Geotechnical Engineering Report

Paulding County Site
Dallas, Paulding County, Georgia
April 24, 2023
Terracon Project No. 49235050

Prepared for:
Highlands Residential, LLC.
Atlanta, Georgia

Prepared by:
Terracon Consultants, Inc.
Atlanta, Georgia

April 24, 2023

Terracon GeoReport

Highlands Residential, LLC.
1777 Peachtree St Ste 200
Atlanta, Georgia 30309

Attn: Mr. Hunter Holiday
P: (404) 694 1861
E: HHoliday@HighlandsResidential.com

Re: Geotechnical Engineering Report
Paulding County Site
4070 Charles Hardy Parkway
Dallas, Paulding County, Georgia
Terracon Project No. 49235050

Dear Mr. Holiday

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. P49235050 dated March 3, 2023. This report presents the results of the Multichannel Analysis of Subsurface Waves (MASW) seismic testing performed at the project site.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

GEORGIA REGISTERED No. 21774 PROFESSIONAL ENGINEER WILLIAM J. SHEFFIELD

Nikheel Padhye, E.I.T.
Senior Staff Engineer

William J. Sheffield, P.E.
Manager | Geotechnical Services

Terracon Consultants, Inc. 2105 Newpoint Place, Suite 600 Lawrenceville, Georgia 30043
P (770) 623 0755 F (770) 623 9628 terracon.com

REPORT TOPICS

Note: This report was originally delivered in a web-based format. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Geotechnical Engineering Report

Paulding County Site
4070 Charles Hardy Parkway
Dallas, Paulding County, Georgia
Terracon Project No. 49235050
April 24, 2023

INTRODUCTION

Seismic refraction testing has been performed for the Paulding County Site generally located at 4070 Charles Hardy Parkway in Dallas, Paulding County, Georgia. Terracon's geotechnical services included the performance of 4 Multichannel Analysis of Subsurface Waves (MASW) seismic refraction traverses.

The purpose of these services was to provide a preliminary information relative to the estimated depths to rock at the site. We note that groundwater is more likely to be present in the lower areas of the site and could result in a "false" rock interpretation.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of readily available geologic and topographic maps as well as provided documents, plans, etc.

Item	Description
Parcel Information	The project is located at 4070 Charles Hardy Parkway in Dallas, Paulding County, Georgia. Approximate size of property: ±23 acres Approximate Coordinates: 33.9325662°N / -84.7258348° W
Existing Improvements	The north and eastern portions of the site appear to be cleared and developed with multiple residential structures, two driveways, and fields that appear to have been used for agricultural purposes in the past. A small pond is also present in the northern portion of the site. The remaining portions of the site appear to be undeveloped, wooded land.
Current Ground Cover	The site consists of open grass field towards the north and east of the site and is moderately to heavily wooded to the west and southern part of the site.

Item	Description
Existing Topography (from USGS)	The site appears to be defined by a high point in the wooded area at the southeast corner of the site and a drainage feature that crosses through the central portion of the site. From the high areas, the ground surface generally slopes down to the drainage feature that exits the property in the Southwestern portion of the site. Overall total topographic relief appears to approach 60 feet. We note that the drainage feature that nearly bisects the site appears to be listed on the National Wetlands Inventory.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. Our current understanding of the project conditions is as follows:

Item	Description
Information Provided	Our understanding of the project is based upon email correspondence and telephone conversations with you. ■ Link to the array location plan. (https://www.google.com/maps/d/edit?mid=1RcbXG4VuuwSjvYOsFP8wAAhaimSay-jR&usp=sharing)
Project Description (assumed)	Based on the information provided in May 2022, the proposed project is planned to be developed to include multiple single-story senior cottages with attached parking lot, amenities and landscaped areas. More specific information is still not available.
Finished Floor Elevations	Will vary across site
Maximum Loads (assumed)	■ Columns: 50 kips ■ Walls: 2 kips per linear foot (klf) ■ Slabs: 100 pounds per square foot (psf)

GEOTECHNICAL CHARACTERIZATION

Site Geology

The project site is located in the Piedmont Physiographic Province of Georgia which is characterized by medium to high grade metamorphic rocks and scattered igneous intrusions. The term metamorphic describes rocks that have been subjected to high temperatures and/or pressures, usually deep within the earth's crust. These high temperatures and pressures cause the textural and mineralogical characteristics of the original rock to be altered and can also cause certain rock types to fully melt, becoming what is known as magma. Magma is less dense than the surrounding solidified rock and tends to move upward through fractures and joints, displacing the surrounding rock. This rock type is known as an igneous intrusion. Metamorphic rocks are predominant in this region but, due to erosion and uplift, both of these rocks will eventually become exposed at the land surface.

The subsurface bedrock in this region has undergone differing rates of weathering, which often produces a considerable variation in depth to competent rock over short horizontal distances. It is also not unusual for lenses and boulders of hard rock and zones of partially weathered rock to be present within the soil mantle above the general bedrock level. The typical residual soil profile consists of clayey soils near the surface, where soil weathering is more advanced, underlain by sandy silts and silty sands, which often consist of saprolites (native soils which maintain the original fabric of the parent rock). Generally, the soil becomes harder with depth to the top of parent crystalline rock or “massive bedrock” which occurs at depth.

The boundary between soil and rock is typically not sharply defined. A transitional zone termed "partially weathered rock" is normally found overlying bedrock. Partially weathered rock (PWR) is defined for engineering purposes as residual material with a standard penetration resistance exceeding 100 blows per foot (bpf).

According to *The United States Geologic Survey (USGS) website,* the project site is underlain by rocks of the Precambrian-Paleozoic geologic area; Hornblende Gneiss/ Amphibolite.

Cultivated soils are naturally developed residual soil profiles may be altered by man’s activities, such as farming, construction, etc. The upper more weathered soil overburden may be disturbed by harrowing, planting, or construction activities. These cultivated soils usually exist in a loose state and contain some topsoil and plant matter. They also have a propensity to hold water.

Summary of Inferred Subsurface Profile

Multichannel Analysis of Subsurface Waves (MASW) seismic testing is a non-invasive technique used to evaluate depth and layer velocity, or density/hardness, of soil, partially weathered rock (PWR), and rock. MASW is performed by collecting surface waves created by a seismic source. For this project, our seismic profile lengths were 260, 300, and 360 feet with geophones spaced at ten-foot intervals. The array and energy source configuration for this investigation provided an effective depth of investigation of approximately 50 feet.

During the sampling process, the geophones measure the compression waves that are generated from a sledgehammer striking an aluminum plate and send the information to a Geometrics Geode 24-channel seismograph for timing, storage, stacking, and enhancement. As the compression waves refract through harder/denser layers in the subsurface, the wave velocities increase. By varying the source to receiver location throughout the receiver array, a graph of time versus distance is developed which is used to calculate velocities (densities) and depths of the underlying materials. Changes in surface elevation along each array were measured and recorded using a survey level rod and hand level and were incorporated into the analysis process.

The data is processed using dispersion analysis software (SurfSeis, engineered by the Kansas Geological Survey) that extracts the fundamental-mode dispersion curve(s). The curves are inverted and modeled to yield a 1D shear-wave (S-wave) velocity profile along the array for a corresponding depth. Many 1D S-wave velocity profiles are created along the array and then combined to yield a 2D profile.

Four (4) MASW traverses were performed at the approximate requested locations at the site. No machine clearing was performed.

Based on the results of the MASW seismic testing, we developed the following general conclusions regarding the subsurface conditions:

- The interior arrays, S-2 and S-3, depicted moderate to thick layers of soil, soil saprolite, and soft PWR extending to at least 20 feet, with some occasional PWR lenses as shallow as 10 feet below existing grades. These layers were underlain by fractured rock and hard PWR at roughly 20 to 30 feet below existing grades.
- The exterior arrays, S-1 and S-4, depict thinner layers of soil, soil saprolite, and soft PWR that grade into dense PWR at approximately 5 to 20 feet below existing grades. Lenses of rock are found within 15 feet of depth below existing grade in S-1 and as shallow as 2 feet of depth below existing grade for S-4.
- A layer of solid rock is interpreted at a depth of 30 feet in array S-1 and a depth of 10 feet in array S-4.

We note these profiles are interpretations, and should not be considered precise, but instead approximate. The depths shown above are based on interpolation of the of the MASW data. We note that the transition depths vary across each traverse. We note that groundwater is more likely to be present in the lower areas of the site and could result in a “false” rock interpretation. In addition, some of the data was affected by very shallow rock, likely less than 10 feet below the existing grade.

The results of the seismic subsurface evaluation (MASW) must be validated with soil test borings and test pits, or a combination thereof.

Groundwater

No information regarding the depth to groundwater is available since neither soil test borings nor test pits were not performed in conjunction with the seismic refraction field work.

SUPPLEMENTAL GEOTECHNICAL EXPLORATIONS

Terracon should be retained to perform additional geotechnical explorations at the site once development concepts (including structure types and loads) and preliminary grading plans are generated. The additional field work should include soil test borings to supplement the current seismic subsurface evaluation results and to aid in establishing the depth of groundwater, laboratory testing, and engineering analysis to provide project specific recommendations for earthwork and foundation support.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our limited site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction.

Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide supplemental geotechnical services as project design and development is performed, as well as observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either substantiate or modify our conclusions in writing.

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of MASW Traverses	Approximate Profile Depth (feet)	Planned Location
4	50 feet	Across the site

Traverse Layout and Elevations: Terracon personnel provided the traverse layout. Coordinates were obtained with a handheld GPS unit. Site topographic information was not available. Therefore, traverse elevations have not been established.

Subsurface Exploration Procedures: Terracon conducted a MASW seismic exploration to aid in evaluating subsurface conditions at the site. The exploration was conducted as follows:

- A seismic refractions system consisting of a Geometrics Geode and 24-channel geophone set was utilized.
  - The 24 geophones were at a 10-foot spacing in a linear array.
- MASW is performed by collecting surface waves created by a seismic source consisting of a 10lb. sledgehammer striking a metal plate in contact with the ground.
- A seismic profile was collected every 10 feet along the array.
- The data is processed using dispersion analysis software (SurfSeis, engineered by the Kansas Geological Survey) that extracts the fundamental-mode dispersion curve(s). The curves are inverted and modeled to yield a 1D shear-wave velocity profile along the array for a corresponding depth. Many 1D profiles are created along the array and then combined to yield a 2D profile.

ATTACHMENTS

EXPLORATION RESULTS

Contents:

Results of the Multichannel Analysis of Surface Waves seismic testing

March 27, 2023

Mr. Bill Sheffield, P.E.
Terracon
2105 Newpoint Place
Suite 600
Lawrenceville, Georgia 30043

Subject: Results of Seismic Refraction Investigation
4070 Charles Hardy Parkway
Dallas, Georgia

Dear Mr. Sheffield:

We have completed the subsurface investigation that was requested for the 4070 Charles Hardy Parkway project in Dallas, Georgia. The purpose of this study was to use seismic refraction to investigate the geologic conditions below selected areas of proposed land development. Seismic refraction is commonly used to identify depth and competency of subsurface materials such as soil, partially weathered rock, and competent rock and ultimately is used to assess the rippability characteristics that will be encountered during grading and earthwork operations. This report describes the project site, discusses the field techniques used to collect the data, presents our findings, and outlines possible limitations to the seismic refraction method.

Study Area Description

The project site is located on the south side of State Route 120/ Charles Hardy Parkway, directly to the southeast of the intersection of East Paulding Drive and State Route 120 in Dallas, Georgia. The site has multiple points of access. The project area is lightly to moderately wooded, characterized by both hardwoods and pine, patches of younger hardwoods and pine, and sparse undergrowth composed of brush, privet, and woody vines. The topography of the project site is defined by a pair of fields to the northeast and a low hill to the southwest, divided by a runoff creek which flows from a culvert under State Route 120 near the center of the northern edge of the property to the southeastern corner. The parcel is bordered on the west, south, and east by late 20th-century housing developments and to the north by Charles Hardy Parkway. The highest elevation is found at the westernmost of the two crests on the hill to the southwest of the project area. There are several wooden single family dwellings and accompanying outbuildings on the property, of which two are accessed directly from State Route 120 and three via a short private drive which connects to it.

The site has been mapped by Lawton, D.E, and others (1976) in the Geologic Map of Georgia for the Georgia Geological Survey as being a Precambrian to Paleozoic-aged hornblende gneiss and amphibolite unit. Gneiss float rock pebbles and cobbles are observed sporadically across the parcel and a small gneiss boulder pile is found near the top of the hill to the southwest.

Scope

For this study, we conducted four seismic refraction test arrays in areas where earthworks are proposed. All of the test locations were located using the provided sitemap as well as a GPS unit in the field. Some arrays were shifted to avoid unfavorable field conditions such as dense brush, lumber piles, rock piles, and unmanageable topography. The endpoints of the seismic arrays were designated with blue and white striped flagging tape. Midpoint latitude/longitude coordinate data were collected at each location and are posted on the resulting seismic models contained in this report. The attached site plan depicts the approximate locations of the seismic arrays.

Field Technique

Seismic refraction is a non-invasive technique used to determine the depth and layer velocity, or density/hardness, of soil, partially weathered rock (PWR), and rock. Layer velocities are particularly useful in determining excavation equipment and techniques required for earthwork activities. For this project, our seismic profile lengths were 260, 300, and 360 feet with geophones spaced at ten-foot intervals. The array and energy source configuration for this investigation provided an effective depth of investigation of approximately 50 feet. During the sampling process, the geophones measure the compression waves that are generated from a sledgehammer striking an aluminum plate and send the information to a Geometrics Geode 24-channel seismograph for timing, storage, stacking, and enhancement. As the compression waves refract through harder/denser layers in the subsurface, the wave velocities increase. By varying the source to receiver location throughout the receiver array, a graph of time versus distance is developed which is used to calculate velocities (densities) and depths of the underlying materials. Changes in surface elevation along each array were measured and recorded using a survey level rod and hand level and were incorporated into the analysis process.

Results

The raw data collected from the field were reduced into velocity models, which were the basis for the seismic profiles we have included in this report. We conducted tomographic processing on each data set. This method provides a subsurface velocity model that shows subtle vertical and horizontal changes in the underlying soil and rock. The tomographic results on the attached models consist of the color contour data representing measured compression wave velocity. These data were used to annotate a geologic interpretation on each model by delineating subsurface layers where compression wave velocities change. Each layer contains labels that identify its geologic interpretation as well as any possible lateral velocity changes that occur within the layers. By using the annotated layer interpretation together with the tomographic contouring, the nature of the layer interface can be determined. A narrow, tight tomographic contouring at a layer interface would be indicative of a sharp transition between adjacent layers. An area with wide, consistent contours, on the other hand, would suggest that the layer interface is more gradational making a rock/weathered rock/PWR depth interface interpretation more ambiguous.

The following defines our layer-based interpretation of the profile geology by categorizing the velocities into three general groups. Because the difficulty in excavating increases as compression wave velocity increases, we have added soil/saprolite and dense PWR subcategories to soil and PWR to indicate material that may be more difficult to excavate using stated techniques. Also, site-specific variables such as the degree of fracturing or weathering, local stratigraphy, the relative orientation of the equipment, and experience of the equipment operator will influence excavation.

0-2500 ft/sec	***Soil*** – Material that is relatively easy to excavate using dozers, backhoes, and pans. ***Soil/Saprolite*** (~1750-2500 ft/sec) - Soil and highly weathered rock near the consistency of soil that may be more difficult to excavate near 2500 ft/sec.
2500-5000 ft/sec	***Partially Weathered Rock (PWR)*** – Material that can usually be ripped using a single-tooth ripper mounted on a Caterpillar D-8 or equivalent crawler tractor. Trench excavation using a Caterpillar Model 322 or equivalent trackhoe may require blasting. ***Dense PWR and/or Fractured Rock*** (~3500-5000 ft/sec) – Higher velocity PWR that is more difficult to rip or excavate and has characteristics similar to rock near 5000 ft/sec.
>5000 ft/sec	***Rock*** – Competent material normally requiring blasting in trench and mass excavations.

Overall, seismic data from the two interior arrays, S-2 and S-3, indicate the most favorable conditions for future development and earthwork across the area tested. The resulting models depict moderate to thick layers of soil, soil/saprolite, and soft (low-velocity) PWR extending to a depth of at least 20 feet, with some shallow lenses of dense PWR at roughly 10 feet of depth. These layers are underlain by a layer of fractured rock and dense PWR which appears roughly 20 to 30 feet below the surface. The data from the two exterior arrays, S-1 and S-4, show somewhat less favorable conditions. These models depict a thinner soil and soil/saprolite overburden which grades into a layer of low-density PWR and denser PWR between 5 and 20 feet of depth. Shelves and lenses of rock interrupt these layers within 15 feet of depth in the model for array S-1 and as shallow as 2 feet beneath the ground surface in the model for array

S-4. A layer of competent rock is interpreted at a depth of 30 feet in array S-1 and a depth of 10 feet in array S-4.

Overall, the seismic data should be judged as moderately favorable for excavations using standard earth moving equipment across most of survey area. In the event final grades extend to depths or areas where the more dense mediums are displayed, the need for difficult ripping and possibly blasting may become necessary.

Limitations

Good correlation has been proven to exist in site investigations that use geotechnical methods, such as borings or test pits, and seismic refraction. However, with any geotechnical or geophysical subsurface investigation, limitations exist. The following are two limitations that are occasionally encountered given specific geologic and geographic conditions for a particular site:

- The seismic refraction method is only capable of interpreting layers of increasing velocity (density or hardness) with depth. Lower velocity zones underlying higher velocity layers will be masked by the denser, shallower material.
- The presence of a well-established groundwater table can produce a shallow, flat layer with a characteristic seismic velocity of approximately 5000 ft/sec. If present, this groundwater zone can be mistaken for competent rock and can also create a masking effect on lower velocity layers that are below it. Typically, this influence is only encountered when test locations are in or very near the proximity and elevation of a floodplain.

Please feel free to contact us with any questions you might have. We appreciate the opportunity to provide these services for Terracon, and we look forward to working with you on future projects.

Sincerely,

GeoWave Solutions, Inc.

Hayden Souder
Geologist

Michael C. Stone, P.G.
Principal

GeoWave Solutions, Inc.

4575 Ansley Lane
Cumming, Georgia 30040

Tel (770) 886-3776
Fax (770) 886-7212

www.geowavesolutions.com

4070 Charles Hardy Parkway

Dallas, Georgia

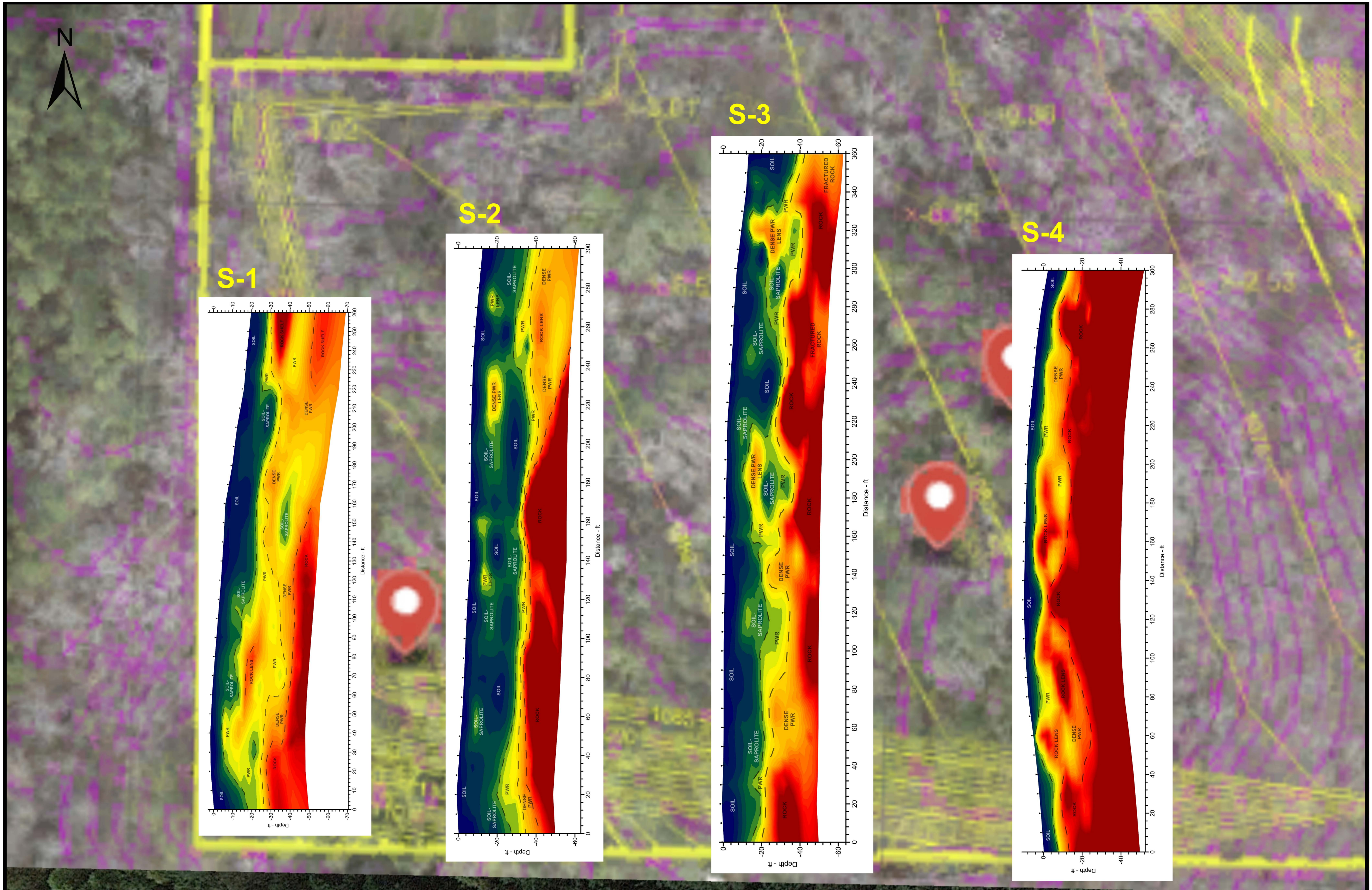
Terracon

Seismic Refraction Investigation

Sitemap

March 16, 2023

Project Manager: H. Souder



GeoWave Solutions, Inc.
4575 Ansley Lane
Cumming, Georgia 30040
Tel (770) 886-3776
Fax (770) 886-7212
www.geowavesolutions.com

4070 Charles Hardy Parkway

Dallas, Georgia

Terracon

Seismic Refraction Investigation

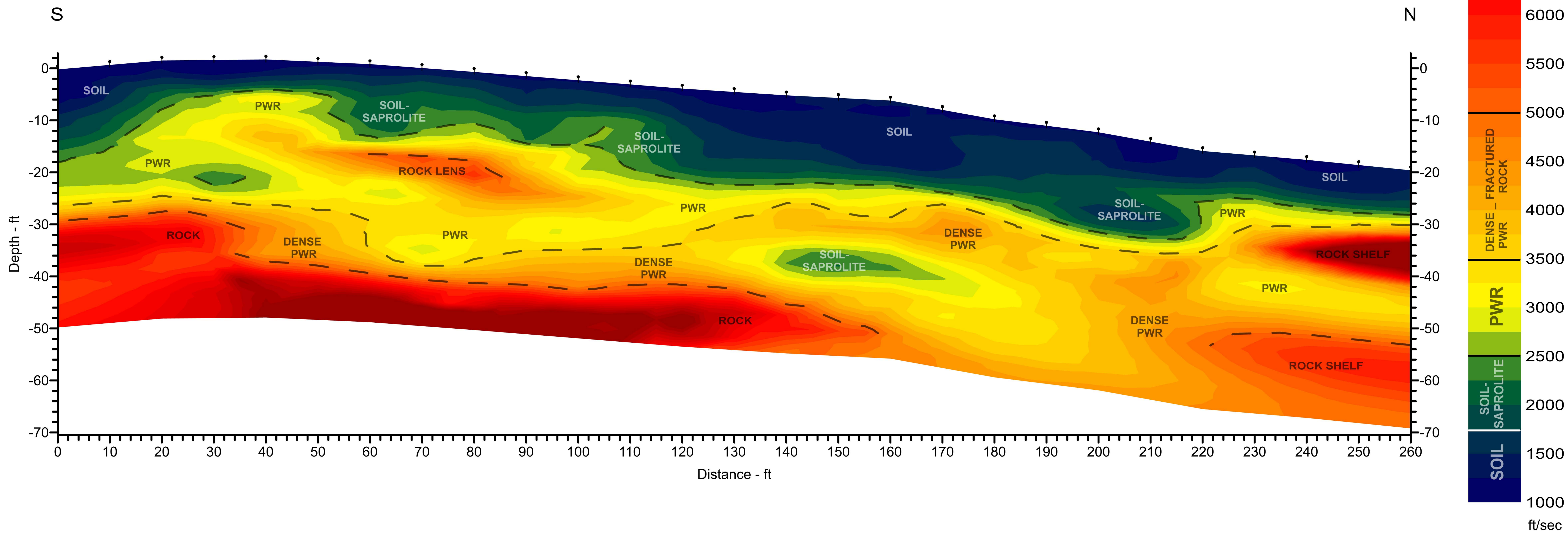
Composite Sitemap

March 24, 2023

Project Manager: H. Souder

S-1

33°55.883'N 84°43.661'W



GeoWave Solutions, Inc.
4575 Ansley Lane
Cumming, Georgia 30040
Tel (770) 886-3776
Fax (770) 886-7212
www.geowavesolutions.com

4070 Charles Hardy Parkway

Dallas, Georgia

Terracon

Seismic Refraction Investigation

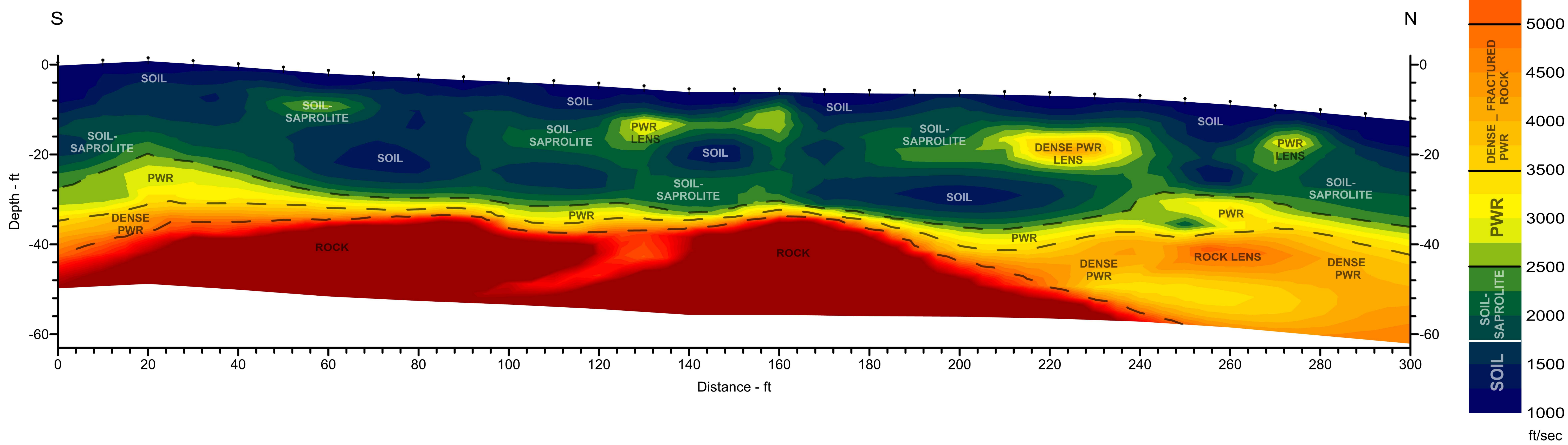
March 17, 2023

Project Manager: H. Souder

S-1

S-2

33°55.884'N 84°43.633'W



GeoWave Solutions, Inc.
4575 Ansley Lane
Cumming, Georgia 30040
Tel (770) 886-3776
Fax (770) 886-7212
www.geowavesolutions.com

4070 Charles Hardy Parkway

Dallas, Georgia

Terracon

Seismic Refraction Investigation

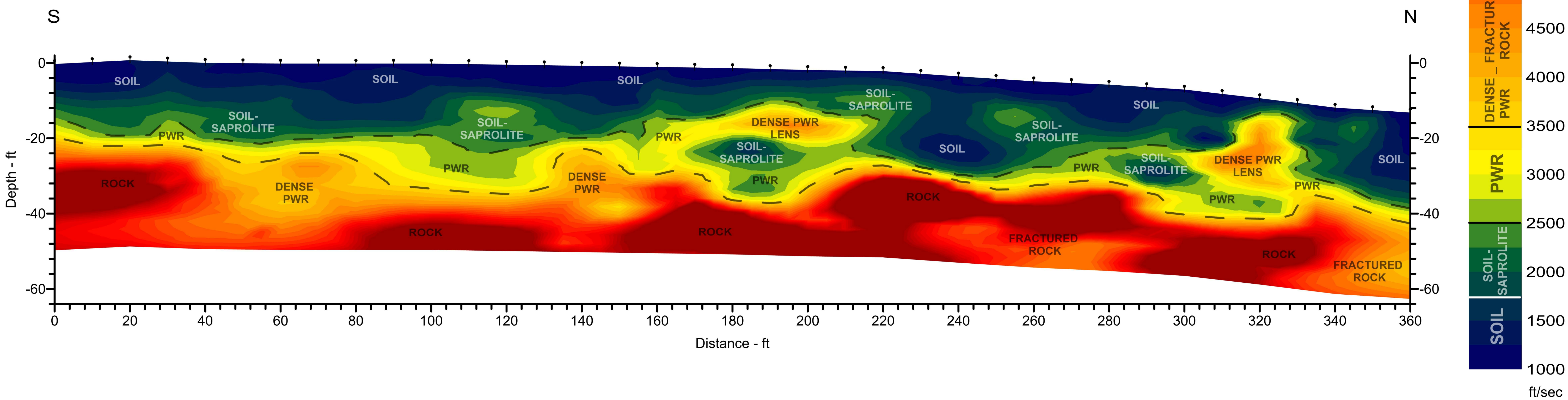
March 17, 2023

Project Manager: H. Souder

S-2

S-3

33°55.888'N 84°43.603'W



GeoWave Solutions, Inc.
4575 Ansley Lane
Cumming, Georgia 30040
Tel (770) 886-3776
Fax (770) 886-7212
www.geowavesolutions.com

4070 Charles Hardy Parkway

Dallas, Georgia

Terracon

Seismic Refraction Investigation

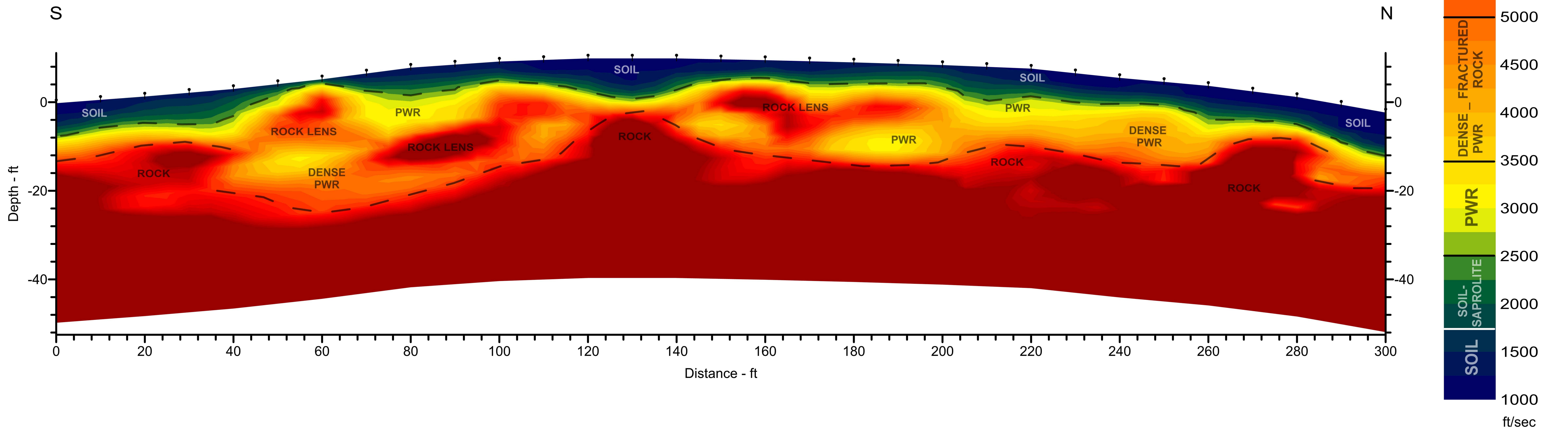
March 17, 2023

Project Manager: H. Souder

S-3

S-4

33°55.884'N   84°43.570'W



GeoWave Solutions, Inc.
4575 Ansley Lane
Cumming, Georgia 30040
Tel (770) 886-3776
Fax (770) 886-7212
www.geowavesolutions.com

4070 Charles Hardy Parkway

Dallas, Georgia

Terracon

Seismic Refraction Investigation

March 17, 2023

Project Manager: H. Souder

S-4