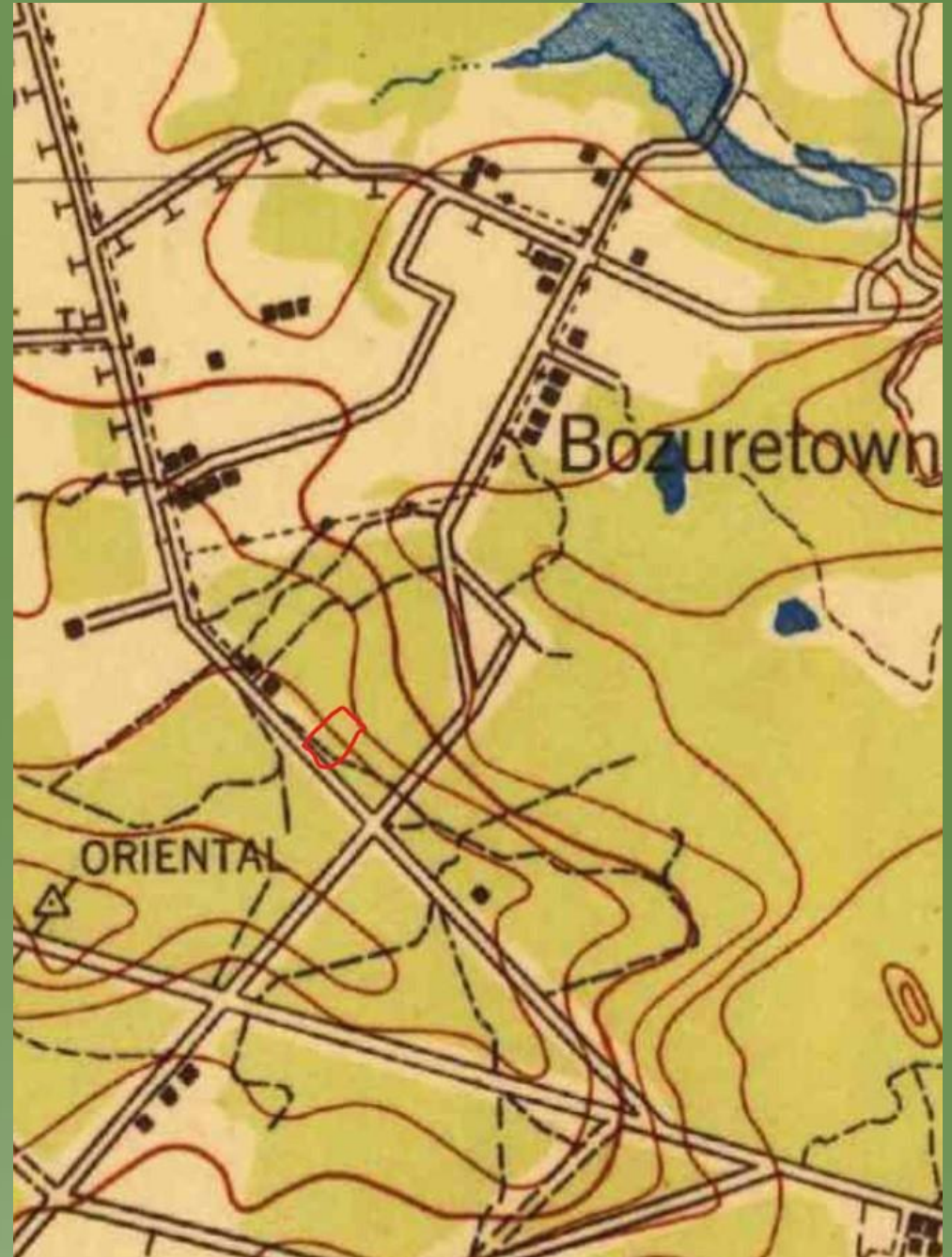
AME Church Cemetery- History



- 1816: AME Church was founded in Philadelphia
- 1868: Property sold to the "Trustees of the African M.E. Ch."
 - Deed names George Eayers, David Thompson and Stacey Mires
- 1930: Church appears visible in historic aerial image
- 1937: Veterans Grave Registration survey map depicts George Eares grave marker and "Foundation of old church"



1930 aerial image



1942 USGS topo map

WOODLAND

20

Geo. H. EARES.

PRIVATE ROAD.

FOUNDATION
OF
OLD
CHURCH.

WOODLAND

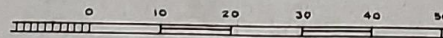
WOODLAND

TO TABERNACLE
ABOUT 3 MILES.

OLD TUCKERTON ROAD

TO CARANZA MONUMENT.

AFRICAN CEMETERY AT HAMPTON GATE
TABERNACLE TOWNSHIP
Scale: One Inch = 10 Feet.



—LEGEND—

Numbers appearing in the pathways
at the foot of burial sites indicates
the following Wars —

War of the Rebellion - No. 20

- GRAVE WITH MONUMENT
- GRAVE WITHOUT MONUMENT

VETERANS GRAVES REGISTRATION

STATE WIDE PROJECT No. WORKS PROGRESS ADMINISTRATION
sponsored by

WILLIAM A. HIGGINS ADJUTANT GENERAL STATE OF NEW JERSEY
Under Direction Of
J. E. LAURENCELLE
June 8, 1938

COUNTY of BURLINGTON

Delineated by W. H. K. Date Jan. 21, 1937
Wm. H. Kenderdine - Engineer Francis J. Mulvaney - County Supervisor

WORKS PROGRESS ADMINISTRATION

WILLIAM M. J. ELY

STATE ADMINISTRATOR

DIVISION of WOMEN'S and PROFESSIONAL PROJECT

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STATE DIRECTOR

WILLIAM A. KEARNS

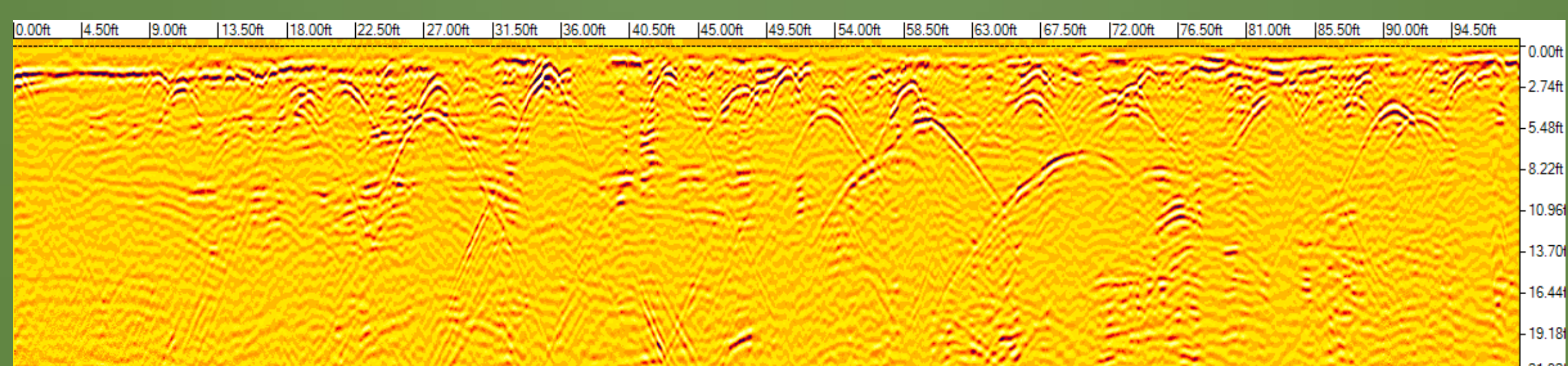
ASST STATE DIRECTOR

S/21
RF

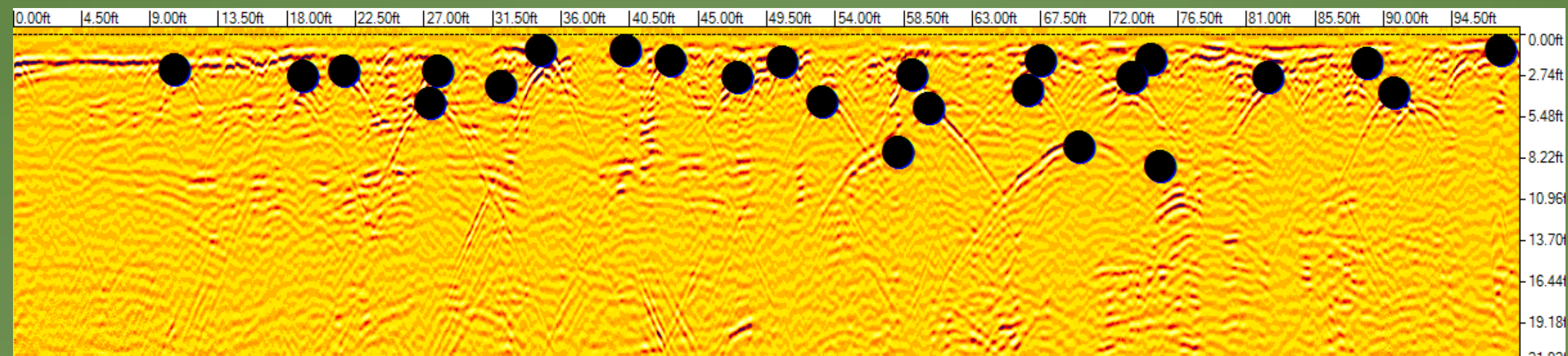
GPR Survey Methods – AME Church

- Fieldwork conducted on September 21, 2023
- Baseline established between Lots 28 and 32
- End line established on N side of access road
- Transects were run parallel to Carranza Road and marked out at 2-foot intervals (total of 96)





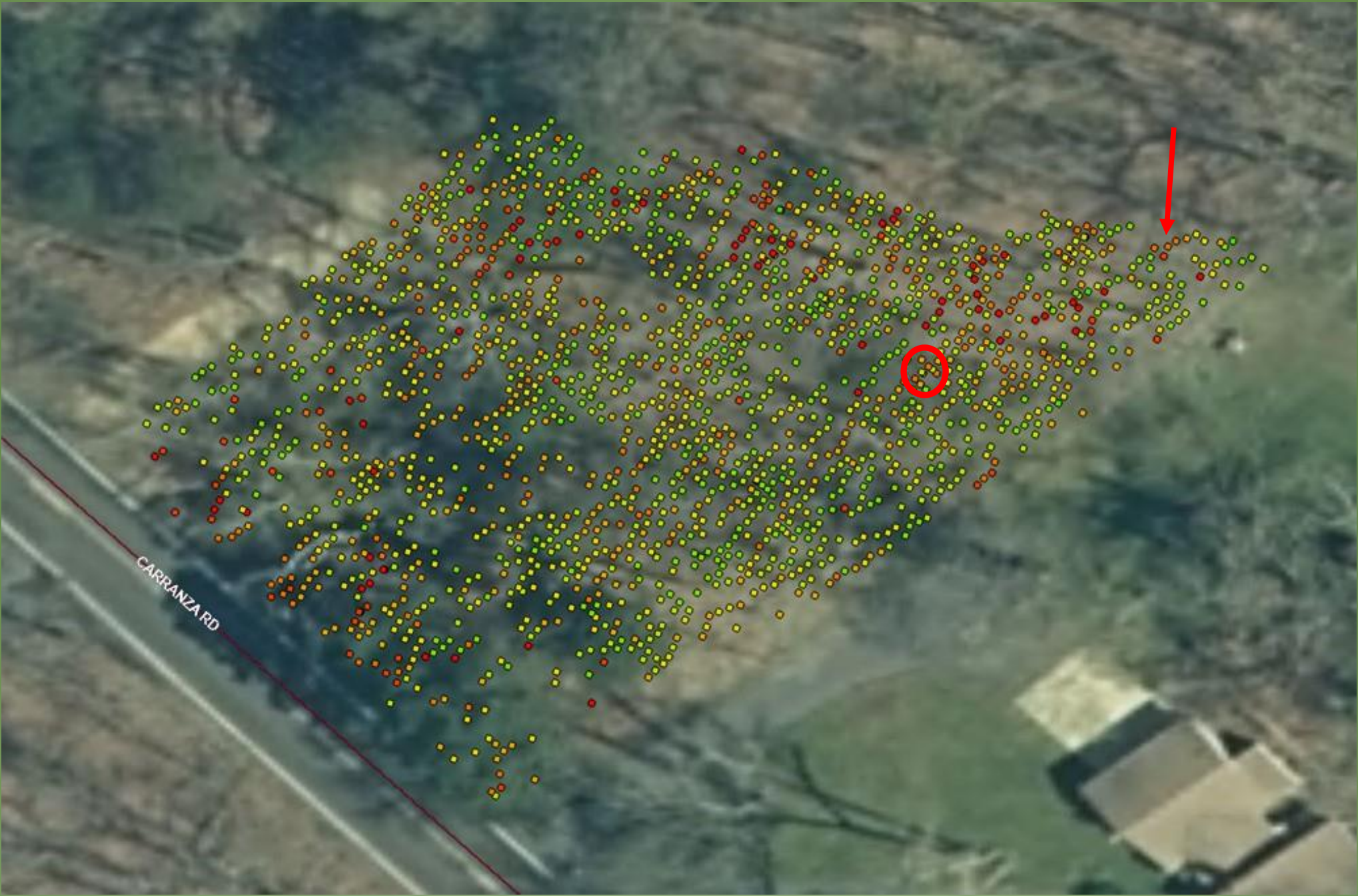
Reflection Profile – Transect 64



Reflection Profile – Transect 64 with mark up

Estimated Depth (feet bgs)	Total Number of Anomalies
0-0.5	5
1	333
2	419
3	436
4	322
5	122
6	33
7	34
8	28
9	19
10	4
11	16
12 to 17	11
TOTAL	1782

- Image shows all data points between 0 and 9.5 feet deep
- Red/Orange indicates depth of ≈ 4 to 7 feet
- Possible burial noted on far edge of cemetery (arrow)
- George Eares tombstone (circled)



- Map showing all anomalies found below 5.5 feet
- Almost none in area where building likely stood
- Surrounding building on front and back
- Data points include both marked and unmarked burials
- Note orientation of multiple point anomalies





Conclusions-

- Potential for many unmarked burials on the site
 - Several near Carranza Road
 - One in rear of the site (possibility for more in unmaintained woods)
- Building was likely located in the area with few subsurface anomalies

Whitesbog Historic Village GPR Survey

Browns Mills,
Burlington County

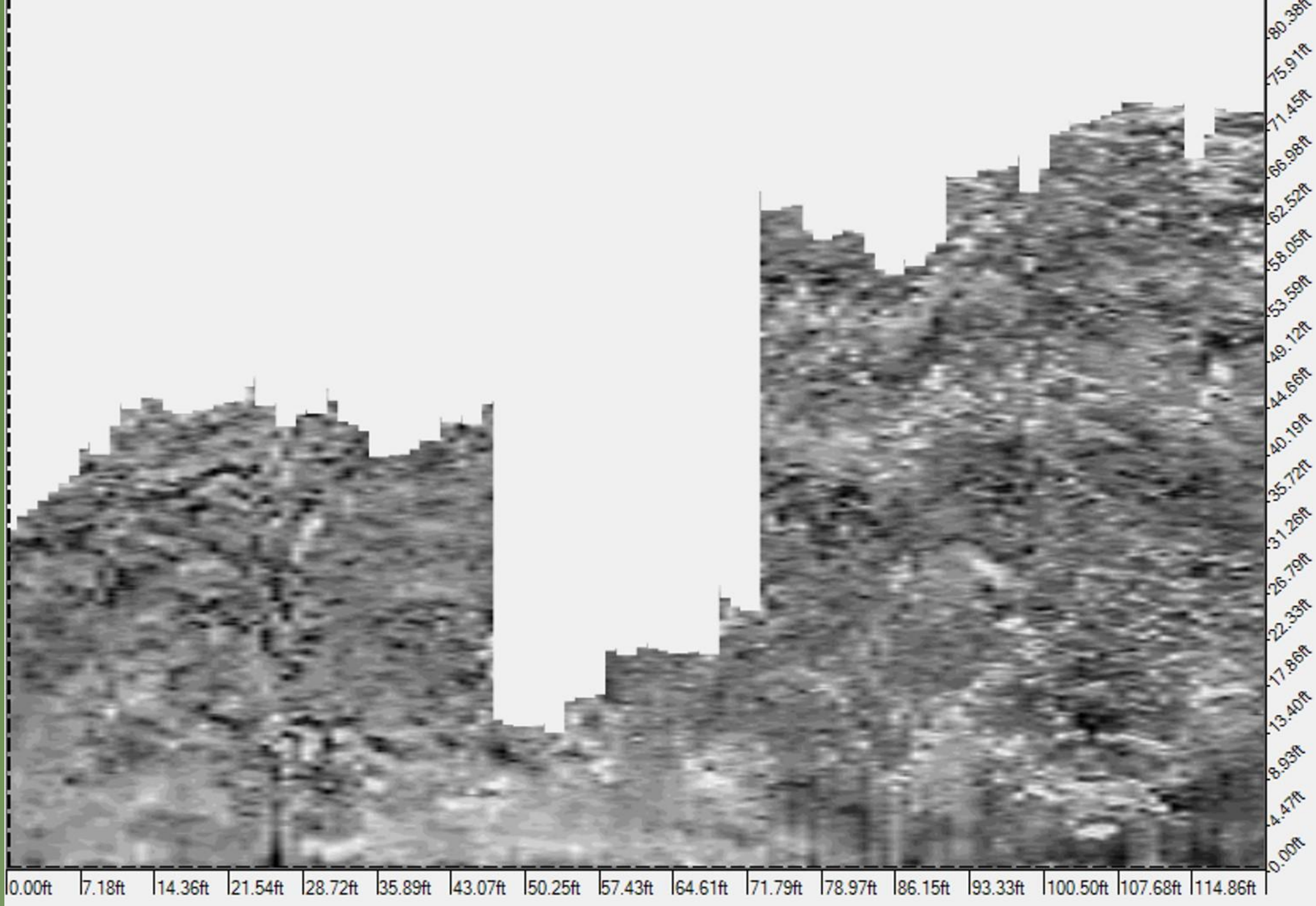


Whitesbog Historic Village

- Fieldwork conducted on April 9-10, 2025
- Baseline established along N Whitesbog Road
- Transects set at 1-foot increments and walked toward the NE ending at woodline
- Total of 124 transects recorded



- Goal for project is to identify if this portion of Whitesbog had historic buildings
- Depth Slice shows data from all 124 transects at a depth of .5ft
- Possible walkway and small structure in lower left
- More to come...



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THANK YOU!

- Questions?

- For Pinelands GPR Surveys go to <https://www.nj.gov/pinelands/landuse/culturalres/>