Report of Roadway Geotechnical Exploration

Grand View Development
Jenkins (Letcher County), Kentucky
Stations 100+00 to 141+00
Item No.: 12-00173

Project: 25050086SHE

March 26, 2026

Prepared for:
Palmer Engineering
400 Shoppers Drive, P.O. Box 747
Winchester, KY 40392

By:
CTL Engineering, Inc.

CTL Engineering, Inc.
1535 Old Finchville Rd Shelbyville KY 40065
Phone:
email: ctl@ctleng.com

AN EMPLOYEE OWNED COMPANY

Consulting Engineers • Testing • Inspection Services • Analytical Laboratories

Established 1927

March 26, 2026

Mr. Joshua Samples, PE
Project Manager
Palmer Engineering
400 Shoppers Drive, P.O. Box 747
Winchester, KY 40392

Subject: Report of Roadway Geotechnical Exploration
Grand View Development
Station 100+00 to 141+00
Jenkins (Letcher County), Kentucky
Item No.: 12-00173
Project ID: R-019-2025
CTL Project 25050086SHE

Dear Mr. Samples,

CTL Engineering, Inc., has completed the geotechnical subsurface exploration for the proposed access road to the Grand View neighborhood. This exploration was in general accordance with the guidelines in the Kentucky Transportation Cabinet (KYTC) Geotechnical Manual and our proposal 25050041SHEPPL. The purpose of this exploration was to obtain subsurface data to develop recommendations for the design and construction of the proposed roadway. This report describes our understanding of the project, summarizes our findings, discusses the geotechnical concerns, and contains our engineering recommendations.

CTL Engineering, Inc. appreciates the opportunity to provide you with these geotechnical services. Should you have questions or require any additional information, please contact us.

Respectfully submitted,

CTL Engineering, Inc.

Conner M. Barnes, EIT
Staff Engineer

Matthew J. Slusser, PE
Senior Engineer
Licensed Kentucky 32059

STATE OF KENTUCKY
MATTHEW JONATHAN SLUSSER
32059
LICENSED
PROFESSIONAL ENGINEER

Wayne A. Karem, PhD, PE, PG
Consultant

TABLE OF CONTENTS

SECTION **PAGE**

LIST OF APPENDICES

1 PROJECT INFORMATION

Project information was provided through correspondence with Palmer Engineering, including the following documents. During the preparation of the proposal for the geotechnical exploration, Palmer provided KMZ files and preliminary design drawings. However, during the duration of our exploration, the alignment changed. Therefore, some of the borings are not on the revised alignment.

- *Grand View Development Cross Sections*, sheets 100+50.00 to 144+50.00, prepared by Palmer Engineering, undated
- *Grand View Development Cross Sections*, sheets 100+50.00 to 144+50.00, prepared by Palmer Engineering, undated
- *Grandview High Ground Site, Typical Sections,* road profile for normal and superelevated sections, prepared by Palmer Engineering, undated

As part of the Grand View neighborhood development on an old strip mine in Jenkins, Letcher County, Kentucky, the Kentucky Transportation Cabinet (KYTC) will build a road to replace the existing gravel access road. The road will begin at US Highway 23, turning southeast and traveling up the mountainside before turning toward the north to extend across the mine spoil fill plateau to the proposed residential Grand View neighborhood development. The road will be two lanes with lane widths of 11 feet, with a 2-foot shoulder on each side for a total roadway width of 26 feet. Preliminary design for the road section consists of 1½ inches of asphalt surface, 8 inches of asphalt base, 4 inches of dense graded aggregate (DGA) road base, and 24 inches of crushed rock road base (material not defined in preliminary design documents). The portion of the access road explored in this report extends from station 100+00 to 144+50 with grades ranging from about -4 percent to +11 percent parallel to the roadway and ±5.74 percent across the roadway for drainage.

2 SITE SURFACE CONDITIONS

As part of the geotechnical site characterization, the site surface conditions were observed for general topography and drainage. The following section reports our findings.

2.1 Site Surface Conditions

Mr. Matthew Slusser, PE with CTL Engineering, observed the surface conditions on May 8, 2025, as part of the scope development for this geotechnical exploration. Mr. Conner Barnes, EIT, then visited the site during the subsurface exploration and sampling activities to aid in interpreting the subsurface data and to detect conditions that could affect the proposed development of the road. The following is a general description of the site.

From station 100+00 to 103+50, the proposed access road generally follows the existing gravel road. The gravel road and hillside generally slope downwards to the west, with the site grades and shallow ditches along the gravel road directing surface water towards US Route 23.

From about station 103+50 to 118+00, the proposed road travels south to southwest up the hillside. The hillside is moderately to heavily wooded, with some boulders found along the slope. A small bench is approximately located at station 104+75; however, it is unclear whether this was created during mining operations, is a man-made trail, or a natural feature. From approximately 108+00 to 110+00, the proposed road travels across two benches. The lower bench appears to have been a diversion ditch for directing water runoff from the mine area, and the upper bench appears to have been a bench for mining operations. The benches are generally clear of large trees; however, thick underbrush was present at both benches, and two overland gas lines run along the western edge of the upper bench. One gas line is out of service (and is partially buried), and one line is currently active. From station 115+00 to 118+00, the proposed road travels uphill of an embankment pond.

From about station 118+00 to 144+50, the site is open and reasonably flat. The surface cover consisted of short grass and a gravel access road. This area of the proposed road alignment is the location of previous strip mining (referred to as the Mine Site). From about station 133+00 to 137+50, mining maps of the strip mine suggest that the proposed road will be in the vicinity of a hollow fill. Drainage in this area was judged to be poor, with small depressions capturing water.

3 GEOLOGY

As part of the geotechnical site characterization, the available geological and mining maps were reviewed. The following sections report the findings.

3.1 Area Geology

The Geologic Map of the Jenkins West Quadrangle, Kentucky (GQ-1126), published by the U.S. Geological Survey (USGS) indicates the site is underlain by two formations: the Hyden Formation and the Pikeville Formation (Figure 1). The Hyden Formation consists of sandstone, siltstone, shale, and coal and is generally located at higher elevations. The upper 20 to 30 feet of the formation is sandstone. The siltstone and shale, interbedded with sandstone, overlies a fire clay coal bed. The Pikeville Formation is generally mapped below an elevation of about 1800 feet, consisting of sandstone, siltstone, shale, and coal. The sandstone is light to medium gray and very fine to fine-grained and is above interbedded siltstone and shale. The site is rated as non-Karst by the KGS, indicating that the geologic conditions present on site are not typically susceptible to the solutioning activity that causes sinkholes and Karst conditions.

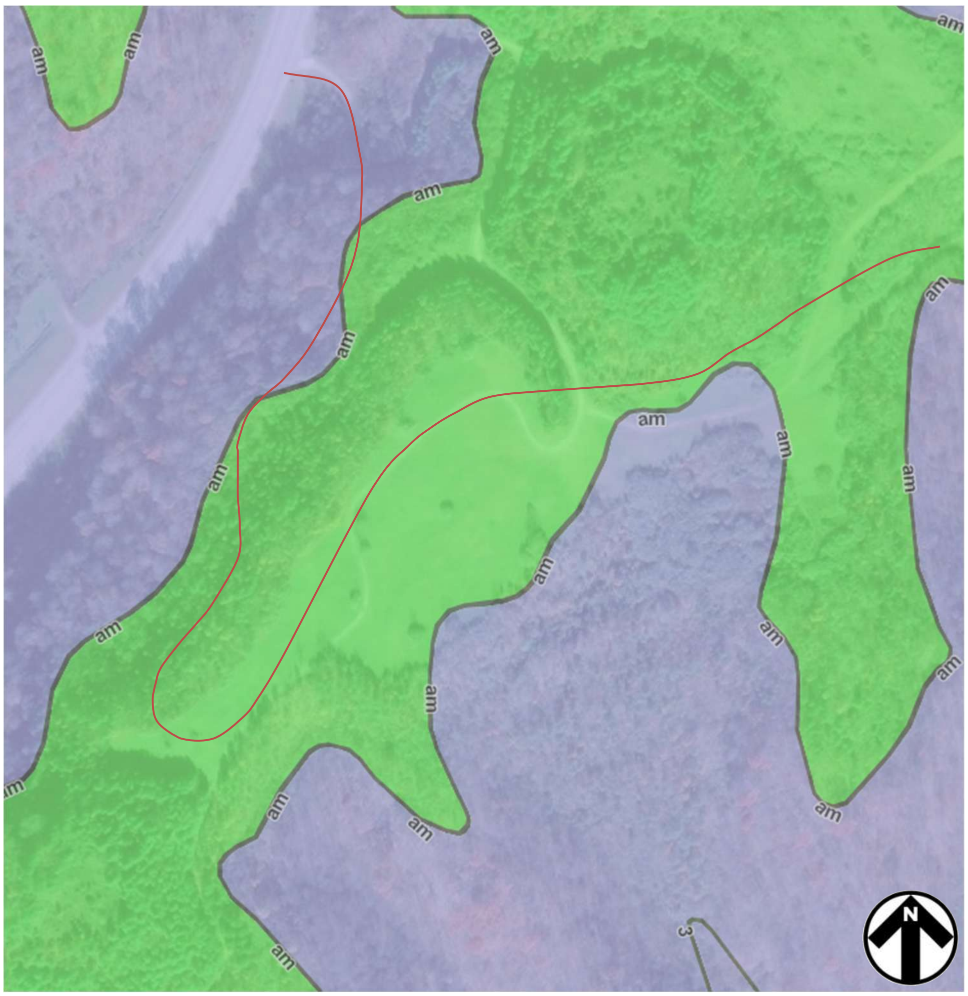


Figure 1: The green shading indicates areas underlain by the Hyden Formation, while the lavender indicates the Pikeville Formation. Located near the transition between the Hyden and Pikeville formations (labeled as am) is the Amburgy coal bed. The red line indicates the approximate road alignment.

The Kentucky Geological Survey indicates two coal seams in the project area: the Amburgy coal bed and the Upper Elkhorn No. 3 coal bed (Figure 1). Based on historic topography and KGS coal seam data, the Amburgy seam is at an approximate elevation of 1800 to 1820 feet, while the Upper Elkhorn No. 3 seam is at an approximate elevation of 1600 to 1620 feet, or about 100 feet below the lowest elevation along the road. The Amburgy coal bed is reported to be typically 10 to 15 feet thick, but approaches 45 feet thick near Elkhorn Creek, which runs through Jenkins, Kentucky. The nearby JNKNSWST (Jenkins West) 1 boring, performed by the USGS about 2 miles northwest of the project site, encountered two distinct coal seams within the Amburgy coal bed; one seam about 18 inches thick with a base elevation of 1795 feet and one seam about 43 inches thick with a base elevation of 1752 feet. These depths support a thickness of about 45 feet for the Amburgy coal bed in the general project vicinity.

3.2 Review of Available Mining Information

The Kentucky Mine Mapping Information System was reviewed for available coal mine maps. Based on the available mine maps and historical aerial photographs, it appears that mining was completed in the early 2000's. The mine map, *Mining and Reclamation Plan Map, 867-0355 Minor Rev.* 2, dated January 30, 1998, indicates that mining in the vicinity of the access road consisted of surface mining of the Amburgy coal seam. The entrance of an underground mine is denoted in the mine maps on the eastern side of the mountain; however, mapping for this mine was not available in the Kentucky Mine Mapping Information system. The mine entrance is shown near an elevation of 1600 feet and is over a quarter mile east of the closest point of the proposed access road. While this mapping may not be exact, the extents noted in the mapping appear generally consistent with the historic aerial photographs.

Detailed mining methods for the site have not been conveyed to CTL; however, from the review of available mine mapping, the observed benches on the hillside, and experience on similar sized mines in the area, the surface mining likely consisted of contour mining on the mountainside as well as mountaintop removal (strip) mining. Typical contour mining consists of stripping and grubbing before constructing drill benches by bulldozers. The overburden is drilled and blasted to expose the coal seam. Bulldozers push the blasted rock to a front-end loader. The loader loads the overburden into haul trucks for transport to the deposition location.

Mountaintop or ridge top removal mining removes the entire top of a mountain ridge, creating a level surface at the coal seam. The same type of equipment used for contour mining is used in mountaintop removal. Mountaintop mining does affect much larger areas of land versus the relatively thin bands characteristic of contour mining.

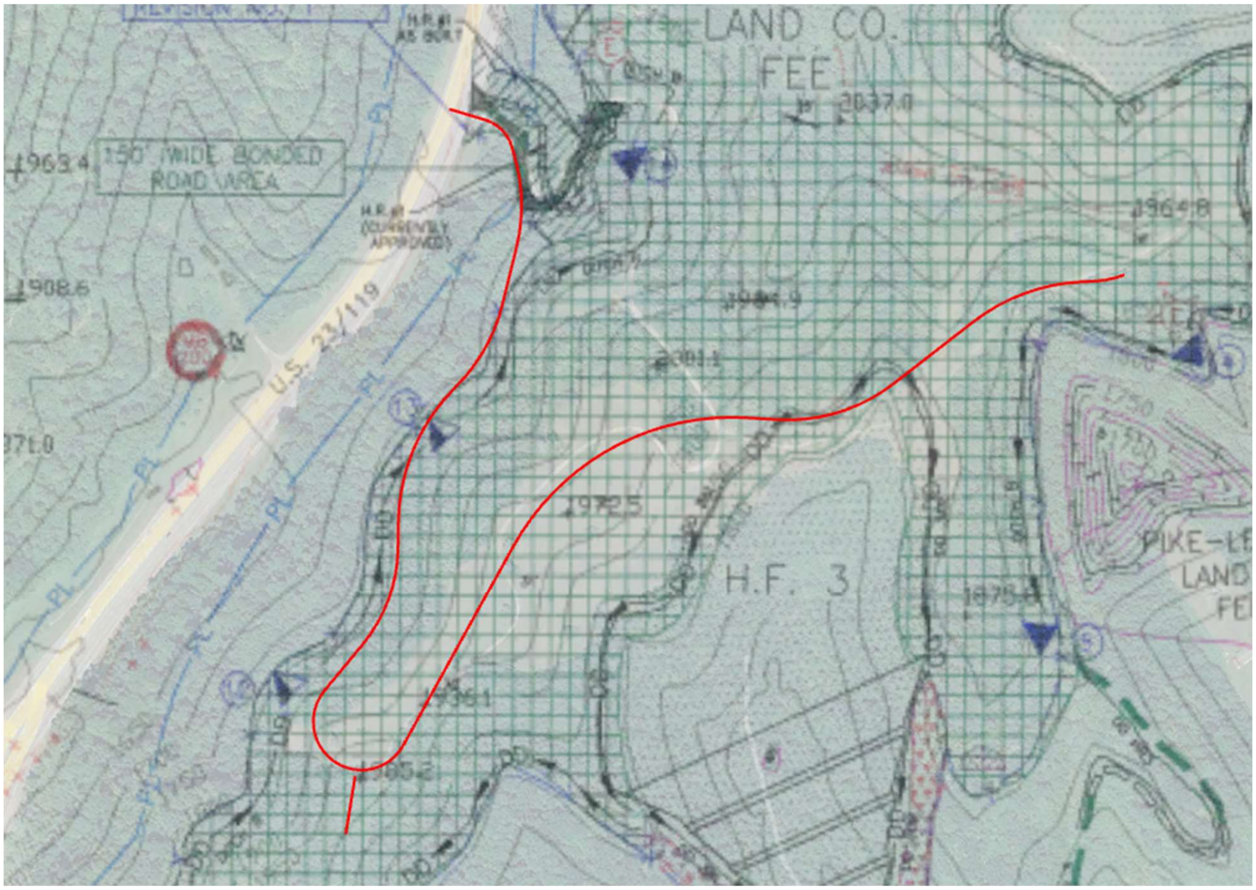


Figure 2: Most recent mining map with the approximate road alignment in red. The mined areas are indicated with green square hashing. The orange shaded area is indicated as hollow fill.

Typically, the excavation begins along the deepest economically removable coal seam outcrop parallel to the ridgeline. To start the operation, the first cut is transferred by rock haul trucks to the hollow fill. After overburden drilling and blasting, front-end loaders and haul trucks work progressively toward the center of the mountain. Concentrically circling the mountain, the lower benches advance ahead of the upper excavations. The excavation continues with trucks hauling material to the mine spoil storage area using ramps connecting the series of benches until a level surface remains. The bench heights are determined by either the occurrence of a coal seam or by equipment limitations. Typically, the equipment used for placing the mine spoil consisted of bulldozers (most likely Caterpillar model D9's or similar) and Caterpillar model 777B (triple 7's) dump trucks. The dump trucks end-dump the mine spoil into the valley or onto the benches. The bulldozers were used to level the top of the mine spoil piles. No compactive effort, other than the bulldozers tracking in material, was conducted in the hollow fills.

We understand that typically, the mine spoils are placed by end-dumping from the top of the mine bench into the valleys. The initial phase of the mining would have used the valleys to place spoil material, with later phases consisting of ridgetop removal and back stacking the spoils against the highwalls created by contouring and on the plateau.

End dumping of the spoil creates a loose structure that tends to consolidate, thereby reducing the void space between particles over a long period. In addition, water infiltration can cause slaking of the shale portion of the mine spoil fills, which can lead to a condition called hydrocompression, where settlement can occur from loss of strength from the reduced rock-to-rock contact points and the creation of conduits that can collapse over time. Due to the variability of the constituents, placement methods, and thickness of the mine spoil, differential settlement can occur in these fills. The quantity and time for completed settlements cannot be accurately predicted.

We understand that several areas within the project area have been filled with mine spoils. Based on the top of ground elevations from available topographic data and the elevations in the mine mapping, the depth of mine spoil fill in the general project vicinity ranges from 0 feet in unmined areas to up to 200 feet in the hollow fills.

4 SUBSURFACE EXPLORATION

After researching the readily available published geological and mining information, a preliminary subsurface profile is formulated. The soil boring program is a means to substantiate the assumptions made in the preliminary profile and assist in developing a representative subsurface profile along the proposed roadway alignment. The subsurface conditions will vary between borings thereby making the development of a representative and reliable profile dependent upon the number of borings or data points obtained during the field operations. The following discusses the interpreted subsurface profile along the roadway based on the published information and the results of the subsurface exploration. The individual Boring Logs and Soil Profile Sheets attached to this report will have specific details at the location of the boring.

4.1 Drilling and Sampling Methods

A total of twenty-seven (27) borings and three (3) rockline soundings were performed to explore the subsurface conditions along the road alignment. The borings consisted of twenty-one (21) roadway borings, three (3) cut slope/rock cut borings, and three (3) embankment fill borings. Mr. Conner Barnes, EIT, under the guidance of Mr. Matt Slusser, PE, directed drilling operations. Drilling operations were performed by Horn & Associates Inc. The boring locations were located in the field by using a recreationalgrade Garmin Etrex 22x handheld GPS. Offsets were measured using a cloth tape measure. Boring surface elevations were interpolated from the topographic map and profile drawings provided by Palmer. Because of the methods used, the soil boring locations shown on the Boring Location Plan and the surface elevations shown on the Boring Logs in the attachments are approximate. The stratification lines shown on the Boring Logs represent the approximate boundaries between soil or rock types. The transitions may be more gradual than shown.

We obtained soil samples using a split-barrel sampler driven by an automatic hammer assembly in general accordance with ASTM D1586. We also collected two (2) relatively undisturbed soil samples using a thin-walled (Shelby) tube according to ASTM D1587 and five (5) bag samples. A casing advancer was used in several borings to advance through the mine spoil fill. The procedures used by CTL Engineering for field sampling and testing are in general accordance with applicable ASTM procedures and established engineering practice.

4.2 Subsurface Conditions

The borings generally encountered two profiles across the site; moderate to deep fill extending to bedrock, and native soil and shallow bedrock. The majority of the soil borings encountered a thin layer of topsoil (0 to 7 inches) underlain by mine spoil fill soils consisting of a mixture of lean clay, sand, silt, weathered shale, and sandstone fragments and boulders. The standard penetration tests ranged from 3 blows per foot (bpf) to in excess of 50 bpf. A statistical analysis of the N-values indicates an average value of 26 bpf, a median value of 19 bpf, and a standard deviation of 17. The result of the statistical analysis matches well with penetration data from other sites in the area; therefore, we have incorporated our experience with previously explored sites with this site.

Table 1: Statistical Analysis of SPT N-Values for the Grandview Access Road and other mine sites in the Eastern Kentucky area.

	Maximum SPT N-Value	Minimum SPT N-Value	Mean SPT N-Value	Median SPT N-Value	Standard Deviation
Grandview Access Road	50+	3	26	19	17
Grandview Neighborhood	50+	6	24	16	16
Chestnut Ridge Mine Site	50+	2	24	18	16
Core Capital Mine Site	50+	4	20	14	16

Borings B-3, B-4, and B-5 encountered what was interpreted to be native soil throughout the boring. Undisturbed sampling (UD) was attempted in B-4, but refused on weathered sandstone. Auger refusal on bedded material (bedrock) in these borings ranged from about 2½ to 5 feet.

The borings were located along spacings of about 100 to 200 feet to evaluate the depths indicated on the available mining map and along the hillside. The borings generally encountered auger refusal within depths that reasonably agreed with the mapping and geophysical data. On the boring logs, some of the coring conducted through the auger refusal material was judged to be large boulders within the fill and not actual bedrock. Table 1 lists the interpreted bedrock depths based on our review of the soil and rock specimens and the geophysical data.

Table 2: Estimated Bedrock Depths

Boring Number	Approximate Depth to Native Soil/Rock from Mining Map (Feet)	Depth to Refusal (Feet)	Approx. Depth from Geophysical Survey (Feet)	Judged Bedrock Depth (Feet)	Approximate Judged Bedrock Elevation (feet)
B-1*	0-20	22.1	-	22.1	1695.9
B-2*	0-20	25.9	-	25.9	1696.1
B-3*	0-10	3.7	-	2.4	1754.3
B-4*	0-10	7.9	-	4.7	1756.1
B-5*	0-10	4.0	-	3.2	1786.0
B-6	10-20	9.0	-	9.0	1799.0
B-7	15-25	32.5	-	32.5	1793.5
B-8	10-20	34.7	-	30.8	1781.2
B-9	15-25	32.4	-	32.4	1791.6
B-10	50-60	44.5	-	44.5	1833.5
B-11	50-60	4.5	-	4.5	1865.5
B-12	50-60	49.5	53	49.5	1828.5
B-13	50-60	81.5	83	81.5	1796.5
B-14	50-60	55	66	66[1]	1808[1]
B-15	50-60	49.7	75	75[1]	1805[1]
B-16	60-70	64.0	-	64.0	1816.0
B-17	60-70	57.5	72	72[1]	1810[1]
B-18	50-60	48.7	78	78[1]	1790[1]
B-19	40-50	36	80	80[1]	1780[1]
B-20	40-50	37.5	-	64[1]	1790[1]
B-21	30-50	18	-	58[1]	1790[1]
B-30	10-20	35	-	35	1791.0
B-31*	0-10	18.3	-	13.0	1697.0

Boring Number	Approximate Depth to Native Soil/Rock from Mining Map (Feet)	Depth to Refusal (Feet)	Approx. Depth from Geophysical Survey (Feet)	Judged Bedrock Depth (Feet)	Approximate Judged Bedrock Elevation (feet)
B-32*	0-10	4.3	-	2.0	
B-33	10-20	21	-	17	1799.0
B-34	0-10	8.0	-	5.2	1790
B-35	50-60	51	-	51	1833.0

* - indicates the boring was not in an area where mining occurred.

[1] – indicates a judged bedrock depth/elevation from MASW data at or near the boring location

From about station 100+00 103+50, it is anticipated that moderately deep fill soil will be encountered, extending to depths ranging from 20 to 30 feet before encountering bedrock. This portion of the alignment was not in the mine area, but encountered similar subsurface conditions to those in mine areas. The fill consisted of materials that are consistent with mine spoils; however, it is unclear whether this fill was brought from mined areas for the construction of the access road or whether it was brought from one of the nearby highway construction cuts.

From about station 103+50 to 108+50, it is anticipated that native soil and shallow bedrock will be encountered. Borings B-3, B-4, and B-5 encountered weathered bedrock at depths ranging from 2 to 5 feet. This area is located on the hillside and was not mapped as a mined area.

From about station 108+50 to 117+00, it is anticipated that relatively shallow mine spoil fill (less than about 40 feet) will be encountered. This area is located along a bench within the mined area, and the borings encountered refusal at an elevation ranging from about 1780 to 1800 feet.

From about station 117+00 to 144+50, it is anticipated that deep mine spoil fill will be encountered. This area is likely the primary mine site, and the borings and MASW indicate that mine spoil fills range from about 44 to 83 feet deep in this area. The data indicates bedrock elevations ranges from about 1780 to 1830 feet. The bedrock depths generally agree with the depth of the Amburgy coal seam. In Boring B-11, bedrock was encountered at a depth of about 4 ½ feet. This shallow bedrock could be indicative of a highwall along the south perimeter of the site

4.2.1 Groundwater

Groundwater was not encountered in the borings. Since rock coring and casing advancing uses water during drilling, an accurate groundwater level reading cannot be obtained after coring/casing advancing.

It has been CTL's experience that groundwater does exist at the bottom of the mine spoil fill and within perched zones within the fill. Additionally, some damp to wet samples were encountered in the borings, supporting the likelihood of perched water. CTL's previous experience on mine spoil fill sites and research conducted by the Kentucky Geological Survey suggests that groundwater typically enters the fill from infiltration of surface water and through buried coal seams. Typically, groundwater issues when working in mine spoil fills are related to trapped or perched water which occurs in irregular, discontinuous locations within the fill, or near a bedrock/soil interface. When these water-bearing strata are exposed in excavations, such as cut slopes and utility or footing trenches, they can produce widely varying seepage duration and rates depending on recent rainfall activity and other site-specific characteristics of the area.

4.3 Geophysical Testing

To further evaluate the extent of mine spoil fill, a geophysical survey was conducted by Near Surface Geophysics (NSG). The purpose of the geophysical survey was to attempt to determine if the old subsurface mine benches and/or edges of the hollow fill are located along particular areas of the roadway alignment. Differing mine spoil thicknesses are more common at benches and hollow fills and will result in differential settlement which could be detrimental to the long-term performance of roads and utilities.

Three geophysical arrays were conducted utilizing Multichannel Analysis of Surface Waves (MASW). MASW evaluates ground stiffness by measuring shear wave velocity (Vs) of the subsurface materials. The seismic waves are generated using a steel plate and sledgehammer, with the waves collected using geophones spaced along a line. The shear wave velocity is a direct indicator of the soil and bedrock stiffness. A low shear wave velocity indicates a soil material, and a high velocity would represent bedrock. Table 2 illustrates typical ranges for the various materials.

Table 3: Shear Wave Velocities and Earth Material Type

Site Class	General description	Detailed Description	Shear Wave velocity		Blows/Foot (N value)	Shear Stregth S_u (psf)
			m/sec	ft/sec		
A	Hard Rock	Includes unweathered intrusive igneous rock. Soil types A and B do not contribute greatly to shaking amplification.	> 1,500	> 5,000		
B	Rock	Volcanics, slightly weathered intrusive igneous, and high-grade crystalline metamorphic bedrock (upper range) to well-cemented and lithified coarse-grained sedimentary or low-grade metamorphic rock (lower range)	750 - 1,500	2,500 - 5,000		
C	Soft rock and Very dense Soil	poorly-cemented coarse-grained to fine-grained sedimentary rock to dense Early to mid Pleistocene or older granular sediment	350 - 750	1,200 - 2,500	> 50	> 2,000
D	Stiff Soil	Mid to Late Pleistocene granular sediment or properly Enginered Fill (post 1985)	200 - 350	600 - 1,200	15 - 50	1,000 - 2,000
E	Soft Soil	Holocene granular sediment, pre-1985 artificial fill, includes some Late Quaternary muds, sands, gravels, silts and mud. Significant amplification of shaking by these soils is generally expected.	< 200	< 600	< 15	< 1,000
F	Unstable Soil	Includes water-saturated mud and undocumented or pre-1950 artificial fill. The strongest amplification of shaking due is expected for this soil type.	requires site specific measurement	requires site specific measurement		

Compressional-wave velocity is a function of the density, bulk modulus, and shear modulus of the material. The data was used in combination with boring data to estimate the characteristics of the soil materials. The MASW survey line locations are shown in Figures 3 and 4. Figure 4 illustrates the reported mining operations as well as the boring locations.

The MASW data was collected at the same time as the drilling exploration. The field procedures involved use of a 24-channel 4.5-Hz geophone array with a geophone spacing of ten feet. The energy source used during the MASW surveys was a sledgehammer striking a high-density polyethylene plate approximately 100 feet from the array. The seismic data were recorded digitally using a Seismic Source DAQ III data recorder and VibraScope Seismic software.

The MASW data was processed using Parkseis™ proprietary software to produce compressional-wave velocity models of the subsurface. One velocity model (profile) was produced for each geophysical survey line. The ground surface of each model is based on available topographic data for the site and should be considered approximate.

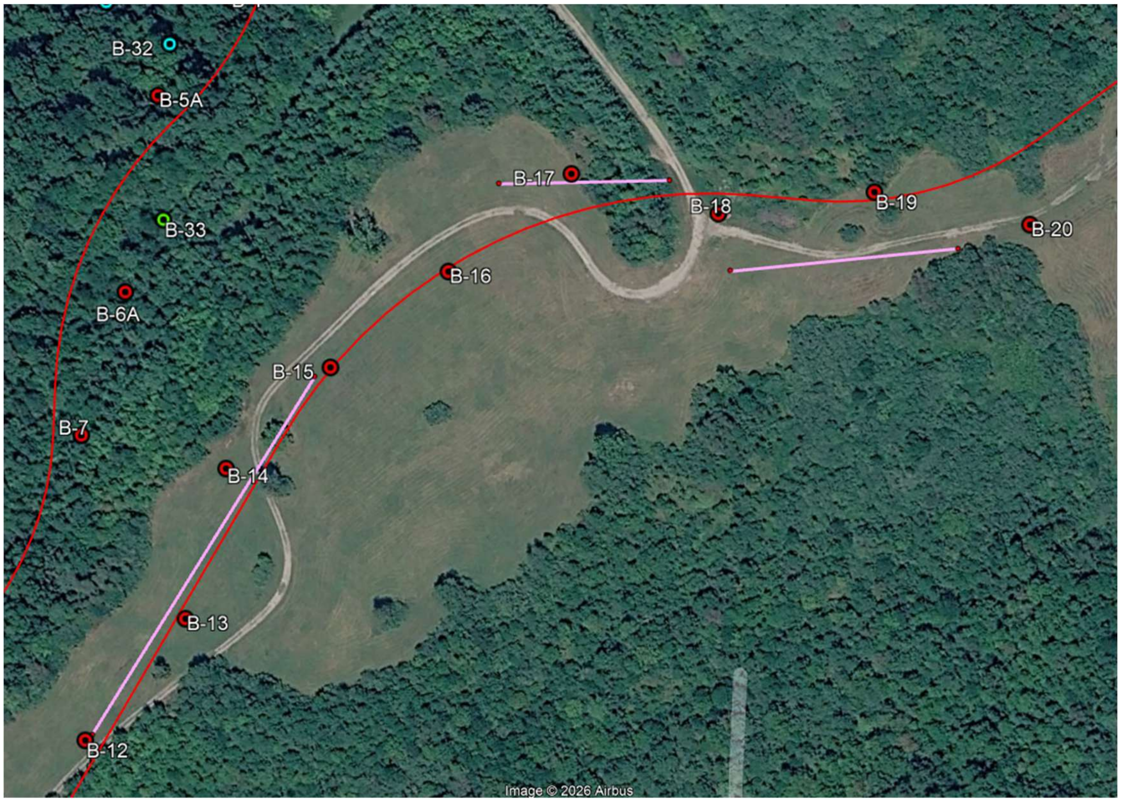


Figure 4: MASW lines (pink) and boring locations. The approximate outline of the roadway is indicated in red.

Figure 5: MASW line locations (pink) with respect to reported mining locations. The approximate outline of the roadway is indicated in red.

Compressional-wave (i.e. P-wave) velocities varied laterally and with depth based on the materials encountered. Shallow soil, fill, and weathered rock generally exhibited lower velocity values than materials at greater depths, indicating a weaker soil/fill structure near the surface. The NSG report is included in the Appendix and contains additional details about the geophysical exploration, including the profile figures for each survey line. However, the results from line 1 are illustrated in Figure 5. The MASW shear wave velocities over about 2,500 feet per second would generally indicate weathered bedrock.

MASW Line 1 suggests bedrock is about 50 feet deep at the southwest end of the line and about 75 to 80 feet over most of the line, with areas near the south and middle ends of the line indicating bedrock depths of up to about 90 to 100 feet. This is generally consistent with the findings of the borings. Boring B-12 is located near the far southwest end of the alignment and encountered auger refusal at 49½ feet, correlating very closely to the bedrock depth suggested MASW data. Boring B-13 encountered auger refusal at 81½ feet, correlating closely to the 80-foot depth to bedrock depth suggested in the MASW data. The MASW data suggested depths to bedrock of about 60 to 65 feet, respectively, near borings B-14 and B-15. The depth for Boring B-14 correlates well with the auger refusal at depth of 60½ recorded in the exploration. However, the auger refusal depth of 49½ feet in Boring B-15 did not correlate well with the MASW depth, suggesting that the auger refusal depth may be indicative of a highly resistant boulder within the soil instead of bedrock.

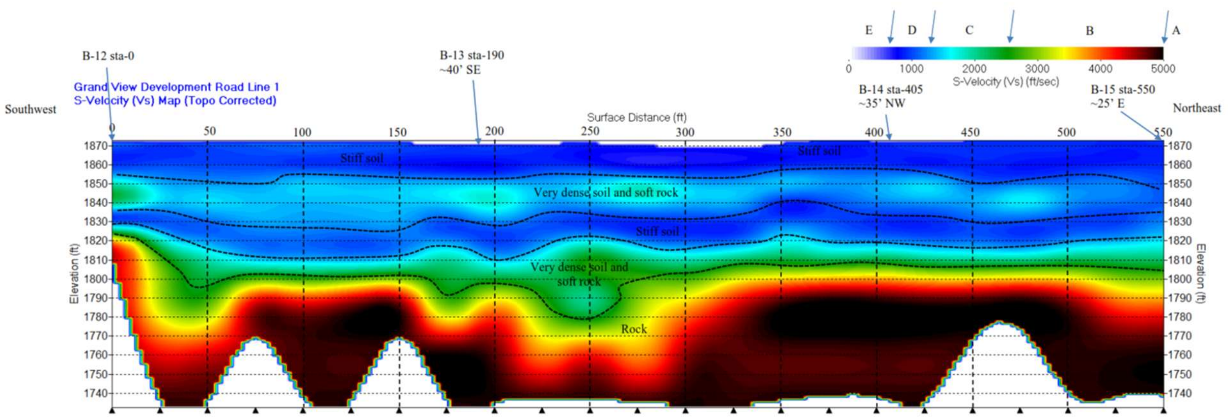


Figure 6: Results of MASW Survey along line 1. The yellow, red, and brown areas represent suspected bedrock. The green area represents very dense soil or hard rock, while the blue areas represent soil and soft rock. Based on boring data, the black line indicating the transition between dense soil and rock is generally consistent with the interpreted bedrock depths in our borings.

MASW Line 2 suggests a depth to bedrock of about 90 feet over most of the array, with a peak just west of the middle of the line indicating a bedrock depth of about 50 feet and a slope up to a depth of about

65 feet at the east end. Boring B-17, located north of the middle of the line, encountered auger refusal at 57½ feet, which is generally consistent with the depths suggested in the MASW data. However, borings B-16 and B-18, located near the west and east ends of the line, respectively, encountered auger refusal at depths of 64 and 48½ feet, respectively. This is shallower than the 90 and 65 feet, respectively, indicated by the MASW. This suggests that the auger refusal may be indicative of boulders instead of bedrock.

MASW Line 3 suggests an undulating depth to bedrock ranging from about 55 to 90 feet. Borings B-18 to B-20, located in the general vicinity of this line, encountered auger refusal at depths ranging from 36 to 48½ feet. This again suggests that refusal may have been on boulders above bedrock. It is important to note that, throughout all of the MASW lines, the elevations of the apparent bedrock is noted between about 1760 to 1820 feet. This is relatively consistent with the elevations anticipated for the two seams of the Amburgy coal at this site based on mine mapping and available geologic data. Therefore, the shallow depths to bedrock indicated by the MASW report appear to be generally consistent with the depth required to mine the upper coal seam of the Amburgy coal, while the deeper bedrock depths indicated appear generally consistent with the depths required for the lower coal seam.

5 LABORATORY TESTING

During the subsurface exploration, the soil and bedrock samples were sealed in the field and returned to the CTL office, where select samples were delivered to our subcontract laboratory, S&ME, for laboratory testing. Mr. Matthew Slusser, the project geotechnical engineer, reviewed the field soil classifications using visual-manual methods and the Unified Soil Classification System (USCS, ASTM D2487) and prepared a laboratory testing plan. Upon laboratory testing, the appropriate test samples were classified according to the American Association of State Highway and Transportation Officials (AASHTO) guidelines. S&ME performed the laboratory testing in general accordance with the applicable AASHTO and/or Kentucky Methods of Soil Testing specifications. The laboratory testing results are summarized below and included in the report appendices.

5.1.1 Classification Testing

One to two classification tests were generally performed on each boring throughout the site. The classification results generally indicated the soil as a gravel with sand or sand with gravel, with the soils exhibiting low to no plasticity. Atterberg limits and classification results are summarized in Table 2, and grain size distributions are summarized in the appendix. Moisture content testing was performed on soil samples at 5-foot intervals, and the results are summarized in the appendix.

Table 2: Atterberg Limits Results

Boring ID	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Percent Passing No. 200	USCS Classification	AASHTO Classification
B-1	7-8.5	30	19	11	20	GC	A-2-6
B-2	14-15.5	31	22	9	43	SC	A-4
B-3	0-4	24	19	5	42	SC-SM	A-4
B-5	2-3.5	26	18	8	39	SC	A-4
B-6	4.5-6	0	0	0	20	GM	A-1-b
B-7	7-8.5	31	21	10	15	GC	A-2-4
B-8	24.5-26	27	18	9	18	GC	A-2-4
B-9	2.5-4	31	21	10	33	SC	A-2-4
B-10	9.5-11	34	22	12	39	SC	A-9
B-12	19.5-21	23	18	5	31	SC-SM	A-2-4
B-13	19-20.5	0	0	0	17	GM	A-1-b
B-14	5-6.5	0	0	0	23	SM	A-1-b
B-15	4.5-6	29	20	9	32	GC	A-2-4
B-15	24.5-26	0	0	0	21	GM	A-1-b
Boring ID	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Percent Passing No. 200	USCS Classification	AASHTO Classification
B-16	21-22.5	0	0	0	16	SM	A-1-b
B-17	19.5-21	21	16	5	21	SC-SM	A-1-b
B-18	9.5-11	24	16	8	19	GC	A-2-4
B-18	39.5-41	31	20	11	40	SC	A-6
B-19	4.5-6	23	17	6	20	GC-GM	A-1-b
B-19	34.5	29	19	10	31	SC	A-2-4
B-21	2.5-4	25	19	6	17	GC-GM	A-1-b
B-30	19.5-21	23	16	7	25	GC-GM	A-2-4
B-31	9-10.5	24	16	8	35	SC	A-2-4
B-33	4.5-6	21	16	5	18	GC-GM	A-1-b
B-34	4-5.5	26	18	8	14	GC	A-2-4
B-35	14.5-16	39	22	17	47	SC	A-6

5.1.2 Standard Proctor Testing

A standard proctor test was performed on each of the bulk bag samples collected within the anticipated subgrade materials. The results are shown in Table 3.

Table 3: Results of Proctor Tests

Boring ID	USCS Classification	AASHTO Classification	Mine Spoil Fill	Maximum Dry Density (lbs/ft3)	Optimum Moisture (%)
B-3	SC-SM	A-4	No	116.6	12.6
B-6	GM	A-1-b	Yes	132.1	9.1
B-9	SC	A-2-4	Yes	122.7	12.5
B-15	GM	A-1-b	Yes	127.9	9.7
B-19	SC	A-2-4	Yes	130.5	7.3

6 ENGINEERING ANALYSES

Five stations were chosen as critical sections to be evaluated for short term, intermediate term, and long term stability as appropriate for the slope configuration. The global stability of these sections was analyzed using Slide2 software (version 9.040). Factors of safety were chosen in consideration of GT-601-3. Due to the inherent variability of mine spoil fill and the inability to collect undisturbed samples for triaxial shear testing, soil properties were selected based on research performed on remolded samples and correlations from sites previously constructed on mine spoils. These properties were cross checked with the existing slopes on site, which appear to be generally stable and do not show obvious signs of tension cracks or toe bulges. Shear strength parameters used for the embankment fill and cut slopes are shown on the sections in the appendix. Table 4 summarizes the shear-strength parameters modeled for the embankment and cut materials.

Table 4: Assumed Shear-Strength Parameters

Material	Total Stress	Effective Stress*
Mine Spoils	c = 500 psf Φ = 18° δ = 125 pcf	c' = 200 psf Φ' = 30° δ = 125 pcf
Compacted Mine Spoils	c = 800 psf Φ = 23° δ = 125 pcf	c' = 100 psf Φ' = 32° δ = 125 pcf
Sandy Silt	c = 500 psf Φ = 23° δ = 120 pcf	c' = 100 psf Φ' = 30° δ = 120 pcf
Sandstone Fill	c = 0 psf Φ = 36° δ = 135 pcf	c' = 0 psf Φ' = 36° δ = 135 pcf
* For the long-term condition on cut slopes, the cohesion used for our analysis is 20 percent of the cohesion listed in this table, as per GT-601-4		

Bedrock encountered in the rock core borings generally agrees with the available geologic mapping of the Pikeville Formation below the Amburgy coal seam. The bedrock consists primarily of sandstone, with shale present near the assumed bottom elevation of the Amburgy coal seam, and an unnamed coal seam at an elevation of about 1744 feet. This coal seam was underlain by underclay in two borings and shale in one boring, and contained less than 12 inches of clean coal. The shales exhibited Slake Durability Indexes (SDIs) of between 92 and 99; however, it is our experience that these shales will degrade over time. In the analyses, the shale was treated as a Class I Non-Durable shale due to the minor thicknesses and our experience, and was determined to be non-governing for the slope stability and rock cut design.

The structural contours from the USGS indicate that bedrock in this area is relatively flat and sloping at less than 1.5 percent to the west, which generally agrees with the borings. A few weathered and water stained joints were observed in the core holes along the hillside (Borings B-4 and B-5); however, this was within the upper 5 feet of bedrock. The jointing of the rock was typically flat; however, some joints were observed ranging from 20 to 30 degrees, and a few joints ranging from 50 to 70 degrees were observed at irregular spacings.

Boring B-30, located along the edge of the bench, was offset towards the center of the bench due to an overland gas line restricting access. Due to this offset, assumptions must be made regarding the bedrock and soil interface. The bedrock interface to the edge of the bench has been assumed to be at the elevation where mining occurred. It is likely that the mining operations stripped the site down to bedrock to an elevation of about 1798 feet and extended to the edge of the hillside. Therefore, it is assumed that soil above the elevation of 1798 feet is mine spoil fill. Bedrock depth along the hillside has been assumed to be 5 to 10 feet deep. It is recommended that these assumptions be confirmed through supplemental MASW testing or visually during sitework. If conditions are found to be different from those anticipated, we should be contacted to assess the new findings.

Table 5: Summary of Cut Slope Stability Analysis

Station	Rock Cut	Soil Slope Configuration	Factors of Safety	
			Intermediate Term	Long Term
107+00	Yes	3H:1V	1.9	1.8
115+00	No	3H:1V	2.5	2.5
119+50	No	2.5H:1V	2.2	1.7
144+00	No	2.5H:1V	2.0	1.6

Table 6: Summary of Embankment Fill Stability Analysis

Station	Approximate Embankment Height (ft)	Soil Slope Configuration	Factors of Safety	
			Short Term	Long Term
115+00	25	2H:1V	1.7	1.7
117+00	40	2H:1V	1.7	1.7
117+00[1]	40	2H:1V	1.5	1.5
144+00	95	2H:1V	1.8	1.4
144+00[1]	95	2H:1V	1.4	1.4
[1] – indicates the embankment is constructed from sandstone fill material				

If embankment fill slopes are to be constructed over 40 feet tall, CTL should be contacted to evaluate if flatter slopes are required. The embankment fill from Station 143+00 to 144+50 must be benched into bedrock below the elevation to meet acceptable factors of safety. The attached stability section in the appendix estimates a bedrock elevation of 1805 feet in this area from a nearby boring in the neighborhood development; however, this assumption should be confirmed through additional MASW surveys or field verification. Any native soil or existing mine spoil fill along the slope will result in an unsuitable factor of safety and must be removed and replaced with compacted mine spoil fill. It should be noted that even though the models indicate that 2H:1V embankment fills are stable, sloughing, shallow slips, and erosion rills may develop, especially before the establishment of vegetation. These risks can be reduced by using flatter embankment fill slopes where practical.

The analysis for the embankment fill was performed with processed mine spoils assumed as the fill material. Factors of safety have been provided for the use of sandstone as embankment material; however, we do not recommend the use of sandstone fill at station 115+00. When sandstone is used as embankment fill, care must be taken to prevent edge failure due to a lack of confining pressure. Any embankments constructed from sandstone fill must extend at least three feet past the pavement loading area. Alternatively, a pad of compacted mine spoils that is two feet thick can be constructed beneath the pavement load area. Plan drawings have not been provided for the sandstone fill. If a material other than sandstone or mine spoil fill (processed and compacted per the recommendations in this report) is to be considered for embankment fill, CTL must be contacted to revise our analyses accordingly.

As previously stated, these analyses were performed with correlations from the borings and research performed on mine spoils using remolded samples. Conservative values were chosen from the correlations, similar materials, and research. Due to the heterogeneous nature of mine spoils, unsuitable fill may be encountered during grading. Conditions such as loose soils, pockets of wet or organic material, and large boulders will need to be assessed on a case by case basis. Remediations may include undercut and replacement, flattening of the slopes, or in-place stabilization such as soil nailing. Field observation and coordination with the Geotechnical Engineer and roadway design team will be critical to the performance of the slopes.

6.1 Rock Cut Slopes

Rock cut slopes are based on guidance presented in GT-608-2, past experience, and nearby rock cut slopes in the same formations. Presplit slopes of ½H:1V will be used on the rock within the cut sections. Intermediate benches of 20 feet will be used on pre-split slopes. Overburden benches of 15 feet have been placed at the top of rock, which has been interpreted to be at an elevation of about 1798 feet. The overburden bench elevations are subject to change during construction when the actual top of rock is encountered.

Specific cut slope recommendations are provided in the cut stability sections in the Appendix.

7 DISCUSSION

The mine spoil fill conditions at this site represent a significant geotechnical challenge and financial impact to the proposed roadway development. The following subsections provide additional details and discuss other geotechnical concerns.

7.1 Mine Spoil Fill

There have been several developments on mine spoil fill sites throughout the region, including residential, commercial, educational, and industrial. The primary concern of building on mine spoil fill sites is the amount of differential settlement that can occur. Settlement will generally result from two primary processes: the consolidation settlement of the fill under its own weight and degradation of the shale portion of the fill over time due to water infiltration. The initial settlement of mine spoil fill is primarily due to a reduction in void space within the material from self-weight. The amount of time for this primary initial settlement to occur will vary based on the individual site conditions. However, previous research indicates that for fills less than about 100 feet thick (such as those underlying the proposed roadway), the majority of the settlement occurs within the first 8 to 10 years after the mine spoil was placed. Additionally, research conducted by the Kentucky Geological Survey also indicates that the initial settlement in mine spoil studied at an Eastern Kentucky mine had occurred within 8 years of placement. Once the void space reduction occurs, additional initial settlement results for short-term compression as the fine-grained material is loaded. Short-term compression will continue until the stresses are distributed uniformly throughout the fill at which time long-term or secondary settlement begins.

After the initial settlement phase of mine spoil fills has occurred, the secondary settlement phase can produce significant magnitudes of settlement, although they are not as severe as the settlement for the initial phase. However, changes in water infiltration through subsurface groundwater recharge and/or surface water infiltration drastically affect the settlement of mine spoil fills.

Observations of numerous mine spoil sites in Eastern Kentucky generally indicate that on relatively new sites and sites that have been recently regraded, evidence of water infiltration from rainfall, such as sinkholes and piping into the subsurface, is common. On older sites, large amounts of water infiltration into the surface of the mine spoil fill is not as prevalent. This is evidenced by the presence of ponds and wetland-type vegetation. On established mine spoil fill sites, the surface will develop a crust. The weathering process of the upper materials results in voids within the upper portions of the mine spoil becoming filled by the downward migration of small particles, thus increasing the density of the spoil and prohibiting the infiltration of water. Desiccation of the surface layer of mine spoil may also contribute to the formation of a surface crust. Desiccation is a process where the soil moisture in clay is drawn to the surface and evaporated. During this process, the clay becomes stiffer. Since natural precipitation does not expel more than a small part of the air contained in the voids of surface soil, cohesion in the soil can survive wet periods of long duration. However, once a site is disturbed by construction activity, the crust is disturbed, and the weathering process is reinitiated.

The age, placement methods, and type of mine spoil material would indicate that the primary consolidation period for the project site has been achieved. However, as mentioned, there is a risk of secondary consolidation that could take many years. Based on our prior research on similar sites, we are anticipating secondary settlements over the next 10 to 20 years for the fills less than 50 feet thick to be less than an inch. For fills over 50 feet and less than 100 feet, we anticipate additional long-term settlement over the next 10 to 20 years to be less than 1 to 3. Typically, to reduce the risk of differential settlements, individual structures should be located on a generally uniform fill thickness. However, this is not an option for a roadway, which must cross areas of varied mine spoil fill depth. Therefore, special care must be taken to reduce the risks of differential settlement through prudent construction practices and remediation.

A higher risk concern is the amount of water infiltration that can occur soon after construction has been completed. Previous experience and research suggests that the hydrocompression process is accelerated by introduction of water into the subsurface from poor site drainage, building gutters, septic tank fields, and runoff from paved and landscaped areas. Water infiltration can rapidly (within a few years) cause detrimental settlement issues. As previously mentioned, the weathering process of the upper materials results in voids within the mine spoil being filled, eventually preventing infiltration of surface water. However, the process of regrading and developing a site for construction destroys this crust. Newly disturbed construction sites will allow the infiltration of water until the crusting process reestablishes itself. Therefore, it is imperative that the alignment have adequate positive drainage away from the roadway. Additionally, the implementation of roadside ditches and other prudent forms of stormwater management will be critical to reducing the risks of excessive settlement and poor roadway performance. Roadside ditches, catch basins and stormwater management systems should be inspected and maintained at regular intervals to lessen the risk of overflow into the mine spoils. We anticipate that settlement from hydrocompression could range 1 to 3 percent of the wetted thickness in addition to the secondary settlement. Our research indicates that saturated thickness due to surface water infiltration can approach up to 10 feet, and therefore could range between 1 and 4 inches.

From our experience with mine spoil sites and the information obtained along the alignment, we believe that this site is suitable for the proposed roadway provided KYTC understands and accepts the risk of building over the mine spoil fill. The proposed roadway alignment transitions between areas of native soil, bedrock, and fill of various depth. In areas where the road is underlain by mine spoil fill, we recommend minimizing cuts into the mine spoil fill to preserve the existing crust and reduce the risks of hydrocompression. We anticipate that this will be practical from stations 114+50 to 118+00, 124+00 to 132+50, 133+25 to 135+00, 136+50 to 138+25, and 140+25 to 144+50, where the proposed grading plan indicates that the roadway will be supported on new structural fill placed over the mine spoil fill. However, we understand that some cutting into the mine spoils will be required in other areas along the alignment. In these areas, we recommend that the mine spoil fill be undercut to a depth of 5 feet below the planned subgrade and the fill be recompacted into the undercut to reduce the risks of settlement due to hydrocompression. The mine spoil fill should be placed in thin lifts of about 12 inches and recompacted using bulldozers and compactors. The recompacted mine spoil acts as a "mat" supporting the roadway within the uncompacted mine spoil. The type of equipment used for recompaction varies; However, Caterpillar D-8 bulldozers or similar are typical for spreading the mine spoil, and Caterpillar 825 sheepsfoot rollers or similar are typical for compacting the mine spoil. The compaction of the fill should be tested to at least 98 percent of the mine spoils maximum dry density as determined by the standard Proctor compaction test (KM 64-511). From previous research, the maximum dry unit weight of mine spoil in this area ranges from about 120 pcf to 125 pcf with optimum moisture contents of 10 to 20 percent. Based on our testing from this site, the maximum dry unit weight ranges from 120 pcf to 135 pcf with optimum moisture contents of 5 to 15 percent. Geotextile separator fabric between the mine spoil subgrade and the overlying stone pavement base is not required, as the risk of stone base embedding into the mine spoil fill is low.

Alternatively, the design team may consider lining the subgrade and ditches with a high-density polyethylene (HDPE) liner to reduce infiltration into the mine spoil subgrade. If this liner option is selected, the liner must extend high enough along the side ditches to fully contain the anticipated water. Additionally, the liner, stone road base, and side ditches must be graded and constructed such that water can freely drain from beneath the road. CTL can provide additional guidance on the HDPE liner option, if desired.

7.2 Refusal Depths and Rock Excavations

Refusal material was encountered in our borings along the road alignment. As discussed previously, this material was generally interpreted as bedrock, although some locations may be indicative of large sandstone boulders within the mine spoil fill. From about station 103+50 to 108+00, which were interpreted as natural hillside slopes, the depths to auger refusal were fairly consistent, ranging from about 2 to 5 feet, and were interpreted as bedrock. From station 108+00 to 141+00, the exploration encountered mine spoil fill, indicating that this area was subject to previous mining activities. While the interpreted depths to bedrock in this area generally ranged from about 1781 to 1833 feet, we have considered an elevation of about 1795 as the typical top of bedrock elevation.

Based on the proposed site grades, we anticipate bedrock will be encountered during site grading, especially between stations 103+50 and 111+00. These areas will require cutting and removal of bedrock to reach the final grade. The bedrock surface at this site will likely be irregular, particularly in the previously mined area. Bedrock may be encountered at elevations both higher and lower than indicated by the borings.

The information collected during rock coring indicates that the shale is non-durable and weathered near the top of bedrock. However, the sandstone on site is hard and of high quality. Therefore, while the upper foot of shale bedrock may be able to be removed by mechanical means, blasting will be necessary to efficiently remove most of the bedrock on site.

8 DESIGN RECOMMENDATIONS

As previously stated, the mine spoil fill at this site represents a risk of differential support of the proposed roadway, which could lead to differential settlement and cracking within the pavement. We have provided recommendations to reduce, but not eliminate, these risks in Section 7.1 of this report. As previously discussed, mine spoil fill is particularly sensitive to volumetric settlement from hydrocompression, which occurs due water infiltration. Therefore, minimizing infiltration of water into the subgrade and rapid removal of subsurface water is critical for the successful long-term performance of the pavement. Pavement and subgrade surfaces must be sloped to promote drainage to the side ditches to reduce the risk of water infiltration into the mine spoil subgrade.

For pavement to perform satisfactorily, the subgrade soils must have sufficient strength and be stable enough to avoid deterioration from construction traffic and support the paving equipment. Also, the completed pavement sections must resist freeze/thaw cycles and wheel loads from traffic. Generally, construction traffic loading is more severe than the traffic after construction. As such, we recommend holding off on final paving of the road surface until the building construction within the residential neighborhood has been completed. This will allow for the remediation of failed/settled areas.

The resilient modulus test results are included in the appendix. The resilient modulus is dependent on the confining stress of the overlying materials and the deviator stress, which is a function of the traffic loading. Selection of the appropriate parameters is important to selecting the resilient modulus for the design. Assuming a deviator stress of about 6 psi and a confining stress of about 2 psi, the resilient moduli obtained in our tests range from about 9,200 to 23,050 psi for compacted mine spoil fill, and about 15,200 psi for compacted native soil. This correlates to CBR values ranging from about 6 to 15 for the compacted mine spoils, and a CBR value of about 10 for the compacted native soil. We anticipate that the alignment will be underlain by compacted mine spoil fill or blasted rock. Due to the variability of mine spoil fill, as seen in the testing, we recommend selecting a conservative value for the pavement design (CBR of 6).

9 GEOTECHNICAL NOTES

1. Clearing and grubbing shall be completed in accordance to the requirements of Section 202 of the Kentucky Department of Highways Standard Specifications for Roadway and Bridge Construction.

2. All water wells and/or cisterns within the limits of construction, whether shown on the plans or not, shall be plugged in accordance with Section 708 of the current Kentucky Department of Highways Standard Specifications for Roadway and Bridge Construction.

3. In accordance with Section 206 of the current Kentucky Department of Highways Standard Specifications for Roadway and Bridge Construction, the moisture content of embankment material shall not vary from the optimum moisture content as determined by KM 64-511 by more than +2 percent or less than -2 percent. This moisture content requirement shall have equal weight with the density requirement when determining the acceptability of embankment construction. In accordance with Section 206, compact the embankment foundations and embankment to a density of at least 95 percent of maximum density as determined according to KM 64-511.

4. Excavation of surface ditches and channel changes adjacent to embankment areas shall be performed prior to the placement of adjacent embankments. The material excavated for the channel changes and surface ditches is suitable for embankment construction if dried to proper moisture content in accordance with Section 206 Kentucky Department of Highways Standard Specifications for Roadway and Bridge Construction.
5. The contractor is responsible for conducting any operations necessary to excavate the cut areas to the required typical section. These operations shall be incidental to the roadway price.
6. The contractor shall conduct grading operations in such a manner that sandstone and/or durable shale (SDI > 95) from roadway excavation be stockpiled separately or otherwise manipulated so that ample quantities are available for those areas requiring said material.
7. All soils, whether from roadway excavation or borrow, may require manipulation to obtain proper moisture content prior to compaction.
8. Some of the soil horizons and slopes on the project are subject to erosion. Necessary procedures in accordance with Sections 212 and 213 of the current Kentucky Department of Highways Standard Specifications for Roadway and Bridge Construction shall be followed on construction.
9. Cut intervals in soil shall be constructed with 2.5H:1V or flatter slopes
10. Any saturated, soft, organic laden, or unstable areas encountered within cut slopes shall receive specific case by case recommendations by the Engineer.
11. Any saturated, soft, organic laden, or unstable areas encountered within roadway areas should be undercut and replaced with suitable material.
12. Any saturated, soft, unstable areas encountered within embankment foundation limits and/or any other areas specified by the Engineer shall be drained and stabilized with sandstone from the roadway excavation.
13. Embankment foundation benches and perforated pipe underdrains shall be placed at the following approximate locations and any others designated by the Engineer in accordance with Standard Drawing RGX-010-04 and RDP-006-04. The benches shall be constructed one at a time, beginning with the lowest bench. Each bench shall be backfilled prior to excavation of the next bench. This procedure should be followed to help maintain the stability of the existing slopes in these areas.

<u>APPROXIMATE STATION LIMITS</u>

112+50 – 115+50

133+50 – 135+00

140+00 – 144+50

14. Transverse benching shall be installed at the following approximate locations in accordance with KY Standard Drawing RDP-006 and any others designated by the Engineer.

<u>APPROXIMATE LOCATIONS</u>

101+00

111+00

15. Processed mine spoil fill and shale bedrock obtained from the required cuts do not meet the KYTC Section 805 requirements for use as aggregate or channel lining due to shale content. Additional soundness and wear evaluation will be required to evaluate if the non-friable sandstone meets the KYTC Section 805 requirements for either aggregate or channel lining.

10 LIMITATIONS OF RECOMMENDATIONS

When building on old mine spoil sites, the owner must understand and accept that, no matter how much evaluation and exploration is conducted, there will be a risk of unsuitable pavement performance due to the inherent variability in mine spoil fill. There are numerous documented settlement and building distress issues when building on old mine sites. Therefore, the information provided in this report is to assist in understanding, but not eliminating, the risk of building on this site.

This report has been prepared for the exclusive use of Palmer Engineering and the Kentucky Transportation Cabinet for specific application to the project site. Our recommendations have been prepared using generally accepted standards of geotechnical engineering practice in the Commonwealth of Kentucky. No other warranty is expressed or implied. This company is not responsible for the conclusions, opinions, or recommendations of others based on this data. Additionally, our conclusions and recommendations are based on the information provided to us, the data obtained from our subsurface exploration, and our experience. They do not reflect variations in the subsurface conditions which are likely to exist between borings and in unexplored areas of the site. These variations result from the geologic variability of the subsurface conditions. If conditions are different than those encountered in our exploration, it will be necessary for us to re-evaluate our conclusions and recommendations based upon on-site observation of the conditions. For more information on the use and limitations of this report, please read the GBA document included in the attachments.

If the overall design or alignment of the roadway is changed, the recommendations contained in this report must not be considered valid unless our firm reviews the changes and our recommendations are modified. When the design is finalized, we should be allowed to provide the additional service of reviewing the grading plan and applicable portions of the project specifications. This review will allow us to check whether these documents are consistent with the intent of our recommendations.

We may recommend that a supplementary exploration be performed when significant design changes, such as the movement of the alignment, are incorporated into the final design after the geotechnical exploration has been completed. This supplementary exploration may include obtaining additional soil data along the new alignment to provide specific recommendations.

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

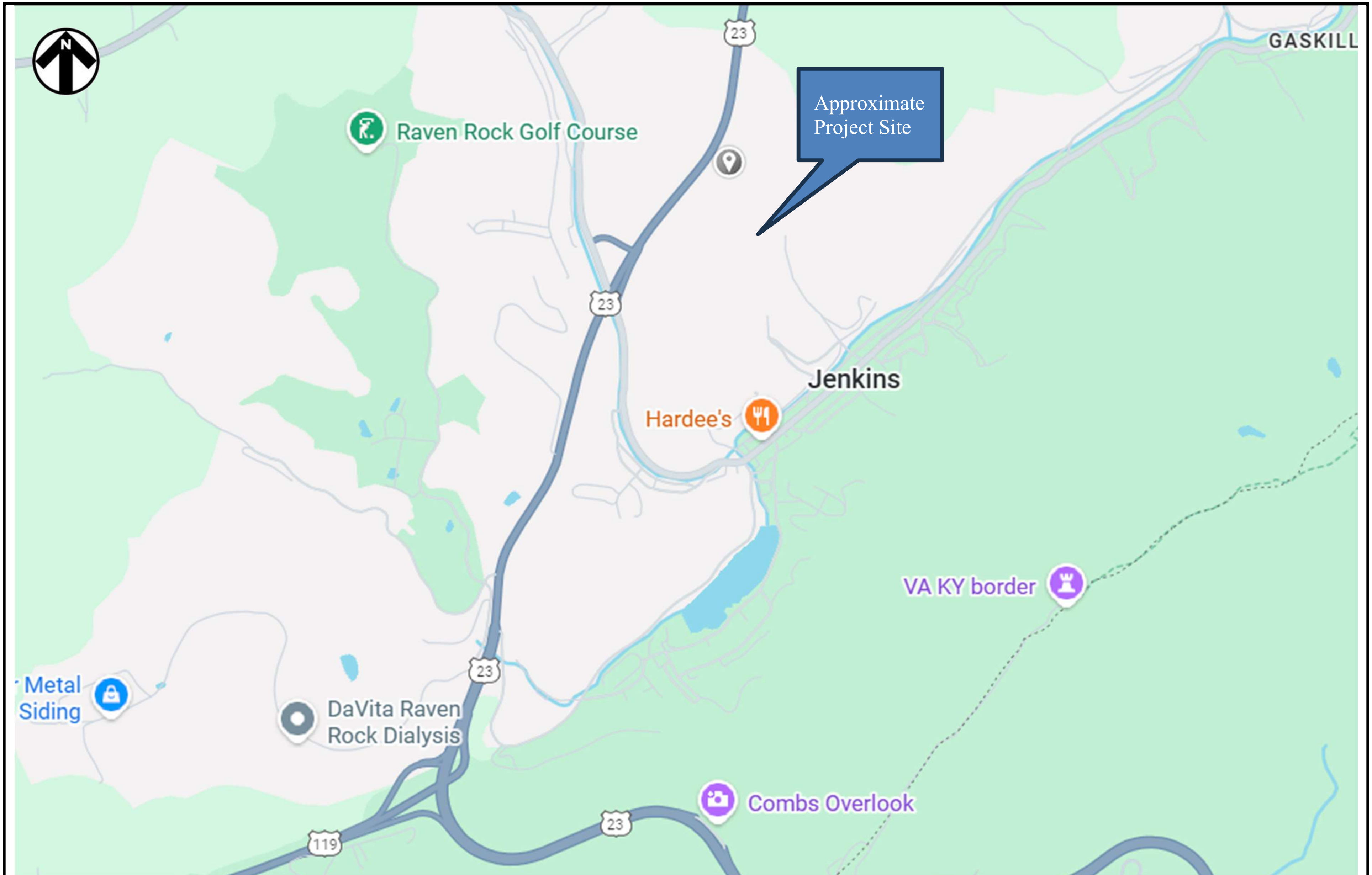
The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

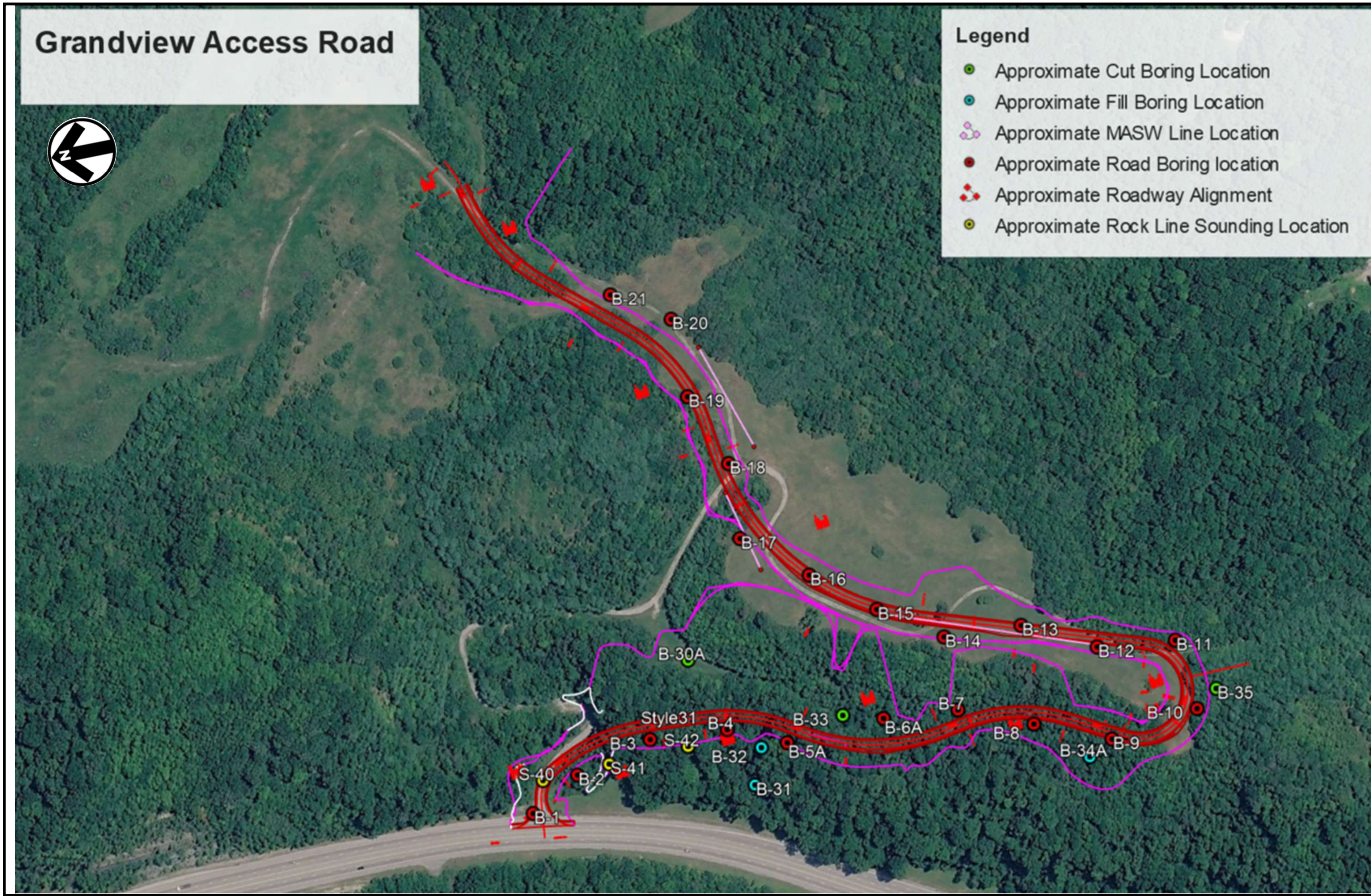
While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

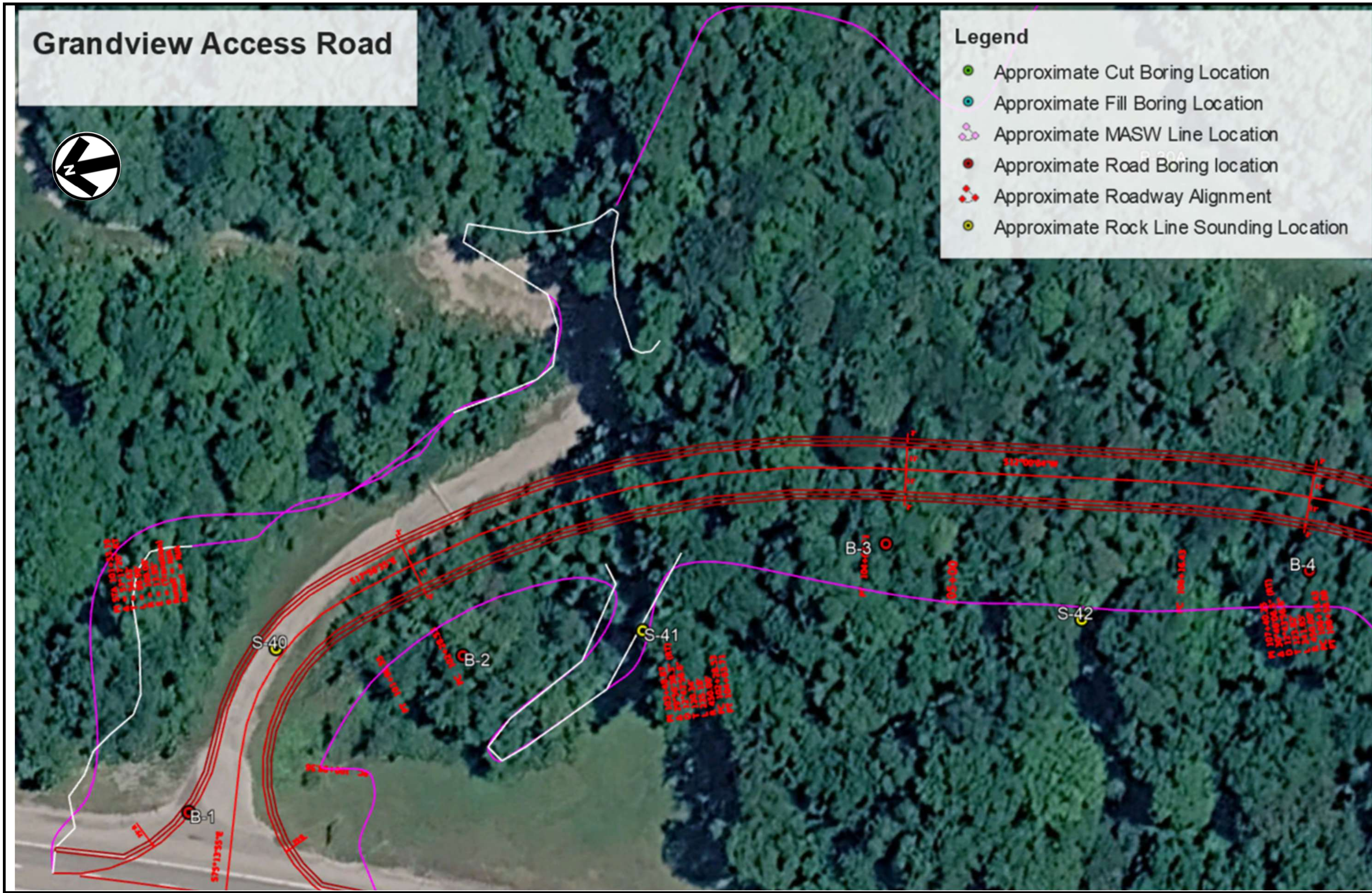
Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org



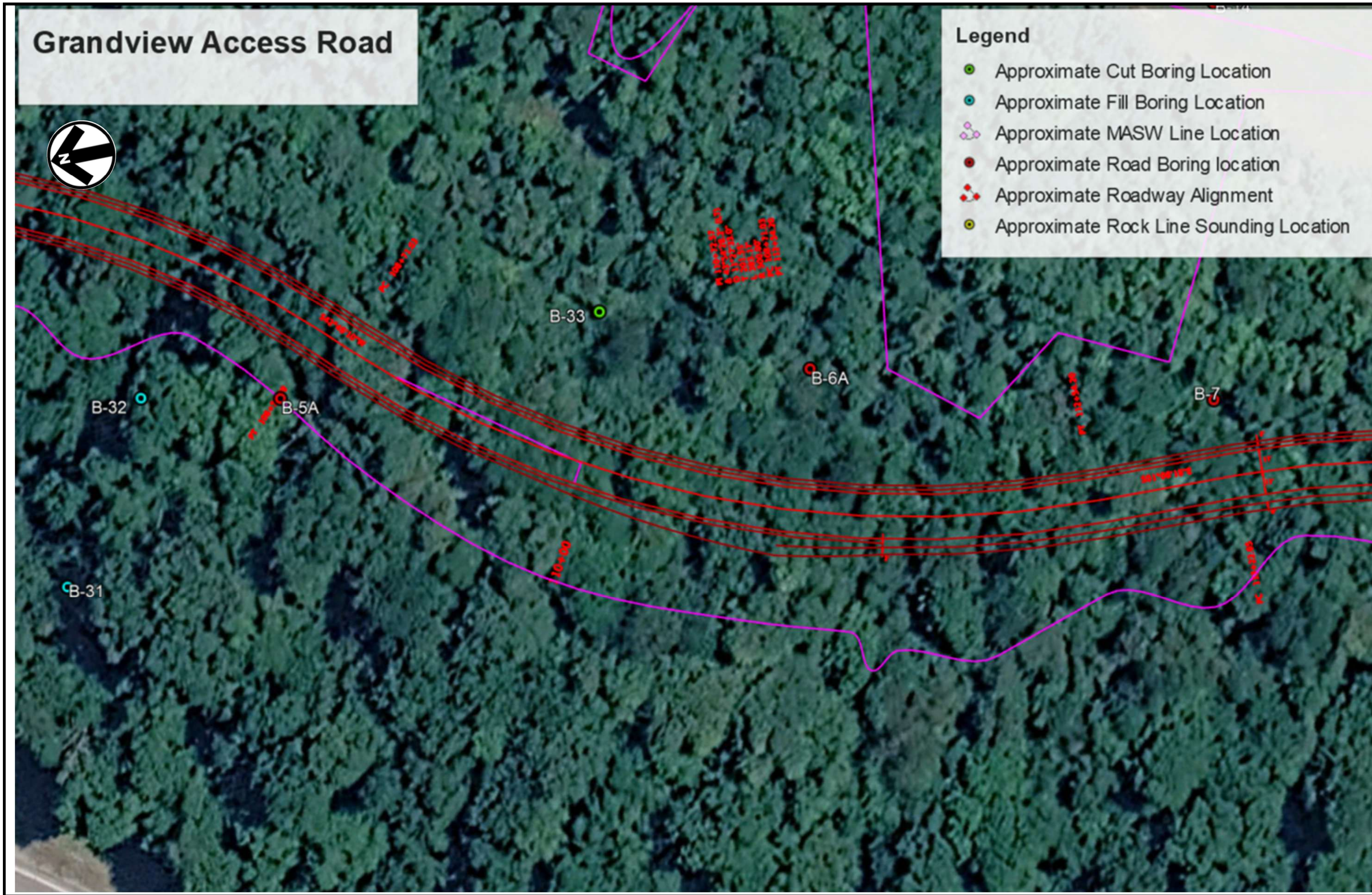
Palmer Engineering	CTL ENGINEERING INC	**Site Location Map** **Grandview Access Road** Jenkins, Kentucky CTL Project 25050086SHE



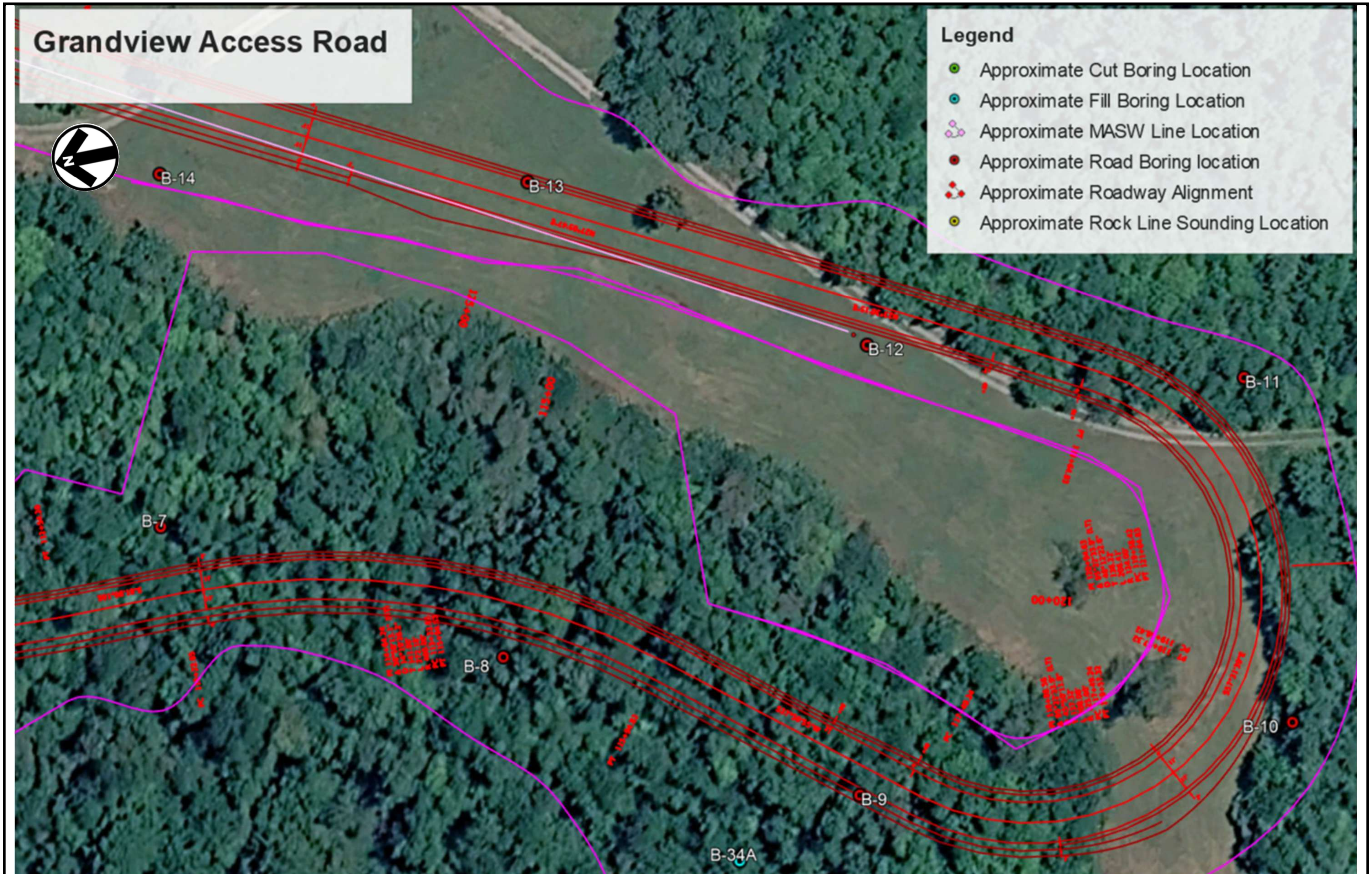
Palmer Engineering	CTL ENGINEERING INC.	**Aerial Photograph** **Grandview Access Road** Jenkins, Kentucky CTL Project 25050086SHE



Station 100+00 to Station 107+00	CTL ENGINEERING INC	**Boring Location Aerial** **Grandview Access Road** Jenkins, Kentucky CTL Project 25050086SHE



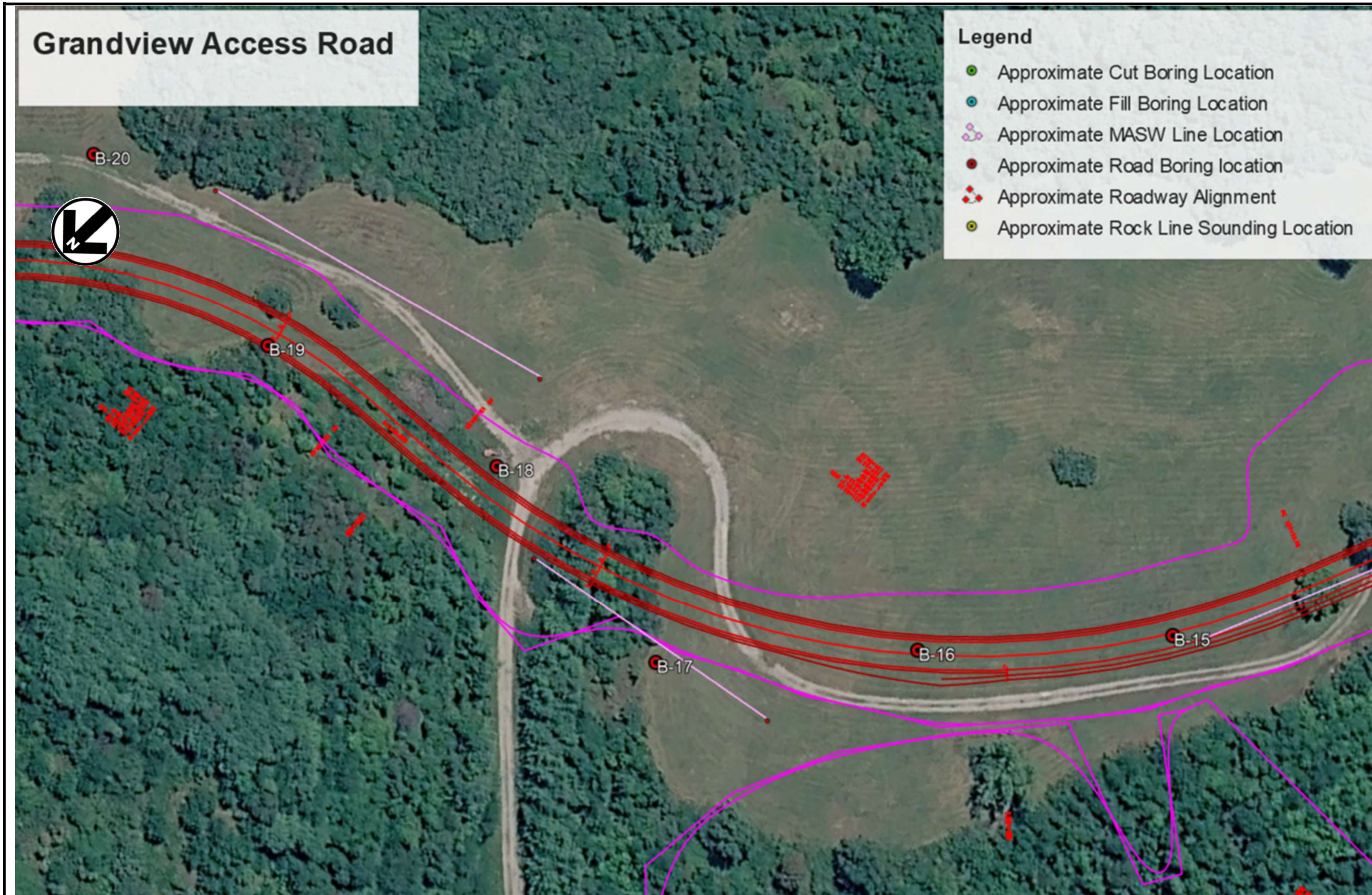
Station 107+00 to Station 112+00	CTL ENGINEERING INC	**Boring Location Aerial** **Grandview Access Road** Jenkins, Kentucky CTL Project 25050086SHE



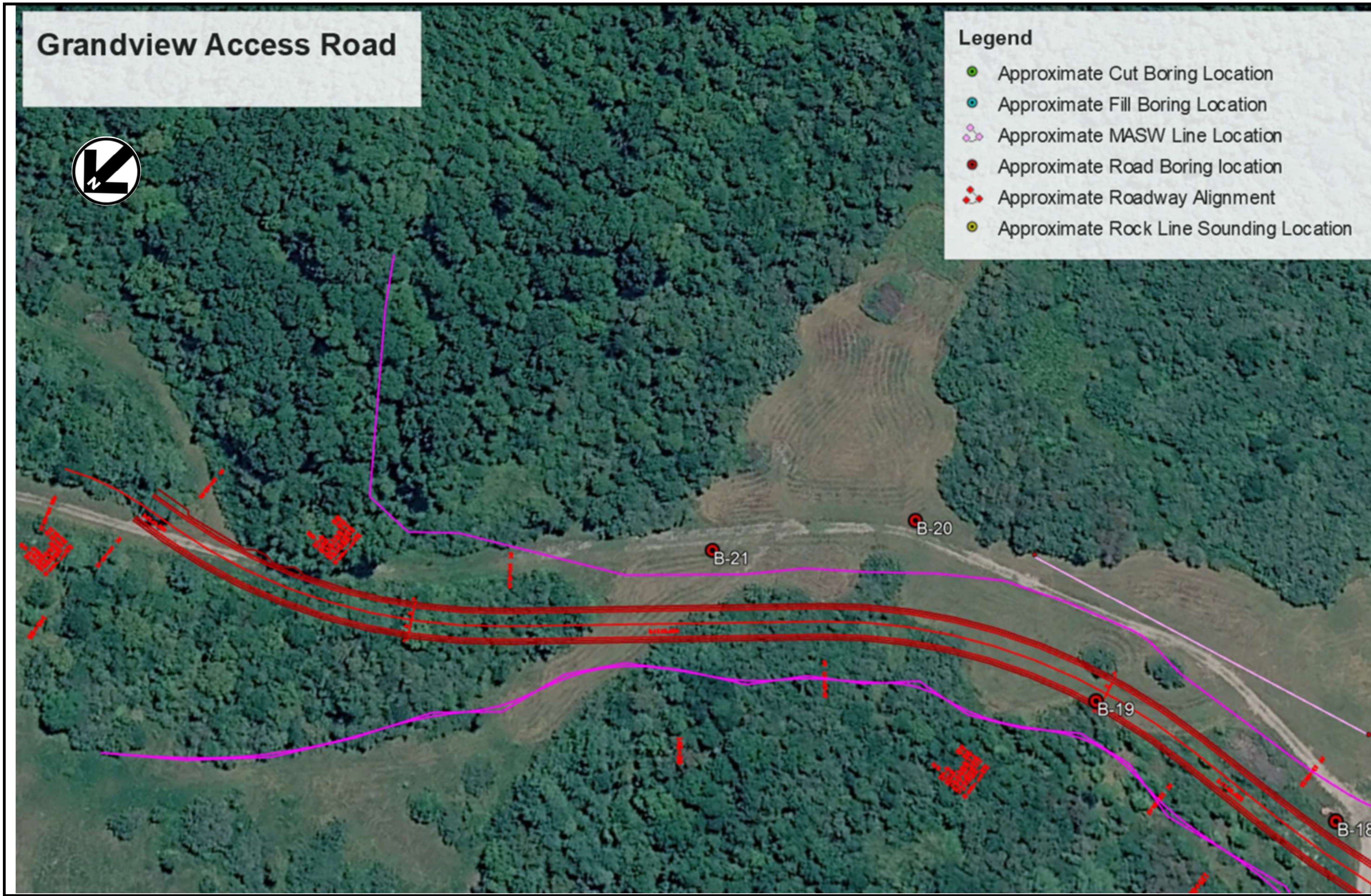
Station 109+00 to Station 126+00

CTL ENGINEERING INC

Boring Location Aerial
Grandview Access Road
Jenkins, Kentucky
CTL Project 25050086SHE



Station 126+00 to Station 135+50	CTL ENGINEERING INC	**Boring Location Aerial** **Grandview Access Road** Jenkins, Kentucky CTL Project 25050086SHE



Station 134+00 to Station 144+50

CTL ENGINEERING INC.

Boring Location Aerial

Grandview Access Road

Jenkins, Kentucky

CTL Project 25050086SHE

GEOTECHNICAL SYMBOL SHEET

AASHTO Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35% or less passing 0.075 mm)							Silt-Clay Materials (More than 35% passing 0.075 mm)			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve Analyses, percent Passing											
2.00 mm (No. 10)	50 max	---	---	---	---	---	---	---	---	---	---
0.425 mm (No. 40)	30 max	50 max	51 min	---	---	---	---	---	---	---	---
0.075 mm (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of Fraction Passing 0.425 mm (No. 40)											
Liquid Limit	---		---	40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity Index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min

Unified Soil Classifications

MAJOR DIVISIONS		SYMBOL		NAME
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW		Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP		Poorly graded gravels or gravel-sand mixtures, little or no fines.
		GM		Silty gravels, gravel-sand-silt mixtures.
		GC		Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW		Well-graded sands or gravelly sands, little or no fines.
		SP		Poorly graded sands or gravelly sands, little or no fines.
		SM		Silty sands, sand-silt mixtures.
		SC		Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS LL IS LESS THAN 50	ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
	SILTS AND CLAYS LL IS GREATER THAN 50	MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH		Inorganic clays of high plasticity, fat clays.
UNCLASSIFIED MATERIAL		NONE		Non-classified material (i.e. overburden, pavement, slag, etc.) Include visual description.

Symbol	Description
AI	Activity Index
LI	Liquidity Index
S+C	Silt + Clay (% finer than No. 200 Sieve)
○	Rockline Soundings
◕	Disturbed Sample Boring
◎	Undisturbed Sample Boring
⊙	Undisturbed Sample Boring & Rock Core
○	Rock Core
□	Open Face Log
⌖	Slope Inclinometer Installation typical applications:
OW	Observation Well
→	Approximate Footing Elevation
▼ (Date)	Water Elevation
VS (psf)	Field Vane Shear Strength
■	Thin-walled Tube Sample
<	Standard Penetration Test Sample
N	Penetration Resistance
Qu (psf)	Unconfined Compressive Strength
UU (psf)	Unconsolidated Undrained Triaxial Strength
w(%)	Moisture Content
KY RQD	Rock Quality Designation (Kentucky Method)
STD RQD	Rock Quality Designation (Standard Method)
SDI(JS)	Slake Durability Index (Jar Slake Test)
REC	Core Recovery
ϕ	Angle of Internal Friction (Total Stress)
$\bar{\phi}$	Angle of Internal Friction (Effective Stress)
c (psf)	Cohesion (Total Stress)
$\bar{c}$ (psf)	Cohesion (Effective Stress)
γ (psf)	Total Unit Weight
RDZ	Rock Disintegration Zone
OB	Overburden Bench
IB	Intermediate Bench
R	Refusal
NR	Refusal Not Encountered

LIMESTONE

SANDSTONE

DURABLE SHALE (SDI ≥ 95)

NONDURABLE SHALE (SDI < 95)

COAL

TALUS, MINE WASTE, FILL MATERIAL, BOULDERS, & ETC.

GRANULAR EMBANKMENT

STRUCTURE GRANULAR BACKFILL

SLOPE PROTECTION

GEOTECHNICAL NOTES

1) Clearing and grubbing shall be completed in accordance to the requirements of Section 202 of the Kentucky Department of Highways Standards and Specifications for Roadway and Bridge Construction.

2) All water wells and/or cisterns within the limits of construction, whether shown on the plans or not, shall be plugged in accordance to Section 708 Kentucky Department of Highways Standards and Specifications for Roadway and Bridge Construction

3) In accordance with Section 206 of the current Kentucky Department of Highways Standards and Specifications for Roadway and Bridge Construction, the moisture content of embankment material shall not vary from the optimum moisture content as determined by KM 64-511 by more than +2 percent or less than -2 percent. The moisture content requirement shall have equal weight with the density requirement when determining the acceptability of of embankment construction. In accordance with Section 206, compact the embankment foundations and embankment to a density of at least 95 percent of maximum density as determined according to KM 64-511.

4) Excavation of surface ditches and channel changes adjacent to embankment areas shall be performed prior to the placement of adjacent embankments. The material excavated for the channel changes and surface ditches is suitable for the embankment construction if dried to proper moisture content in accordance with Section 206 Kentucky Department of Highways Standards and Specifications for Roadway and Bridge Construction

5) The contractor is responsible for conducting any operations necessary to excavate the cut areas to the required typical section. These operations shall be incidental to the roadway price.

6) The contractor shall conduct grading operations in such a manner that sandstone and/or durable shale (SDI > 95) from roadway excavation be stockpiled separately or otherwise manipulated so that ample quantities are available for those areas requiring said material.

7) All soils, whether from roadway excavation or borrow, may require manipulation to obtain proper moisture content prior to compaction.

8) Some of the soil horizons and slopes on the project are subject to erosion. Necessary procedures in accordance to Sections 212 and 213 of the current Kentucky Department of Highways Standards and Specifications for Roadway and Bridge Construction shall be followed on construction.

9) Cut intervals in soil shall be constructed on 2H:1V or flatter slopes.

10) Any saturated, soft, organic laden, or unstable areas encountered within roadway areas should be undercut and replaced with suitable material.

11) Any saturated, soft, organic laden, or unstable areas encountered within roadway areas should be undercut and replaced with suitable material.

12) Any saturated, soft, unstable areas encountered within embankment foundation limits and/or any other areas specified by the Engineer shall be drained and stabilized with sandstone from the roadway excavation.

13) Embankment foundation benches and preforated pipe underdrains shall be placed at the following approximate locations and any others designated by the Engineer in accordance with Standard Drawing RGX-010-04 and RDP-006-04. The benches shall be constructed one at a time, beginning with the lowest bench. Each bench shall be backfilled prior to excavation of the next bench. This procedure should be followed to help maintain the stability of the existing slopes in these areas.

APPROXIMATE STATION LIMITS

112+50 - 115+50
133+50 - 135+00
140+00 - 144+50

14) Transverse benching shall be installed at the following approximate locations in accordance with Standard Drawing RDP-006 RDP-006 and any others designated by the Engineer.

APPROXIMATE LOCATIONS

101+00
111+00

15) Processed mine spoil fill and shale bedrock obtained from required cuts do not meet the KYTC Section 805 requirements for use as aggregate or channel lining due to shale content. Additional soundness and wear evaluation will be required to evaluate if the non-friable sandstone meets the KYTC Section 805 requirements for either aggregate or channel lining.

SAMPLE NO.		1
STATION		104+70
OFFSET		22.0' Lt.
DEPTH		0.0–3.7
COMPOSITION OF TOTAL SAMPLE	GRAVEL (– 3" + NO. 10)	15
	SAND (– NO. 10 + NO. 200)	43
	SILT (– 0.075 mm + 0.002 mm)	37
	CLAY (– 0.002 mm)	6
LIQUID LIMIT		24
PLASTIC LIMIT		19
PLASTICITY INDEX		5
ACTIVITY INDEX		0.91
SPECIFIC GRAVITY		2.711
AASHTO CLASSIFICATION		A–4 (0)
UNIFIED CLASSIFICATION		SC–SM
CALIFORNIA BEARING RATIO		
MAXIMUM DRY DENSITY (pcf)		117
OPTIMUM MOISTURE (%)		13
% +4.75 mm MATERIAL IN CBR & MOISTURE–DENSITY TESTS		13

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

DRAWING TITLE: GRAND VIEW DEVELOPMENT
PROFILE SHEET

HORIZONTAL SCALE: 1"=20'

VERTICAL SCALE: 1"=8'

STA. 100+00.00 TO STA. 106+00.00

ITEM NO. 12-173

COUNTY OF LETCHER

SHEET NO. R4

SAMPLE NO.		2
STATION		110+70
OFFSET		40.0' Lt.
DEPTH		1.0-9.0
COMPOSITION OF TOTAL SAMPLE	GRAVEL (- 3" + NO. 10)	49
	SAND (- NO. 10 + NO. 200)	31
	SILT (- 0.075 mm + 0.002 mm)	100
	CLAY (- 0.002 mm)	0
LIQUID LIMIT		0
PLASTIC LIMIT		0
PLASTICITY INDEX		0
ACTIVITY INDEX		0.00
SPECIFIC GRAVITY		2.650
AASHTO CLASSIFICATION		A-1-b (0)
UNIFIED CLASSIFICATION		GM
CALIFORNIA BEARING RATIO		
MAXIMUM DRY DENSITY (pcf)		132
OPTIMUM MOISTURE (%)		9
% +4.75 mm MATERIAL IN CBR & MOISTURE-DENSITY TESTS		43

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

DRAWING TITLE: GRAND VIEW DEVELOPMENT
PROFILE SHEET

0' 20' 40' 80'
HORIZONTAL SCALE: 1"=20'

0' 8' 16' 32'
VERTICAL SCALE: 1"=8'

STA. 106+00.00 TO STA. 112+00.00

ITEM NO. 12-173
COUNTY OF LETCHER
SHEET NO. R6

SAMPLE NO.		3
STATION		117+70
OFFSET		15.0' Rt.
DEPTH		1.0-32.4
COMPOSITION OF TOTAL SAMPLE	GRAVEL (- 3" + NO. 10)	43
	SAND (- NO. 10 + NO. 200)	24
	SILT (- 0.075 mm + 0.002 mm)	23
	CLAY (- 0.002 mm)	10
LIQUID LIMIT		31
PLASTIC LIMIT		21
PLASTICITY INDEX		10
ACTIVITY INDEX		1.03
SPECIFIC GRAVITY		2.650
AASHTO CLASSIFICATION		A-2-4 (0)
UNIFIED CLASSIFICATION		SC
CALIFORNIA BEARING RATIO		
MAXIMUM DRY DENSITY (pcf)		123
OPTIMUM MOISTURE (%)		13
% +4.75 mm MATERIAL IN CBR & MOISTURE-DENSITY TESTS		31

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

DRAWING TITLE: GRAND VIEW DEVELOPMENT PROFILE SHEET

HORIZONTAL SCALE: 1"=20' (0' 20' 40' 80')

VERTICAL SCALE: 1"=8' (0' 8' 16' 32')

STA. 112+00.00 TO STA. 118+00.00

ITEM NO. 12-173 | COUNTY OF LETCHER

SHEET NO. R8

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

DRAWING TITLE: GRAND VIEW DEVELOPMENT
PROFILE SHEET

HORIZONTAL SCALE: 1"=20'

VERTICAL SCALE: 1"=8'

STA. 118+00.00 TO STA. 124+00.00

ITEM NO. 12-173

COUNTY OF LETCHER

SHEET NO. R10

SAMPLE NO.		4
STATION		128+70
OFFSET		2.0' Lt.
DEPTH		1.0–49.7
COMPOSITION OF TOTAL SAMPLE	GRAVEL (– 3" + NO. 10)	45
	SAND (– NO. 10 + NO. 200)	23
	SILT (– 0.075 mm + 0.002 mm)	91
	CLAY (– 0.002 mm)	9
LIQUID LIMIT		29
PLASTIC LIMIT		20
PLASTICITY INDEX		9
ACTIVITY INDEX		0.99
SPECIFIC GRAVITY		2.650
AASHTO CLASSIFICATION		A-2-4 (0)
UNIFIED CLASSIFICATION		GC
CALIFORNIA BEARING RATIO		
MAXIMUM DRY DENSITY (pcf)		128
OPTIMUM MOISTURE (%)		10
% +4.75 mm MATERIAL IN CBR & MOISTURE-DENSITY TESTS		35

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

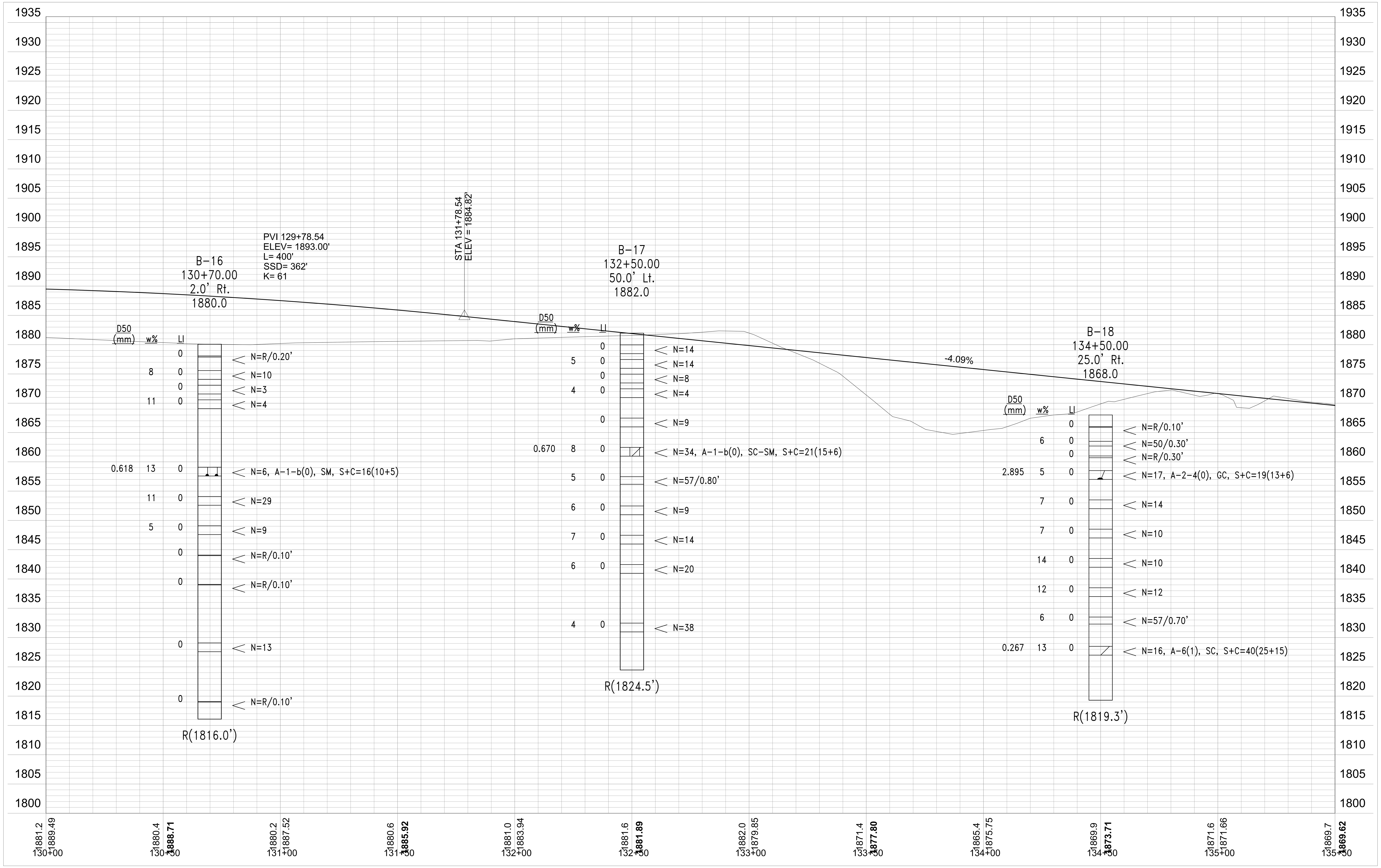
DRAWING TITLE: GRAND VIEW DEVELOPMENT PROFILE SHEET

HORIZONTAL SCALE: 1"=20'

VERTICAL SCALE: 1"=8'

STA. 124+00.00 TO STA. 130+00.00

ITEM NO. 12-173 | COUNTY OF LETCHER | SHEET NO. R12



COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

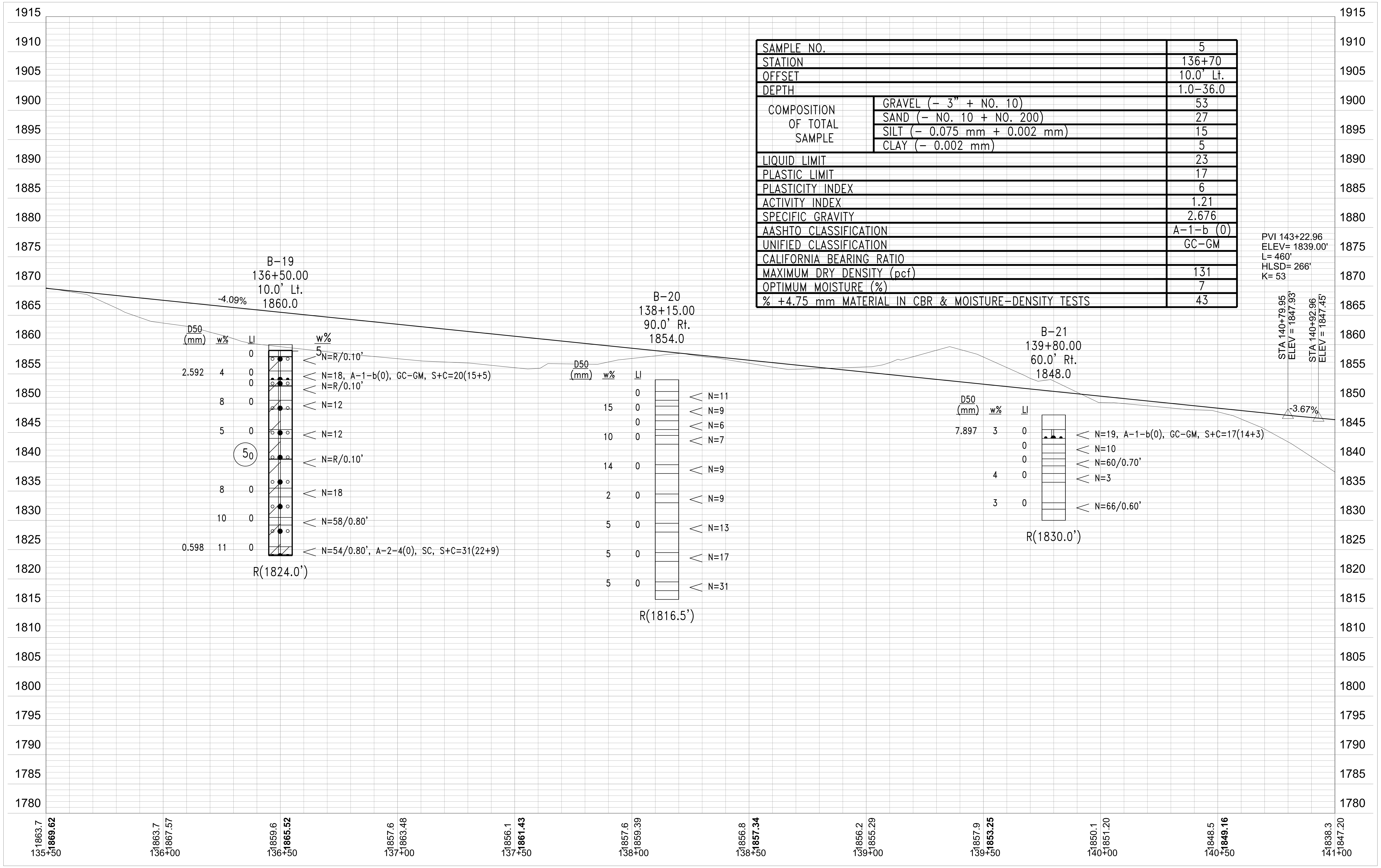
DRAWING TITLE: GRAND VIEW DEVELOPMENT
PROFILE SHEET

HORIZONTAL SCALE: 1"=20'

VERTICAL SCALE: 1"=8'

STA. 130+00.00 TO STA. 135+50.00

ITEM NO.	COUNTY OF
12-173	LETCHER
SHEET NO.	
R14	



SAMPLE NO.	5
STATION	136+70
OFFSET	10.0' Lt.
DEPTH	1.0-36.0
COMPOSITION OF TOTAL SAMPLE: GRAVEL (- 3" + NO. 10)	53
SAND (- NO. 10 + NO. 200)	27
SILT (- 0.075 mm + 0.002 mm)	15
CLAY (- 0.002 mm)	5
LIQUID LIMIT	23
PLASTIC LIMIT	17
PLASTICITY INDEX	6
ACTIVITY INDEX	1.21
SPECIFIC GRAVITY	2.676
AASHTO CLASSIFICATION	A-1-b (0)
UNIFIED CLASSIFICATION	GC-GM
CALIFORNIA BEARING RATIO	
MAXIMUM DRY DENSITY (pcf)	131
OPTIMUM MOISTURE (%)	7
% +4.75 mm MATERIAL IN CBR & MOISTURE-DENSITY TESTS	43

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

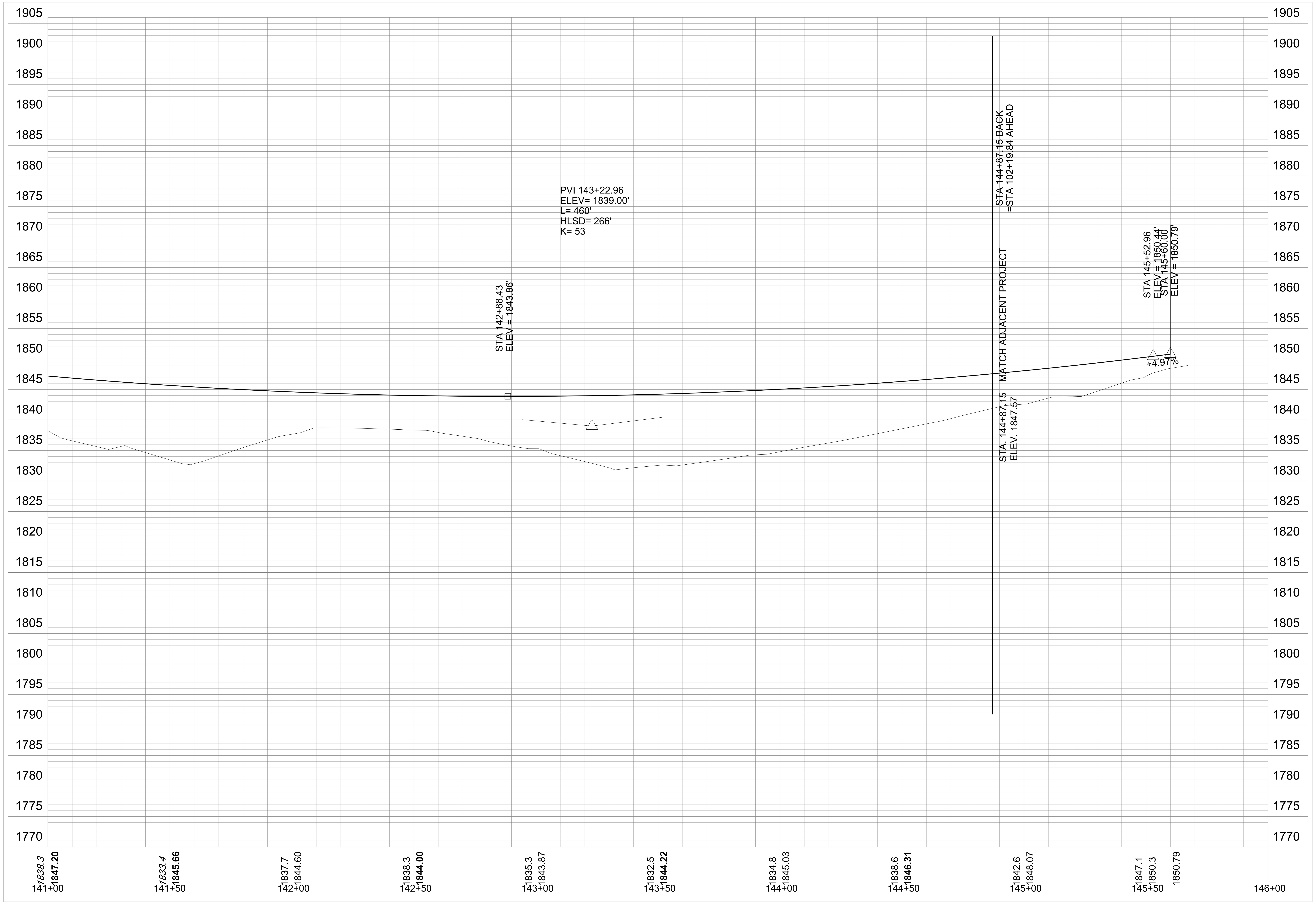
DRAWING TITLE: GRAND VIEW DEVELOPMENT
PROFILE SHEET

HORIZONTAL SCALE: 1"=20'

VERTICAL SCALE: 1"=8'

STA. 135+50.00 TO STA. 141+00.00

ITEM NO. 12-173
COUNTY OF LETCHER
SHEET NO. R16



COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

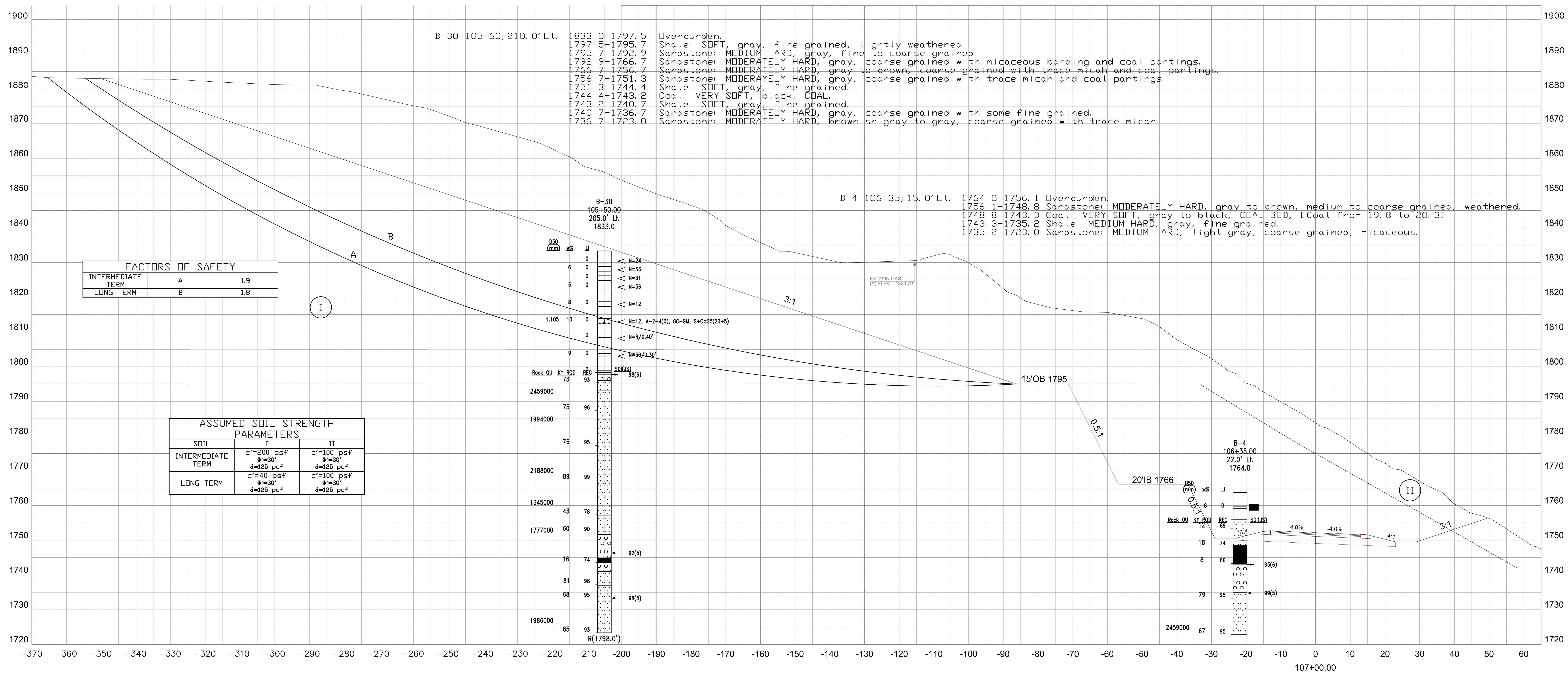
DRAWING TITLE: GRAND VIEW DEVELOPMENT
PROFILE SHEET

0' 20' 40' 80'
HORIZONTAL SCALE: 1"=20'

0' 8' 16' 32'
VERTICAL SCALE: 1"=8'

STA. 141+00.00 TO STA. 144+87.15

ITEM NO. 12-173	COUNTY OF LETCHER
SHEET NO. R18	



FACTORS OF SAFETY		
INTERMEDIATE TERM	A	1.9
LONG TERM	B	1.8

ASSUMED SOIL STRENGTH PARAMETERS		
SOIL	I	II
INTERMEDIATE TERM	c′=200 psf Φ'=30° δ=125 pcf	c′=100 psf Φ'=30° δ=125 pcf
LONG TERM	c′=40 psf Φ'=30° δ=125 pcf	c′=100 psf Φ'=30° δ=125 pcf

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

DRAWING TITLE: CUT SLOPE STABILITY

HORIZONTAL SCALE
SCALE: 1" = 15'

0' 15' 30' 60'

STA. 107+00.00

ITEM NO. 12-173

COUNTY OF LETCHER

SHEET NO. 107+00.00

ASSUMED SOIL STRENGTH PARAMETERS

SOIL	I	II	III
SHORT TERM	c=500 psf Φ=18° δ=125 pcf	c=800 psf Φ=23° δ=125 pcf	c=500 psf Φ=23° δ=125 pcf
INTERMEDIATE TERM	c'=200 psf Φ'=30° δ=125 pcf	c'=100 psf Φ'=32° δ=125 pcf	c'=100 psf Φ'=30° δ=125 pcf
LONG TERM	c'=40 psf Φ'=30° δ=125 pcf	c'=100 psf Φ'=32° δ=125 pcf	c'=100 psf Φ'=30° δ=125 pcf

FACTORS OF SAFETY

SHORT TERM	A	1.7
INTERMEDIATE TERM	B	2.5
LONG TERM	C	1.7

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

DRAWING TITLE: CUT SLOPE AND EMBANKMENT FILL STABILITY

HORIZONTAL SCALE
SCALE: 1" = 10'

0' 10' 20' 40'

STA. 115+00.00

ITEM NO. 12-173
COUNTY OF LETCHER
SHEET NO. 115+00.00

ASSUMED SOIL STRENGTH PARAMETERS		
SOIL	I	II
SHORT TERM	c=500 psf Φ=18° δ=125 pcf	c=800 psf Φ=23° δ=125 pcf
LONG TERM	c'=20 psf Φ'=30° δ=125 pcf	c'=100 psf Φ'=32° δ=125 pcf

FACTORS OF SAFETY		
SHORT TERM	A	1.7
LONG TERM	B	1.7

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

DRAWING TITLE: EMBANKMENT FILL STABILITY

HORIZONTAL SCALE
SCALE: 1" = 10'

0' 10' 20' 40'

STA. 117+00.00

ITEM NO. 12-173
COUNTY OF LETCHER
SHEET NO. 117+00.00

ASSUMED SOIL STRENGTH PARAMETERS	
SOIL	I
INTERMEDIATE TERM	c'=200 psf Φ'=30° δ=125 pcf
LONG TERM	c'=40 psf Φ'=30° δ=125 pcf

FACTORS OF SAFETY		
INTERMEDIATE TERM	A	2.2
LONG TERM	B	1.7

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

DRAWING TITLE: CUT SLOPE STABILITY

HORIZONTAL SCALE
SCALE: 1" = 10'

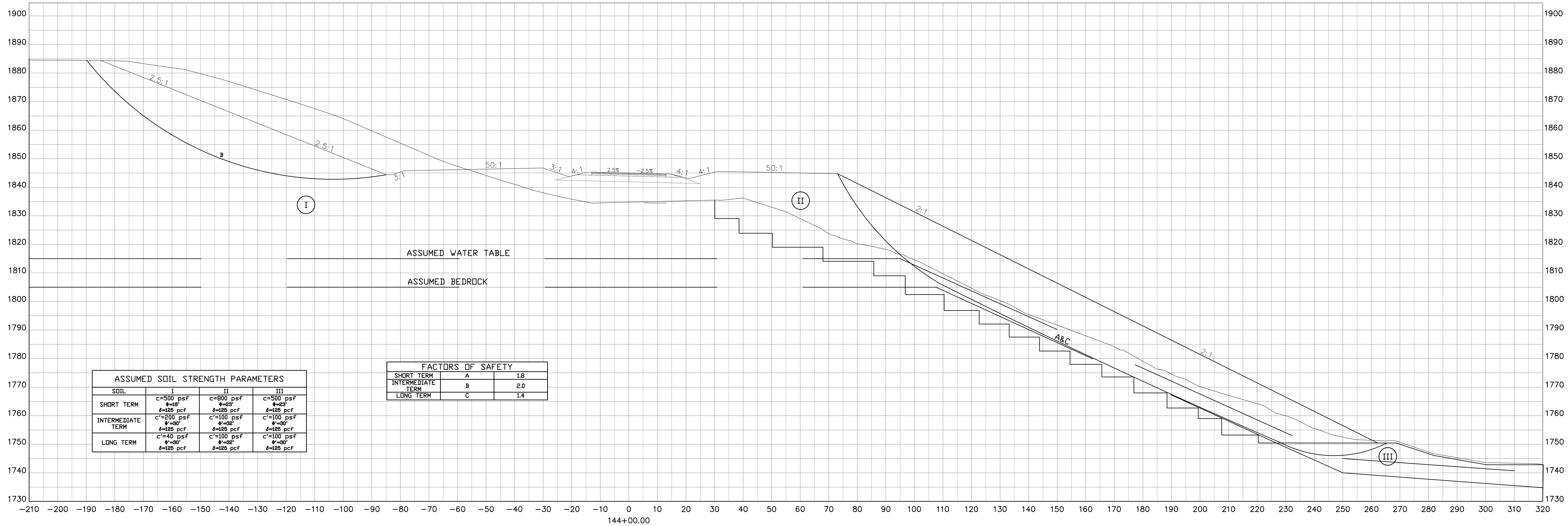
0' 10' 20' 40'

STA. 119+00.00

ITEM NO. 12-173

COUNTY OF LETCHER

SHEET NO. 119+00.00



ASSUMED SOIL STRENGTH PARAMETERS

SOIL	I	II	III
SHORT TERM	c=500 psf Φ=18° δ=125 pcf	c=800 psf Φ=23° δ=125 pcf	c=500 psf Φ=23° δ=125 pcf
INTERMEDIATE TERM	c′=200 psf Φ′=30° δ=125 pcf	c′=100 psf Φ′=32° δ=125 pcf	c′=100 psf Φ′=30° δ=125 pcf
LONG TERM	c′=40 psf Φ′=30° δ=125 pcf	c′=100 psf Φ′=32° δ=125 pcf	c′=100 psf Φ′=30° δ=125 pcf

FACTORS OF SAFETY

SHORT TERM	A	1.8
INTERMEDIATE TERM	B	2.0
LONG TERM	C	1.4

COMMONWEALTH OF KENTUCKY DEPARTMENT OF HIGHWAYS	DRAWING TITLE: CUT SLOPE AND EMBANKMENT FILL STABILITY	HORIZONTAL SCALE SCALE: 1" = 20'	0' 20' 40' 80'	STA. 144+00.00	ITEM NO. 12-173 COUNTY OF LETCHER SHEET NO. 144+50.00

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-1**	Immediate Water Depth **(09/16/25)**	Start Date **09/16/2025**	Hole Type **sample**
Surface Elevation **1718.0'**	Static Water Depth **NA**	End Date **09/16/2025**	Rig_Number **Deitrich D.51**
Total Depth **22.1'**	Driller **Horn & Associates Inc**	Latitude(83) **37.182272**	
Location **100+70.00 22.0' Lt.**		Longitude(83) **-82.636368**	

Lithology: Elevation	Lithology: Depth	Description	Overburden: Sample No. / Rock Core: Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1716.4	1.6	Gray, gravel (Crushed Stone).						
1714.5	3.5	Hard, brown, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	1	2.0-3.5	1.5	5-16-18	SPT	
1709.5	8.5	Hard, gray, rock fragments (Mine Spoil Fill).	2	4.5-6.0	1.4	16-17-24	SPT	
			3	7.0-8.5	1.3	6-6-6	SPT	
1701.0	17.0	Very stiff, gray, moist, lean clay with rock fragments (Mine Spoil Fill).	4	9.5-11.0	1.2	8-9-8	SPT	
			5	14.5-16.0	1.5	3-6-10	SPT	
1700.0	18.0	Boulders (Mine Spoil Fill).						
1695.9	22.1	Medium stiff, brown to gray, moist, lean clay with rock fragments (Mine Spoil Fill).	6	19.5-21.0	0.7	2-1-7	SPT	
		(Bottom of Hole 22.1') (Refusal @ 22.1')						

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-2**	Immediate Water Depth **(09/15/25)**	Start Date **09/15/2025**	Hole Type **sample**
Surface Elevation **1722.0'**	Static Water Depth **NA**	End Date **09/15/2025**	Rig_Number **Deitrich D.51**
Total Depth **25.9'**	Driller **Horn & Associates Inc**	Latitude(83) **37.181870**	
Location **102+25.00 15.0' Rt.**		Longitude(83) **-82.636197**	

Lithology: Elevation	Lithology: Depth	Description	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1715.5	6.5	Very stiff, brown, moist, lean clay with boulders (Mine Spoil Fill).	1	1.5-3.0	1.3	11-14-13	SPT	
			2	4.0-5.5	0.9	11-12-12	SPT	
1709.0	13.0	Stiff, brown, moist, lean clay with boulders (Mine Spoil Fill).	3	6.5-8.0	0.8	4-5-5	SPT	
			4	9.0-10.5	1.0	4-3-5	SPT	
1705.0	17.0	Stiff, brown to gray, moist, sandy lean clay with wood (Mine Spoil Fill).	5	14.0-15.5	1.5	2-2-16	SPT	
1699.0	23.0	Very stiff, gray to brown, moist, lean clay with boulders (Mine Spoil Fill).	6	19.0-20.5	1.0	7-8-8	SPT	
1696.1	25.9	Very stiff, brown to gray, moist, sandy lean clay with boulders (Mine Spoil Fill).	7	24.0-25.5	1.5	5-9-10	SPT	
			8	25.8-25.9	0.0	50/0.10'	SPT	
		(Bottom of Hole 25.9') (Refusal @ 25.9')						

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-3***	Immediate Water Depth ***NA***	Start Date ***09/16/2025***	Hole Type ***cut profile***
Surface Elevation ***1758.0'***	Static Water Depth ***NA***	End Date ***09/16/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***3.7'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.181287***	
Location ***104+35.00 22.0' Lt.***		Longitude(83) ***-82.636148***	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1755.6	2.4	Very stiff, brown, moist, lean clay with boulders.					NMC #1 @ 1'	
1754.3	3.7	Brown, overburden (weathered sandstone bedrock). Bag #1	1	2.0-3.2	1.0	6-18-50/0.20'	SPT	

(Bottom of Hole 3.7')
(Refusal @ 3.7')

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-4***	Immediate Water Depth ***(09/16/25)***	Start Date ***09/16/2025***	Hole Type ***core and sample***
Surface Elevation ***1764.0'***	Static Water Depth ***NA***	End Date ***09/16/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***41.0'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.180745***	
Location ***106+35.00 22.0' Lt.***		Longitude(83) ***-82.636326***	

Elevation	Depth	Description	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1759.3	4.7	Brown, moist, sandy lean clay.	1	4.0-4.7	0.7		ST	
1756.1	7.9	Brown, overburden (weathered sandstone bedrock). (Begin Core)						
1748.8	15.2	Brown with gray sandstone, weathered.	12 / 12	2.6	1.8	69		10.5
			18 / 18	5.0	3.7	74		15.5
1744.2	19.8	Gray shale, (underclay).	8 / 8	5.0	3.3	66		**Coal seam @ 18-18.5** 20.5
1743.3	20.7	Black coal.						
1735.2	28.8	Gray shale.	79 / 79	10.0	9.5	95		30.5
1723.0	41.0	Gray sandstone.	67 / 67	10.5	10.0	95		**Water loss @ 34.7** 41.0
		(Bottom of Hole 41.0')						

Depth scale (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-5***	Immediate Water Depth ***(09/30/25)***	Start Date ***09/30/2025***	Hole Type ***core and sample***
Surface Elevation ***1767.0'***	Static Water Depth ***NA***	End Date ***09/30/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***30.0'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.180822***	
Location ***107+95.00 2.0' Lt.***		Longitude(83) ***-82.636633***	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1763.8	3.2	Very stiff, brown, moist, lean clay with rock fragments.	1	2.0-3.5	1.4	8-8-12	SPT	
1763.0	4.0	Brown, overburden (weathered sandstone bedrock).						
		(Begin Core)	0 / 0	3.0	0.7	23		7.0
			0 / 0	3.5	0.0	0		10.5
1751.5	15.5	Brown sandstone, weathered.	0 / 0	5.0	1.0	20		15.5
1750.0	17.0	Gray sandstone.	27 / 27	1.5	1.1	73		17.0
1749.0	18.0	Gray shale.						**Coal seam @ 17.8-20.1**
1747.6	19.4	Gray shale, (underclay).	29 / 29	8.0	5.1	64		25.0
1737.0	30.0	Gray shale.	74 / 74	5.0	5.0	100		30.0

(Bottom of Hole 30.0')

Moved to station 108+00

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway***
Item Number: ***12-00173.***		Project Manager: ***Adam Ross***

Hole Number ***B-6***	Immediate Water Depth ***(09/18/25)***	Start Date ***09/18/2025***	Hole Type ***cut profile***
Surface Elevation ***1808.0'***	Static Water Depth ***NA***	End Date ***09/18/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***9.0'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.179728***	
Location ***110+50.00 40.0' Lt.***		Longitude(83) ***-82.636823***	

Lithology Elevation	Lithology Depth	Description	Overburden: Sample No. / Rock Core: Std/Ky RQD	Overburden: Depth (ft) / Rock Core: Run (ft)	Overburden: Rec. (ft) / Rock Core: Rec (ft)	Overburden: SPT Blows / Rock Core: Rec (%)	Overburden: Sample Type / Rock Core: SDI (JS)	Remarks
		Very stiff, gray to brown, moist, clayey sand with rock fragments. Bag #2					NMC #1 @ 1.1'	
			1	2.0-3.5	0.8	24-13-3	SPT	
			2	4.5-5.9	1.3	18-40-50/0.40'	SPT	
			3	7.0-7.1	0.1	50/0.10'	SPT	**Auger refusal, switch to casing advancer @ 7.2-9**
1799.0	9.0		4	8.9-9.0	0.0	50/0.10'	SPT	

(Bottom of Hole 9.0')
(Refusal @ 7.2')

Offset 8 feet southeast due to gasline

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-7***	Immediate Water Depth ***(09/22/25)***	Start Date ***09/22/2025***	Hole Type ***cut profile***
Surface Elevation ***1826.0'***	Static Water Depth ***NA***	End Date ***09/22/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***35.3'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.179158***	
Location ***112+50.00 22.0' Lt.***		Longitude(83) ***-82.636946***	

Lithology: Elevation	Depth	Description	Overburden: Sample No. / Rock Core: Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1822.5	3.5	Very stiff, gray, rock fragments (Mine Spoil Fill).	1	2.0-3.5	1.3	12-7-11	SPT	
		Gray, boulders (Mine Spoil Fill).	2	4.5-4.8	0.3	50/0.30'	SPT	
			3	7.0-8.5	1.3	6-34-14	SPT	
1815.7	10.3		4	9.5-10.1	0.4	10-50/0.10'	SPT	
		Overburden (Mine Spoil Fill).	30 / -	3.0	1.5	50		13.3
			0 / -	7.0	0.8	11		20.3
			0 / -	5.0	0.4	8		25.3
			0 / -	5.0	1.1	22		30.3
1793.5	32.5		56 / -	5.0	2.8	56		
1790.7	35.3	Gray sandstone.						35.3
		(Bottom of Hole 35.3') (Refusal @ 10.3')						

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-8***	Immediate Water Depth ***(09/23/25)***	Start Date ***09/22/2025***	Hole Type ***fill profile***
Surface Elevation ***1812.0'***	Static Water Depth ***NA***	End Date ***09/23/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***34.7'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.178694***	
Location ***114+50.00 15.0' Rt.***		Longitude(83) ***-82.637320***	

Lithology Elevation	Lithology Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
		Very stiff, brown, moist, lean clay with rock fragments (Mine Spoil Fill).	1	2.0-2.4	0.4	50/0.40'	SPT	
			2	4.5-6.0	0.7	7-11-9	SPT	
1803.5	8.5		3	7.0-8.5	0.7	5-6-8	SPT	
1801.8	10.2	Gray, boulders (Mine Spoil Fill).						
		Medium stiff, gray, rock fragments (Mine Spoil Fill).	4	9.5-9.7	0.2	50/0.20'	SPT	**Switched to casing advancer @ 10.2**
			5	14.5-16.0	0.2	2-3-5	SPT	
1794.0	18.0							
		Hard, brown to gray, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	6	19.5-20.2	0.3	6-50/0.20'	SPT	
			7	24.5-26.0	0.8	8-13-22	SPT	
1781.2	30.8		8	29.5-31.0	1.3	8-20-15	SPT	
1777.3	34.7	Gray, overburden (weathered bedrock).	9	34.5-34.7	0.2	50/0.20'	SPT	
		(Bottom of Hole 34.7') (Refusal @ 34.7')						

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-9***	Immediate Water Depth ***(09/23/25)***	Start Date ***09/23/2025***	Hole Type ***cut profile***
Surface Elevation ***1824.0'***	Static Water Depth ***NA***	End Date ***09/23/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***32.4'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.178218***	
Location ***117+50.00 15.0' Rt.***		Longitude(83) ***-82.637708***	

Lithology Elevation	Lithology Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1820.0	4.0	Stiff, brown, moist, lean clay with boulders (Mine Spoil Fill).					NMC #1 @ 1.1'	
			1	2.5-4.0	1.5	7-7-6	SPT	
1808.4	15.6	Medium stiff, brown, moist, lean clay with boulders (Mine Spoil Fill).	2	5.0-6.5	0.9	4-4-3	SPT	
			3	7.0-8.3	1.0	3-3-50/0.30'	SPT	
			4	9.5-10.9	0.9	2-4-50/0.40'	SPT	
			5	14.5-16.0	1.0	14-6-5	SPT	
1796.0	28.0	Bag #3 Gray, boulders with rock fragments (Mine Spoil Fill).	6	19.5-21.0	1.3	3-3-5	SPT	
			7	24.5-25.6	0.1	5-10-50/0.10'	SPT	
1791.6	32.4	Stiff, gray to brown, wet, rock fragments (Mine Spoil Fill).	8	29.5-31.0	1.3	4-3-7	SPT	
		(Bottom of Hole 32.4') (Refusal @ 32.4')						

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-10***	Immediate Water Depth ***(09/24/25)***	Start Date ***09/24/2025***	Hole Type ***core and sample***
Surface Elevation ***1878.0'***	Static Water Depth ***NA***	End Date ***09/24/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***46.5'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.177574***	
Location ***119+75.00 25.0' Rt.***		Longitude(83) ***-82.637741***	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1871.5	6.5	Hard, gray to brown, moist, lean clay with boulders (Mine Spoil Fill).	1	2.0-3.5	1.3	15-26-15	SPT	
			2	4.5-4.8	0.3	50/0.30'	SPT	
1869.0	9.0	Very stiff, gray, boulders (Mine Spoil Fill).	3	7.0-8.5	1.3	5-7-15	SPT	
1864.0	14.0	Hard, brown, moist, lean clay with rock fragments (Mine Spoil Fill).	4	9.5-11.0	1.4	3-16-30	SPT	
1855.0	23.0	Very stiff, brown, moist, fat clay with boulders (Mine Spoil Fill).	5	14.5-16.0	1.1	8-8-11	SPT	
			6	19.5-21.0	1.5	7-8-7	SPT	
1850.0	28.0	Very stiff, gray, boulders (Mine Spoil Fill).	7	24.5-26.0	0.9	4-10-6	SPT	
1845.0	33.0	Stiff, brown, moist, sandy fat clay with boulders (Mine Spoil Fill).	8	29.5-31.0	1.3	4-6-4	SPT	
1840.0	38.0	Gray, boulders (Mine Spoil Fill).	9	34.5-36.0	0.9	6-8-11	SPT	
1833.5	44.5	Gray to black, boulders with rock fragments (Mine Spoil Fill). (Begin Core)	10	39.5-41.0	1.3	8-4-8	SPT	
1831.5	46.5	Gray sandstone, silty.	35 / -	2.0	1.9	95		46.5
		(Bottom of Hole 46.5')						

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-11**	Immediate Water Depth **(09/24/25)**	Start Date **09/24/2025**	Hole Type **core and sample**
Surface Elevation **1870.0'**	Static Water Depth **NA**	End Date **09/24/2025**	Rig_Number **Deitrich D.51**
Total Depth **9.5'**	Driller **Horn & Associates Inc**	Latitude(83) **37.177533**	
Location **121+75.00 22.0' Rt.**		Longitude(83) **-82.637100**	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1869.7	0.3	Brown, topsoil.						
		Brown, moist, lean clay with gravel (Mine Spoil Fill).	1	2.0-2.1	0.0	50/0.10'	SPT	**Possible highwall @ 1.5**
1865.5	4.5	(Begin Core)						
			2	4.4-4.5	0.0	50/0.10'	SPT	
		Gray sandy shale.	56 / 56	5.0	4.4	88		
1860.5	9.5							9.5
		(Bottom of Hole 9.5')						

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-12**	Immediate Water Depth **(09/24/25)**	Start Date **09/24/2025**	Hole Type **cut profile**
Surface Elevation **1878.0'**	Static Water Depth **NA**	End Date **09/24/2025**	Rig_Number **Deitrich D.51**
Total Depth **49.5'**	Driller **Horn & Associates Inc**	Latitude(83) **37.178066**	
Location **122+90.00 22.0' Lt.**		Longitude(83) **-82.636892**	

Lithology Elevation	Lithology Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1877.7	0.3	Brown, topsoil.						
1873.1	4.9	Gray, boulders (Mine Spoil Fill).	1	2.0-2.1	0.0	50/0.10'	SPT	
1871.0	7.0	Very stiff, brown, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	2	4.5-6.0	0.8	19-3-16	SPT	
1869.0	9.0	Medium stiff, brown, moist, lean clay with rock fragments (Mine Spoil Fill).	3	7.0-8.5	0.9	4-2-4	SPT	
1865.0	13.0	Soft, brown, moist, lean clay with rock fragments (Mine Spoil Fill).	4	9.5-11.0	0.7	2-2-2	SPT	
1855.9	22.1	Stiff, brown to gray, moist, lean clay with rock fragments (Mine Spoil Fill).	5	14.5-16.0	1.0	1-6-7	SPT	
			6	19.5-20.8	0.9	2-6-50/0.30'	SPT	
1842.9	35.1	Overburden with boulders (Mine Spoil Fill).						**Cored overburden @ 22.1-35.1**
1828.5	49.5	Gray, boulders (Mine Spoil Fill).	7	35.5-35.6	0.1	50/0.10'	SPT	**Switch to casing advancer @ 35.2**
			8	39.5-39.6	0.0	50/0.10'	SPT	
		(Bottom of Hole 49.5') (Refusal @ 49.5')	9	49.4-49.5	0.0	50/0.10'	SPT	

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-13***	Immediate Water Depth ***(09/25/25)***	Start Date ***09/24/2025***	Hole Type ***cut profile***
Surface Elevation ***1878.0'***	Static Water Depth ***NA***	End Date ***09/25/2025***	Rig_Number ***Deitrich D.120***
Total Depth ***81.5'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.178511***	
Location ***124+90.00 10.0' Rt.***		Longitude(83) ***-82.636456***	

Lithology Elevation	Lithology Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1877.7	0.3	Topsoil.						
		Hard, brown, dry, sand with rock fragments (Mine Spoil Fill).	1	1.5-3.0	1.3	23-20-20	SPT	
			2	4.0-4.3	0.3	50/0.30'	SPT	
			3	6.5-6.6	0.0	50/0.10'	SPT	
			4	9.0-10.3	0.8	9-10-50/0.30'	SPT	
			5	14.0-15.5	0.6	5-6-8	SPT	
			6	19.0-20.5	1.0	10-13-15	SPT	
1855.0	23.0							
		Brown, boulders (Mine Spoil Fill).	7	24.0-25.5	0.3	10-13-15	SPT	
			8	29.0-29.1	0.0	50/0.10'	SPT	
1846.0	32.0							
		Gray, boulders with rock fragments (Mine Spoil Fill).	9	34.0-35.3	1.2	7-16-50/0.30'	SPT	
1840.0	38.0							
		Very stiff, gray to brown, moist, sandy lean clay with boulders (Mine Spoil Fill).	10	39.0-40.5	1.1	7-9-13	SPT	
			11	49.0-50.5	1.2	5-16-15	SPT	

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-13***	Immediate Water Depth ***(09/25/25)***	Start Date ***09/24/2025***	Hole Type ***cut profile***
Surface Elevation ***1878.0'***	Static Water Depth ***NA***	End Date ***09/25/2025***	Rig_Number ***Deitrich D.120***
Total Depth ***81.5'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.178511***	
Location ***124+90.00 10.0' Rt.***		Longitude(83) ***-82.636456***	

Lithology Elevation	Lithology Depth	Description	Overburden Sample No. / Rock Core Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
		Very stiff, gray to brown, moist, sandy lean clay with boulders (Mine Spoil Fill).	12	59.0-60.5	1.2	9-10-9	SPT	
			13	69.0-70.5	1.0	7-6-18	SPT	
			14	79.0-79.8	0.3	11-50/0.30'	SPT	
1796.5	81.5	(Bottom of Hole 81.5') (Refusal @ 81.5')						

Depth scale: 55, 60, 65, 70, 75, 80, 85, 90, 95, 100

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-14**	Immediate Water Depth **NA**	Start Date **09/25/2025**	Hole Type **fill profile**
Surface Elevation **1874.0'**	Static Water Depth **NA**	End Date **09/25/2025**	Rig_Number **Deitrich D.51**
Total Depth **60.5'**	Driller **Horn & Associates Inc**	Latitude(83) **37.179052**	
Location **126+90.00 40.0' Lt.**		Longitude(83) **-82.636291**	

Lithology Elevation	Lithology Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1873.4	0.6	Topsoil.						
		Medium stiff, brown, moist, clayey sand with rock fragments (Mine Spoil Fill).	1	2.5-2.6	0.0	50/0.10'	SPT	
1868.0	6.0		2	5.0-6.5	0.7	6-4-4	SPT	
		Soft, brown, moist, sandy clay with rock fragments (Mine Spoil Fill).	3	7.5-9.0	1.3	3-2-2	SPT	
			4	10.0-11.5	1.0	2-16-10	SPT	
1856.0	18.0							
		Stiff, gray to brown, moist, sandy clay with rock fragments (Mine Spoil Fill).	5	20.0-21.5	1.1	3-4-3	SPT	
			6	25.0-26.5	1.0	6-4-6	SPT	
			7	30.0-31.5	0.7	3-5-3	SPT	
			8	35.0-36.5	1.2	11-14-14	SPT	
1835.7	38.3							
		Gray, boulders (Mine Spoil Fill).						**Cored overburden @ 38.3-43.5**
1830.5	43.5							
		Stiff, gray, moist, lean clay with rock fragments (Mine Spoil Fill).						**Switched to casing advancer @ 43.6**

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Printed: 3/26/26

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-14**	Immediate Water Depth **NA**	Start Date **09/25/2025**	Hole Type **fill profile**
Surface Elevation **1874.0'**	Static Water Depth **NA**	End Date **09/25/2025**	Rig_Number **Deitrich D.51**
Total Depth **60.5'**	Driller **Horn & Associates Inc**	Latitude(83) **37.179052**	
Location **126+90.00 40.0' Lt.**		Longitude(83) **-82.636291**	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
			9	50.0-51.5	0.8	5-9-6	SPT	
1819.0	55.0	Stiff, gray, moist, lean clay with rock fragments (Mine Spoil Fill).						
1813.5	60.5	Boulders (sandstone bedrock).						**Consistent hard material @ 55-60.5**
			10	60.0-60.1	0.0	50/0.10'	SPT	
		(Bottom of Hole 60.5') (Refusal @ 60.5') Offset 5 feet northeast due to uneven terrain						

Depth scale: 55, 60, 65, 70, 75, 80, 85, 90, 95, 100

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-15***	Immediate Water Depth ***(09/25/25)***	Start Date ***09/25/2025***	Hole Type ***cut profile***
Surface Elevation ***1880.0'***	Static Water Depth ***NA***	End Date ***09/25/2025***	Rig_Number ***Deitrich D.120***
Total Depth ***49.7'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.179424***	
Location ***128+70.00 2.0' Lt.***		Longitude(83) ***-82.635833***	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1879.7	0.3	Topsoil (Mine Spoil Fill).						
			1	2.0-3.5	1.3	7-10-12	SPT	NMC #1 @ 2'
1873.5	6.5	Medium stiff, brown to gray, moist, lean clay with rock fragments (Mine Spoil Fill).	2	4.5-6.0	1.2	3-3-3	SPT	
1872.0	8.0	Boulders (Mine Spoil Fill).	3	7.0-7.9	0.7	44-50/0.40'	SPT	
		Medium stiff, brown, moist, sandy lean clay with rock fragments (Mine Spoil Fill, damp at 24 feet).	4	9.5-11.0	1.2	7-4-3	SPT	
			5	14.5-16.0	0.7	4-2-4	SPT	
			6	19.5-21.0	0.3	5-3-5	SPT	
1852.0	28.0	Gray, boulders (Mine Spoil Fill). Bag #4	7	24.5-26.0	0.6	0-2-1	SPT	
1846.0	34.0	Very stiff, brown to gray, moist, lean clay with rock fragments (Mine Spoil Fill).	8	29.5-31.0	1.0	8-14-16	SPT	
		Gray, boulders (Mine Spoil Fill).	9	34.5-35.2	0.2	13-50/0.20'	SPT	
			10	39.5-41.0	0.8	9-7-6	SPT	
1830.3	49.7							**Consistent hard material @ 46-49.7**
			11	49.5-49.7	0.2	50/0.20'	SPT	
		(Bottom of Hole 49.7') (Refusal @ 49.7')						

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-16**	Immediate Water Depth **(09/29/25)**	Start Date **09/25/2025**	Hole Type **cut profile**
Surface Elevation **1880.0'**	Static Water Depth **NA**	End Date **09/29/2025**	Rig_Number **Deitrich D.51**
Total Depth **64.0'**	Driller **Horn & Associates Inc**	Latitude(83) **37.179778**	
Location **130+70.00 2.0' Rt.**		Longitude(83) **-82.635314**	

Lithology Elevation	Lithology Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1879.7	0.3	Topsoil.						
1873.5	6.5	Soft, gray, boulders (Mine Spoil Fill).	1	2.0-2.2	0.2	50/0.20'	SPT	
			2	4.5-6.0	1.2	9-6-4	SPT	
1871.0	9.0	Soft, dark gray to brown, moist, fat clay with rock fragments (Mine Spoil Fill).	3	7.0-8.5	1.4	2-2-1	SPT	
1867.0	13.0	Very loose, brown to gray, moist, clayey sand with rock fragments (Mine Spoil Fill).	4	9.5-11.0	0.9	2-2-2	SPT	
1863.5	16.5	Boulders (Mine Spoil Fill).						**Cored overburden @ 13-16.5** **Switched to casing advancer @ 16.6**
		Medium stiff, brown, moist, lean clay with rock fragments (Mine Spoil Fill).	5	21.0-22.5	0.6	3-3-3	SPT	
			6	26.0-27.5	0.5	6-17-12	SPT	
			7	31.0-32.5	0.2	1-3-6	SPT	
			8	36.0-36.1	0.0	50/0.10'	SPT	
			9	41.0-41.1	0.0	50/0.10'	SPT	

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

Project ID: R-019-2025 Item Number: 12-00173.	Letcher - CR-0000	Project Type: Roadway Roadway Project Manager: Adam Ross

Hole Number B-16	Immediate Water Depth (09/29/25)	Start Date 09/25/2025	Hole Type cut profile
Surface Elevation 1880.0'	Static Water Depth NA	End Date 09/29/2025	Rig_Number Deitrich D.51
Total Depth 64.0'	Driller Horn & Associates Inc	Latitude(83) 37.179778	
Location 130+70.00 2.0' Rt.		Longitude(83) -82.635314	

Lithology Elevation	Lithology Depth	Description	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
		Medium stiff, brown, moist, lean clay with rock fragments (Mine Spoil Fill).	10	51.0-52.5	0.1	22-9-4	SPT	
			11	61.0-61.1	0.0	50/0.10'	SPT	
1816.0	64.0	(Bottom of Hole 64.0') (Refusal @ 64')						

Depth scale: 55, 60, 65, 70, 75, 80, 85, 90, 95, 100

DRILLER'S SUBSURFACE LOG

Project ID: **R-019-2025**	**Letcher - CR-0000**	Project Type: **Roadway Roadway**
Item Number: **12-00173.**		Project Manager: **Adam Ross**

Hole Number **B-17**	Immediate Water Depth **(09/29/25)**	Start Date **09/29/2025**	Hole Type **cut profile**
Surface Elevation **1882.0'**	Static Water Depth **NA**	End Date **09/29/2025**	Rig_Number **Deitrich D.120**
Total Depth **57.5'**	Driller **Horn & Associates Inc**	Latitude(83) **37.180139**	
Location **132+50.00 50.0' Lt.**		Longitude(83) **-82.634772**	

Lithology Elevation	Lithology Depth	Description
1881.7	0.3	Topsoil.
1875.5	6.5	Medium dense, gray to brown, moist, clayey sand with rock fragments (Mine Spoil Fill).
1864.0	18.0	Loose, gray to brown, moist, clayey sand with rock fragments (Mine Spoil Fill).
1855.0	27.0	Dense, brown, clayey sand with rock fragments (Mine Spoil Fill).
1849.0	33.0	Loose, brown, clayey sand with rock fragments (Mine Spoil Fill).
		Medium dense, brown, clayey sand with rock fragments (Mine Spoil Fill).

Sample No. (Overburden) / Std/Ky RQD (Rock Core)	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1	2.0-3.5	0.9	8-7-7	SPT	
2	4.5-6.0	0.8	3-5-9	SPT	
3	7.0-8.5	0.5	4-5-3	SPT	
4	9.5-11.0	0.2	1-1-3	SPT	
5	14.5-16.0	0.0	6-2-7	SPT	
6	19.5-21.0	1.4	17-15-19	SPT	
7	24.5-25.8	0.5	6-7-50/0.30'	SPT	
8	29.5-31.0	0.8	5-4-5	SPT	
9	34.5-36.0	0.7	5-6-8	SPT	
10	39.5-41.0	0.8	6-9-11	SPT	

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-17***	Immediate Water Depth ***(09/29/25)***	Start Date ***09/29/2025***	Hole Type ***cut profile***
Surface Elevation ***1882.0'***	Static Water Depth ***NA***	End Date ***09/29/2025***	Rig_Number ***Deitrich D.120***
Total Depth ***57.5'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.180139***	
Location ***132+50.00 50.0' Lt.***		Longitude(83) ***-82.634772***	

Lithology Elevation	Lithology Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1835.0	47.0	Medium dense, brown, clayey sand with rock fragments (Mine Spoil Fill).						
		Dense, brown, clayey sand with rock fragments (Mine Spoil Fill).	11	49.5-51.0	1.0	32-27-11	SPT	
1824.5	57.5	(Bottom of Hole 57.5') (Refusal @ 57.5')						

Depth scale: 50, 55, 60, 65, 70, 75, 80, 85, 90

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-18**	Immediate Water Depth **(09/29/25)**	Start Date **09/29/2025**	Hole Type **cut profile**
Surface Elevation **1868.0'**	Static Water Depth **NA**	End Date **09/29/2025**	Rig_Number **Deitrich D.51**
Total Depth **48.7'**	Driller **Horn & Associates Inc**	Latitude(83) **37.180010**	
Location **134+50.00 25.0' Rt.**		Longitude(83) **-82.634107**	

Lithology Elevation	Lithology Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1867.7	0.3	Topsoil.						
1859.0	9.0	Gray, boulders with clay (Mine Spoil Fill).	1	2.0-2.1	0.0	50/0.10'	SPT	
			2	4.5-5.3	0.5	9-50/0.30'	SPT	
			3	7.0-7.3	0.3	50/0.30'	SPT	
1845.0	23.0	Stiff, brown with gray, moist, lean clay with rock fragments (Mine Spoil Fill).	4	9.5-11.0	1.1	7-8-9	SPT	
			5	14.5-16.0	0.8	5-5-9	SPT	
			6	19.5-21.0	0.7	6-4-6	SPT	
1830.0	38.0	Stiff, brown, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	7	24.5-26.0	1.4	4-4-6	SPT	
			8	29.5-31.0	1.5	5-6-6	SPT	
			9	34.5-35.7	1.2	9-7-50/0.20'	SPT	
1819.3	48.7	Stiff, brown, moist, fat clay with rock fragments (Mine Spoil Fill, roots encountered at about 40 feet).	10	39.5-41.0	1.5	6-8-8	SPT	
		(Bottom of Hole 48.7') (Refusal @ 48.7')						

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-19***	Immediate Water Depth ***(09/30/25)***	Start Date ***09/29/2025***	Hole Type ***cut profile***
Surface Elevation ***1860.0'***	Static Water Depth ***NA***	End Date ***09/30/2025***	Rig_Number ***Deitrich D.120***
Total Depth ***36.0'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.180102***	
Location ***136+50.00 10.0' Lt.***		Longitude(83) ***-82.633408***	

Lithology Elevation	Lithology Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1859.7	0.3	Topsoil.					NMC #1 @ 1.1'	
		Very stiff, gray with brown, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	1	2.0-2.1	0.0	50/0.10'	SPT	
			2	4.5-6.0	1.4	27-13-5	SPT	
1851.0	9.0		3	7.0-7.1	0.1	50/0.10'	SPT	
1847.0	13.0	Stiff, gray with brown, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	4	9.5-11.0	0.8	6-8-4	SPT	
		Bag #5 Medium dense, brown, moist, clayey sand with rock fragments (Mine Spoil Fill).	5	14.5-16.0	0.8	3-5-7	SPT	
			6	19.5-19.6	0.0	50/0.10'	SPT	
1832.0	28.0		7	24.5-26.0	1.3	6-7-11	SPT	
		Hard, brown, moist, sandy fat clay with rock fragments (Mine Spoil Fill).	8	29.5-30.8	1.2	4-8-50/0.30'	SPT	
1824.0	36.0		9	34.5-35.8	0.8	10-4-50/0.30'	SPT	
		(Bottom of Hole 36.0') (Refusal @ 36')						

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number B-20	Immediate Water Depth (09/30/25)	Start Date 09/30/2025	Hole Type cut profile
Surface Elevation 1854.0'	Static Water Depth NA	End Date 09/30/2025	Rig_Number Deitrich D.120
Total Depth 37.5'	Driller Horn & Associates Inc	Latitude(83) 37.180000	
Location 138+15.00 90.0' Rt.		Longitude(83) -82.632704	

Elevation	Depth	Description (Overburden / Rock Core)	Sample No. (Std/Ky RQD)	Depth (ft) (Run (ft))	Rec. (ft) (Rec (ft))	SPT Blows (Rec (%))	Sample Type (SDI (JS))	Remarks
1853.7	0.3	Topsoil.						
1847.5	6.5	Stiff, brown with gray, moist, lean clay with rock fragments (Mine Spoil Fill).	1	2.0-3.5	1.1	7-5-6	SPT	
			2	4.5-6.0	1.1	5-5-4	SPT	
1841.0	13.0	Medium stiff, brown with gray, moist, lean clay with rock fragments (Mine Spoil Fill).	3	7.0-8.5	1.0	3-4-2	SPT	
			4	9.5-11.0	1.2	3-3-4	SPT	
1831.0	23.0	Stiff, brown with gray, moist, lean clay with rock fragments (Mine Spoil Fill, void at 19.5').	5	14.5-16.0	1.1	1-4-5	SPT	
			6	19.5-21.0	0.3	5-4-5	SPT	
1826.0	28.0	Medium dense, brown, sand with rock fragments (Mine Spoil Fill).	7	24.5-26.0	0.7	1-2-11	SPT	
1816.5	37.5	Gray, boulders (Mine Spoil Fill).	8	29.5-31.0	1.3	11-8-9	SPT	
			9	34.5-36.0	1.2	5-6-25	SPT	
		(Bottom of Hole 37.5') (Refusal @ 37.5')						

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Printed: 3/26/26

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number *B-21*	Immediate Water Depth *(09/29/25)*	Start Date *09/29/2025*	Hole Type *cut profile*
Surface Elevation *1848.0'*	Static Water Depth *NA*	End Date *09/29/2025*	Rig_Number *Deitrich D.51*
Total Depth *18.0'*	Driller *Horn & Associates Inc*	Latitude(83) *37.180337*	
Location *139+80.00 60.0' Rt.*		Longitude(83) *-82.632288*	

Lithology Elevation	Lithology Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1847.7	0.3	Topsoil.						
1841.0	7.0	Gray, boulders (Mine Spoil Fill).	1	2.5-4.0	1.0	16-9-10	SPT	
			2	5.0-6.5	0.5	6-2-8	SPT	
1837.0	11.0	Hard, gray to brown, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	3	7.5-8.7	0.5	3-10-50/0.20'	SPT	
			4	10.0-11.5	0.3	7-1-2	SPT	
1830.0	18.0	Hard, gray to brown, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	5	15.0-16.1	0.7	3-16-50/0.10'	SPT	
		(Bottom of Hole 18.0') (Refusal @ 18')						

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-30***	Immediate Water Depth ***NA***	Start Date ***09/16/2025***	Hole Type ***core and sample***
Surface Elevation ***1833.0'***	Static Water Depth ***NA***	End Date ***09/17/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***110.0'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.180864***	
Location ***105+50.00 205.0' Lt.***		Longitude(83) ***-82.635600***	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1832.6	0.4	Topsoil.						
1829.0	4.0	Very stiff, gray, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	1	2.0-3.5	0.7	7-13-11	SPT	
1824.0	9.0	Hard, gray, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	2	4.5-6.0	0.8	3-23-13	SPT	
			3	7.0-8.5	0.3	3-19-12	SPT	
1820.0	13.0	Dense, gray to brown, moist, sand with rock fragments (Mine Spoil Fill).	4	9.5-11.0	1.5	36-31-25	SPT	
1815.0	18.0	Medium stiff, gray to brown, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	5	14.5-16.0	0.5	1-6-6	SPT	
1810.0	23.0	Stiff, gray to brown, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	6	19.5-21.0	0.8	11-6-6	SPT	
1798.0	35.0	Hard, gray, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	7	24.5-24.9	0.4	50/0.40'	SPT	
			8	29.5-30.3	0.8	10-50/0.30'	SPT	
		(Begin Core)	9	34.5-34.6	0.0	50/0.10'	SPT	Switched to casing advancer, auger kick prevented coring @ 34.5-35 No water return @ 36
1795.7	37.3	Gray shale, weathered.	73 / 73	3.0	2.8	93		38.0
1792.9	40.1	Gray sandstone, silty.	75 / 75	8.0	7.7	96		46.0
		Gray sandstone, (coal partings from 53.5' to 56').	76 / 76	10.0	9.5	95		

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-30***	Immediate Water Depth ***NA***	Start Date ***09/16/2025***	Hole Type ***core and sample***
Surface Elevation ***1833.0'***	Static Water Depth ***NA***	End Date ***09/17/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***110.0'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.180864***	
Location ***105+50.00 205.0' Lt.***		Longitude(83) ***-82.635600***	

Lithology Elevation	Lithology Depth	Description (Overburden / Rock Core)
1766.7	66.3	Gray sandstone, (coal partings from 53.5' to 56').
1756.7	76.3	Brown with gray sandstone, (coal partings from 75.3' to 76.3').
1751.3	81.7	Gray sandstone.
1744.4	88.6	Gray shale.
1743.2	89.8	Black coal.
1740.7	92.3	Gray shale.
1736.7	96.3	Gray sandstone, silty.
		Gray with brown sandstone.

Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
76 / 76	10.0	9.5	95		56.0
89 / 89	10.0	9.9	99		66.0
43 / 43	10.0	7.8	78		76.0
60 / 60	5.0	4.5	90		81.0
16 / 16	8.8	6.5	74		89.8
81 / 81	6.2	6.1	98		96.0
68 / 68	4.0	3.8	95		100.0

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-30***	Immediate Water Depth ***NA***	Start Date ***09/16/2025***	Hole Type ***core and sample***
Surface Elevation ***1833.0'***	Static Water Depth ***NA***	End Date ***09/17/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***110.0'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.180864***	
Location ***105+50.00 205.0' Lt.***		Longitude(83) ***-82.635600***	

Lithology: Elevation	Lithology: Depth	Description	Overburden: Sample No. / Rock Core: Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
		Gray with brown sandstone.	85 / 85	10.0	9.3	93		
1723.0	110.0							110.0
		(Bottom of Hole 110.0')						
		Offset 65 feet east						

Depth scale: 105, 110, 115, 120, 125, 130, 135, 140, 145, 150

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-31***	Immediate Water Depth ***NA***	Start Date ***09/15/2025***	Hole Type ***fill profile***
Surface Elevation ***1710.0'***	Static Water Depth ***NA***	End Date ***09/15/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***18.3'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.180711***	
Location ***107+10.00 120.0' Rt.***		Longitude(83) ***-82.636884***	

Lithology: Elevation	Lithology: Depth	Description	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1709.3	0.7	Topsoil.						
1704.0	6.0	Very stiff, brown, moist, sandy lean clay with rock fragments (Mine Spoil Fill, intermixed coal fragments).	1	1.5-3.0	1.2	8-8-9	SPT	
			2	4.0-5.5	1.5	11-15-28	SPT	
1697.0	13.0	Very stiff, brown, moist, sandy lean clay with rock fragments.	3	6.5-8.0	1.5	7-10-17	SPT	
			4	9.0-10.5	1.3	6-9-9	SPT	
1691.7	18.3	Overburden (weathered sandstone bedrock).	5	14.0-14.8	0.4	26-50/0.30'	SPT	
		(Bottom of Hole 18.3') (Refusal @ 18.3')						

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-32***	Immediate Water Depth ***NA***	Start Date ***09/16/2025***	Hole Type ***fill profile***
Surface Elevation ***1816.0'***	Static Water Depth ***NA***	End Date ***09/16/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***4.3'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.180567***	
Location ***106+25.00 15.0' Rt.***		Longitude(83) ***-82.636594***	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1815.2	0.8	Topsoil.						
1814.0	2.0	Brown, sandy lean clay with rock fragments.						
1811.7	4.3	Overburden (weathered sandstone bedrock).	1	2.7-4.2	1.3	21-34-31	SPT	

(Bottom of Hole 4.3')
(Refusal @ 4.3')

5 10 15 20 25 30 35 40 45 50

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-33**	Immediate Water Depth **(09/17/25)**	Start Date **09/17/2025**	Hole Type **core and sample**
Surface Elevation **1816.0'**	Static Water Depth **NA**	End Date **09/17/2025**	Rig_Number **Deitrich D.51**
Total Depth **66.5'**	Driller **Horn & Associates Inc**	Latitude(83) **37.179937**	
Location **109+50.00 75.0' Lt.**		Longitude(83) **-82.636601**	

Lithology Elevation	Depth	Description	Overburden: Sample No. / Rock Core: Std/Ky RQD	Overburden: Depth (ft) / Rock Core: Run (ft)	Overburden: Rec. (ft) / Rock Core: Rec (ft)	Overburden: SPT Blows / Rock Core: Rec (%)	Overburden: Sample Type / Rock Core: SDI (JS)	Remarks
1815.3	0.7	Topsoil.						
		Stiff, gray, moist, clayey sand with boulders (Mine Spoil Fill).	1	2.0-2.1	0.0	50/0.10'	SPT	
			2	4.5-6.0	0.9	5-6-3	SPT	
1807.0	9.0		3	7.0-8.5	0.7	3-5-27	SPT	
1803.0	13.0	Stiff, gray, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	4	9.5-11.0	0.4	2-3-7	SPT	
1799.0	17.0	Very stiff, gray, moist, sandy lean clay with rock fragments (Mine Spoil Fill).	5	14.5-16.0	0.8	9-10-13	SPT	
1795.0	21.0	Overburden (weathered sandstone bedrock). (Begin Core)	6	19.5-20.3	0.8	22-50/0.30'	SPT	
1791.3	24.7	Gray shale, sandy.	43 / 43	3.0	2.9	97		24.0
1776.0	40.0	Gray sandstone.	83 / 83	7.0	6.9	99		31.0
			60 / 60	3.0	2.8	93		34.0
			90 / 90	7.0	7.0	100		41.0
1770.5	45.5	Brown with gray sandstone.	78 / 78	10.0	10.0	100		
		Gray sandstone.						

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: **R-019-2025**	**Letcher - CR-0000**	Project Type: **Roadway Roadway**
Item Number: **12-00173.**		Project Manager: **Adam Ross**

Hole Number **B-33**	Immediate Water Depth **(09/17/25)**	Start Date **09/17/2025**	Hole Type **core and sample**
Surface Elevation **1816.0'**	Static Water Depth **NA**	End Date **09/17/2025**	Rig_Number **Deitrich D.51**
Total Depth **66.5'**	Driller **Horn & Associates Inc**	Latitude(83) **37.179937**	
Location **109+50.00 75.0' Lt.**		Longitude(83) **-82.636601**	

Lithology Elevation	Lithology Depth	Description	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
				10.0	10.0	100		51.0
		Gray sandstone.	73 / 73	10.0	10.0	100		61.0
1749.5	66.5		96 / 96	5.5	5.5	100		66.5
		(Bottom of Hole 66.5')						

Depth scale: 55, 60, 65, 70, 75, 80, 85, 90, 95, 100

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-34***	Immediate Water Depth ***(09/23/25)***	Start Date ***09/23/2025***	Hole Type ***core and sample***
Surface Elevation ***1798.0'***	Static Water Depth ***NA***	End Date ***09/23/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***8.0'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.178354***	
Location ***116+00.00 60.0' Rt.***		Longitude(83) ***-82.637811***	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1797.7	0.3	Topsoil.						
		Very stiff, brown, damp, lean clay with rock fragments.	1	2.0-3.8	1.5		ST	
1792.8	5.2		2	4.0-5.5	0.6	16-16-8	SPT	
1790.0	8.0	Overburden (weathered shale bedrock).	3	7.5-7.9	0.4	50/0.40'	SPT	

(Bottom of Hole 8.0')

Offset 20 feet southeast due to gasline

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-35***	Immediate Water Depth ***(09/23/25)***	Start Date ***09/23/2025***	Hole Type ***cut profile***
Surface Elevation ***1884.0'***	Static Water Depth ***NA***	End Date ***09/23/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***51.0'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.177394***	
Location ***120+25.00 60.0' Rt.***		Longitude(83) ***-82.637638***	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1883.7	0.3	Topsoil.						
1880.0	4.0	Medium stiff, brown, moist, silty lean clay with rock fragments (Mine Spoil Fill).	1	2.0-3.5	0.8	4-4-3	SPT	
			2	4.5-6.0	1.3	15-8-9	SPT	
1875.0	9.0	Gray to red, boulders with organics (Mine Spoil Fill, tree roots at 4.7 feet).	3	7.0-8.5	1.2	12-6-4	SPT	
			4	9.5-10.1	0.6	34-50/0.10'	SPT	
1871.0	13.0	Boulders (Mine Spoil Fill).						
1866.0	18.0	Very stiff, brown to dark gray, moist, fat clay with boulders (Mine Spoil Fill).	5	14.5-16.0	1.3	11-5-16	SPT	
1861.0	23.0	Stiff, dark gray with brown, moist, fat clay with rock fragments (Mine Spoil Fill).	6	19.5-21.0	1.3	6-8-6	SPT	
			7	24.5-26.0	1.3	7-10-7	SPT	
			8	29.5-31.0	1.3	8-10-9	SPT	
1845.0	39.0	Very stiff, dark gray with brown, moist, fat clay with rock fragments (Mine Spoil Fill).	9	34.5-36.0	1.3	15-15-14	SPT	
			10	39.5-41.0	1.4	9-20-21	SPT	
1833.0	51.0	Hard, dark gray with brown, moist, fat clay with rock fragments (Mine Spoil Fill).	11	49.5-51.0	1.2	10-6-6	SPT	
		(Bottom of Hole 51.0') (Refusal @ 51')						

DRILLER'S SUBSURFACE LOG

Project ID: R-019-2025 Item Number: 12-00173.	Letcher - CR-0000	Project Type: Roadway Roadway Project Manager: Adam Ross

Hole Number S-40	Immediate Water Depth NA	Start Date 09/16/2025	Hole Type sounding
Surface Elevation 1726.0'	Static Water Depth NA	End Date 09/16/2025	Rig_Number Deitrich D.51
Total Depth 14.3'	Driller Horn & Associates Inc	Latitude(83) 37.182116	
Location 101+50.00 22.0' Lt.		Longitude(83) -82.636126	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
1711.7	14.3	Overburden (Mine Spoil Fill). (Refusal)						
		(Bottom of Hole 14.3') (Refusal @ 14.3')						

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***S-41***	Immediate Water Depth ***NA***	Start Date ***09/16/2025***	Hole Type ***sounding***
Surface Elevation ***1722.0'***	Static Water Depth ***NA***	End Date ***09/16/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***34.2'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.181627***	
Location ***103+15.00 22.0' Rt.***		Longitude(83) ***-82.636214***	

Lithology		Description	Overburden	Sample No.	Depth (ft)	Rec. (ft)	SPT Blows	Sample Type	Remarks
Elevation	Depth		Rock Core	Std/Ky RQD	Run (ft)	Rec (ft)	Rec (%)	SDI (JS)	
1687.8	34.2	Overburden (Mine Spoil Fill). (Refusal)							
		(Bottom of Hole 34.2') (Refusal @ 34.2')							

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

DRILLER'S SUBSURFACE LOG

Project ID: R-019-2025 Item Number: 12-00173.	Letcher - CR-0000	Project Type: Roadway Roadway Project Manager: Adam Ross

Hole Number S-42	Immediate Water Depth NA	Start Date 09/16/2025	Hole Type sounding
Surface Elevation 1750.0'	Static Water Depth NA	End Date 09/16/2025	Rig_Number Deitrich D.51
Total Depth 2.9'	Driller Horn & Associates Inc	Latitude(83) 37.181052	
Location 105+25.00 22.0' Rt.		Longitude(83) -82.636335	

Lithology		Description	Overburden	Sample No.	Depth (ft)	Rec. (ft)	SPT Blows	Sample Type	Remarks
Elevation	Depth		Rock Core	Std/Ky RQD	Run (ft)	Rec (ft)	Rec (%)	SDI (JS)	
1747.1	2.9	Overburden.	(Refusal)						

(Bottom of Hole 2.9')
(Refusal @ 2.9')

5
10
15
20
25
30
35
40
45
50

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

GEOLOGIST'S SUBSURFACE LOG

Printed: 3/26/26

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-4**	Immediate Water Depth **(09/16/25)**	Start Date **09/16/2025**	Hole Type **core and sample**
Surface Elevation **1764.0'**	Static Water Depth **NA**	End Date **09/16/2025**	Rig_Number **Deitrich D.51**
Total Depth **41.0'**	Driller **Horn & Associates Inc**	Latitude(83) **37.180745**	**GQ-1126** **Jenkins West**
Location **106+35.00 22.0' Lt.**	Geologist Barnes, Conner	Longitude(83) **-82.636326**	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
		Overburden.	1	4.0-4.7	0.7		ST	
1756.1	7.9	(Begin Core)						
		Sandstone: *MODERATELY HARD, gray to brown, medium to coarse grained, weathered.*	12 / 12	2.6	1.8	69		10.5
			18 / 18	5.0	3.7	74		15.5
1748.8	15.2							
		Coal: *VERY SOFT, gray to black, COAL BED, [Coal from 19.8 to 20.3].*	8 / 8	5.0	3.3	66		20.5
1743.3	20.7							
		Shale: *MEDIUM HARD, gray, fine grained.*	79 / 79	10.0	9.5	95	95@21 (6) 99@29 (5)	30.5
1735.2	28.8							
		Sandstone: *MEDIUM HARD, light gray, coarse grained, micaceous.*	67 / 67	10.5	10.0	95		**30° joint @ 32.5** **44° joint @ 35.2** 41.0
1723.0	41.0							
		(Bottom of Hole 41.0')						

Top of Rock = 4.7' Elevation = 1759.3'
Base Weathered Rock = 7.9' Elevation = 1756.1'

Hyden Formation
Pikeville Formation

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

GEOLOGIST'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-5**	Immediate Water Depth **(09/30/25)**	Start Date **09/30/2025**	Hole Type **core and sample**
Surface Elevation **1767.0'**	Static Water Depth **NA**	End Date **09/30/2025**	Rig_Number **Deitrich D.51**
Total Depth **30.0'**	Driller **Horn & Associates Inc**	Latitude(83) **37.180822**	**GQ-1126 Jenkins West**
Location **107+95.00 2.0' Lt.**	Geologist Barnes, Conner	Longitude(83) **-82.636633**	

Elevation	Depth	Description	Overburden: Sample No. / Rock Core: Std/Ky RQD	Overburden: Depth (ft) / Rock Core: Run (ft)	Overburden: Rec. (ft) / Rock Core: Rec (ft)	Overburden: SPT Blows / Rock Core: Rec (%)	Overburden: Sample Type / Rock Core: SDI (JS)	Remarks
1763.0	4.0	**Overburden**. (Begin Core)	1	2.0-3.5	1.4	8-8-12	SPT	
1751.5	15.5	**Sandstone**: *MODERATELY HARD, brown, coarse grained, highly weathered, friable.*	0 / 0	3.0	0.7	23		7.0
			0 / 0	3.5	0.0	0		10.5
			0 / 0	5.0	1.0	20		15.5
1750.0	17.0	**Sandstone**: *MODERATELY HARD, gray, coarse grained.*	27 / 27	1.5	1.1	73		17.0
1749.0	18.0	**Shale**: *SOFT, gray, fine grained.*	29 / 29	8.0	5.1	64	69@18 (2) 98@21 (6)	25.0
1747.6	19.4	**Coal**: *VERY SOFT, gray to black, COAL BED.*						
1746.3	20.7	**Shale**: *SOFT, gray, fine grained.*						
1737.0	30.0	**Shale**: *MEDIUM HARD, gray, fine grained SHALE.*	74 / 74	5.0	5.0	100		30.0
		(Bottom of Hole 30.0')						

Top of Rock = 3.2' Elevation = 1763.8'
Base Weathered Rock = 4.0' Elevation = 1763.0'

Hyden Formation
Pikeville Formation

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

GEOLOGIST'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-11**	Immediate Water Depth **(09/24/25)**	Start Date **09/24/2025**	Hole Type **core and sample**
Surface Elevation **1870.0'**	Static Water Depth **NA**	End Date **09/24/2025**	Rig_Number **Deitrich D.51**
Total Depth **9.5'**	Driller **Horn & Associates Inc**	Latitude(83) **37.177533**	**GQ-1126** **Jenkins West**
Location **121+75.00 22.0' Rt.**	Geologist Barnes, Conner	Longitude(83) **-82.637100**	

Lithology		Description	Overburden: Sample No. / Rock Core: Std/Ky RQD	Overburden: Depth (ft) / Rock Core: Run (ft)	Overburden: Rec. (ft) / Rock Core: Rec (ft)	Overburden: SPT Blows / Rock Core: Rec (%)	Overburden: Sample Type / Rock Core: SDI (JS)	Remarks
Elevation	Depth							
		Overburden.	1	2.0-2.1	0.0	50/0.10'	SPT	
1865.5	4.5	(Begin Core)						
			2	4.4-4.5	0.0	50/0.10'	SPT	
		Shale: *MEDIUM HARD, gray, fine to medium grained, sandy.*	56 / 56	5.0	4.4	88	98@7 (5)	
1860.5	9.5							9.5
		(Bottom of Hole 9.5')						

Top of Rock = 4.5'
Elevation = 1865.5'

Hyden Formation
Pikeville Formation

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

GEOLOGIST'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-30**	Immediate Water Depth **NA**	Start Date **09/16/2025**	Hole Type **core and sample**
Surface Elevation **1833.0'**	Static Water Depth **NA**	End Date **09/17/2025**	Rig_Number **Deitrich D.51**
Total Depth **110.0'**	Driller **Horn & Associates Inc**	Latitude(83) **37.180864**	**GQ-1126** **Jenkins West**
Location **105+50.00 205.0' Lt.**	Geologist Barnes, Conner	Longitude(83) **-82.635600**	

Elevation	Depth	Description	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
		Overburden.	1	2.0-3.5	0.7	7-13-11	SPT	
			2	4.5-6.0	0.8	3-23-13	SPT	
			3	7.0-8.5	0.3	3-19-12	SPT	
			4	9.5-11.0	1.5	36-31-25	SPT	
			5	14.5-16.0	0.5	1-6-6	SPT	
			6	19.5-21.0	0.8	11-6-6	SPT	
			7	24.5-24.9	0.4	50/0.40'	SPT	
			8	29.5-30.3	0.8	10-50/0.30'	SPT	
1797.5	35.5	(Begin Core)	9	34.5-34.6	0.0	50/0.10'	SPT	
1795.7	37.3	**Shale**: *SOFT, gray, fine grained, lightly weathered.*	73 / 73	3.0	2.8	93	98@36 (6)	38.0
1792.9	40.1	**Sandstone**: *MEDIUM HARD, gray, fine to coarse grained.*	75 / 75	8.0	7.7	96		46.0
		Sandstone: *MODERATELY HARD, gray, coarse grained with micaceous banding and coal partings.*	76 / 76	10.0	9.5	95		**25° joint @ 47.3** **39° joint @ 48**

Top of Rock = 35.5'
Elevation = 1797.5'

Hyden Formation
Pikeville Formation

GEOLOGIST'S SUBSURFACE LOG

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***

Hole Number ***B-30***	Immediate Water Depth ***NA***	Start Date ***09/16/2025***	Hole Type ***core and sample***
Surface Elevation ***1833.0'***	Static Water Depth ***NA***	End Date ***09/17/2025***	Rig_Number ***Deitrich D.51***
Total Depth ***110.0'***	Driller ***Horn & Associates Inc***	Latitude(83) ***37.180864***	***GQ-1126*** ***Jenkins West***
Location ***105+50.00 205.0' Lt.***	Geologist Barnes, Conner	Longitude(83) ***-82.635600***	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
			76 / 76	10.0	9.5	95		**22° joint @ 49.8**; **Coal partings @ 53.5-56**; 56.0; **54° joint @ 55.2**
1766.7	66.3	**Sandstone**: *MODERATELY HARD, gray, coarse grained with micaceous banding and coal partings.*	89 / 89	10.0	9.9	99		**24° joint @ 63.5**; 66.0
1756.7	76.3	**Sandstone**: *MODERATELY HARD, gray to brown, coarse grained with trace micah and coal partings.*	43 / 43	10.0	7.8	78		76.0
1751.3	81.7	**Sandstone**: *MODERAYELY HARD, gray, coarse grained with trace micah and coal partings.*	60 / 60	5.0	4.5	90		81.0; **13° joint @ 80.1**
1744.4	88.6	**Shale**: *SOFT, gray, fine grained.*	16 / 16	8.8	6.5	74	92@87 (5)	
1743.2	89.8	**Coal**: *VERY SOFT, black, COAL.*						89.8
1740.7	92.3	**Shale**: *SOFT, gray, fine grained.*	81 / 81	6.2	6.1	98		
1736.7	96.3	**Sandstone**: *MODERATELY HARD, gray, coarse grained with some fine grained.*						96.0
		Sandstone: *MODERATELY HARD, brownish gray to gray, coarse grained with trace micah.*	68 / 68	4.0	3.8	95		**55° joint @ 97**; **54° joint @ 98.8**; 100.0

Top of Rock = 35.5'
Elevation = 1797.5'

Hyden Formation
Pikeville Formation

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

GEOLOGIST'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-30**	Immediate Water Depth **NA**	Start Date **09/16/2025**	Hole Type **core and sample**
Surface Elevation **1833.0'**	Static Water Depth **NA**	End Date **09/17/2025**	Rig_Number **Deitrich D.51**
Total Depth **110.0'**	Driller **Horn & Associates Inc**	Latitude(83) **37.180864**	**GQ-1126** **Jenkins West**
Location **105+50.00 205.0' Lt.**	Geologist Barnes, Conner	Longitude(83) **-82.635600**	

Elevation	Depth	Description	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
							98@100 (5)	
		Sandstone: *MODERATELY HARD, brownish gray to gray, coarse grained with trace micah.*	85 / 85	10.0	9.3	93		
1723.0	110.0							**15° joint @ 109.2** 110.0
		(Bottom of Hole 110.0')						

Depth scale: 105, 110, 115, 120, 125, 130, 135, 140, 145, 150

Top of Rock = 35.5'
Elevation = 1797.5'

Hyden Formation
Pikeville Formation

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

GEOLOGIST'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-33**	Immediate Water Depth **(09/17/25)**	Start Date **09/17/2025**	Hole Type **core and sample**
Surface Elevation **1816.0'**	Static Water Depth **NA**	End Date **09/17/2025**	Rig_Number **Deitrich D.51**
Total Depth **66.5'**	Driller **Horn & Associates Inc**	Latitude(83) **37.179937**	**GQ-**
Location **109+50.00 75.0' Lt.**	Geologist Barnes, Conner	Longitude(83) **-82.636601**	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
		Overburden.	1	2.0-2.1	0.0	50/0.10'	SPT	
			2	4.5-6.0	0.9	5-6-3	SPT	
			3	7.0-8.5	0.7	3-5-27	SPT	
			4	9.5-11.0	0.4	2-3-7	SPT	
			5	14.5-16.0	0.8	9-10-13	SPT	
1795.0	21.0	(Begin Core)	6	19.5-20.3	0.8	22-50/0.30'	SPT	
1791.3	24.7	**Shale**: *MEDIUM HARD, gray, fine to medium grained.*	43 / 43	3.0	2.9	97	99@23 (6)	24.0
1776.0	40.0	**Sandstone**: *MODERATELY HARD, gray, coarse grained.*	83 / 83	7.0	6.9	99		**8° joint @ 24.1** **19° joint @ 29.4** **19° joint @ 30** 31.0
			60 / 60	3.0	2.8	93		**60° joint @ 31.8** **49° joint @ 33.5** 34.0
			90 / 90	7.0	7.0	100		**69° joint @ 34** **24° joint @ 38.6** **51° joint @ 40** 41.0
1770.5	45.5	**Sandstone**: *MODERATELY HARD, grayish brown, coarse grained with trace calcareous bands.*	78 / 78	10.0	10.0	100		**49° joint @ 40.5** **70° joint @ 45.2** **69° joint @ 49.2**
		Sandstone: *MODERATELY HARD, gray, coarse grained, micaceous with trace coal and shale partings.*						

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

Top of Rock = 21.0'
Elevation = 1795.0'

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

GEOLOGIST'S SUBSURFACE LOG

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**

Hole Number **B-33**	Immediate Water Depth **(09/17/25)**	Start Date **09/17/2025**	Hole Type **core and sample**
Surface Elevation **1816.0'**	Static Water Depth **NA**	End Date **09/17/2025**	Rig_Number **Deitrich D.51**
Total Depth **66.5'**	Driller **Horn & Associates Inc**	Latitude(83) **37.179937**	**GQ-**
Location **109+50.00 75.0' Lt.**	Geologist Barnes, Conner	Longitude(83) **-82.636601**	

Lithology: Elevation	Lithology: Depth	Description (Overburden / Rock Core)	Sample No. / Std/Ky RQD	Depth (ft) / Run (ft)	Rec. (ft) / Rec (ft)	SPT Blows / Rec (%)	Sample Type / SDI (JS)	Remarks
				10.0	10.0	100		51.0 **25° joint @ 50.1** **26° joint @ 51.8**
		Sandstone: *MODERATELY HARD, gray, coarse grained, micaceous with trace coal and shale partings.*	73 / 73	10.0	10.0	100		**46° joint @ 57** **24° joint @ 59.2**
1749.5	66.5		96 / 96	5.5	5.5	100		61.0 **24° joint @ 59.5** 66.5
		(Bottom of Hole 66.5')						

Depth scale: 55, 60, 65, 70, 75, 80, 85, 90, 95, 100

Top of Rock = 21.0'
Elevation = 1795.0'

Bringing the Subsurface into View

MASW GEOPHYSICAL SURVEY

Grandview Development Road
Jenkins, Kentucky

Prepared for:

MATT SLUSSER, PE (KY, IN)
GEOTECHNICAL SERVICES MANAGER
Vector Engineers, Inc. – A CTL Engineering Company
Phone: 502.437.5650
Cell: 502.643.4003

October 3, 2025

Prepared by:

NSG Innovations, LLC
Near Surface Geophysics
741 Greenlawn Ave,
Bowling Green KY 42103
859-462-2449

Respectfully submitted:
Thomas B. Brackman
Trent Edwards

Contents

1.0 Introduction

The purpose of this project was to perform a geophysical survey at a past strip mine located off highway US-23 in Jenkins, Kentucky. The location investigated is identified as the proposed Grandview Development and sits atop a strip-mined mountaintop. The site featured areas of open pasture, with dense vegetation across steep hillsides. The intent of this geophysical project was to evaluate the subsurface conditions and determine approximate depth to bedrock along portions of the proposed road development. A total of three Multichannel Analysis of Surface Waves (MASW) survey lines were conducted across the site as directed by CTL personnel and in accordance with their, at the time of this survey, ongoing boring program. Note that MASW Line 2 and Line 3 were conducted separately instead of one long line as originally proposed due to a large pile of debris present near the end of Line 2. A vicinity map showing the location of the site is included as Figure 1 and an aerial photograph or map (termed site map) showing the location of the survey area in relation to the project site is illustrated in Figure 2. Figure 3 is a detailed aerial view or map illustrating the approximate locations of the MASW 2-D shear-wave velocity profiles (line location map).

2.0 Technical Background

The challenge for this project was to select the correct non-intrusive tools and techniques to evaluate the subsurface on site and delineate the extent of strip-mining activity. In general, a variety of geophysical techniques can be applied to the mapping of subsurface features; however, certain methods, sensitive to a range of contrasting physical properties, can have attributes that make them more suitable than others, depending on site-specific conditions. Contrasting physical properties that typically are found to be useful for mapping soil and bedrock include electrical conductivity or resistivity, acoustic velocity, density, and magnetic susceptibility. Of these, MASW is commonly found to have a sufficient range of contrast and is most applicable for detailed characterization of sites. Given the desired depth of investigation (approximately 100 feet), two-dimensional (2-D) MASW was selected as the method of choice to document the soil-sediment-rock profile beneath the site. A description of techniques used in this field study is presented in the sections following basic geologic setting discussion.

2.1 Geological Setting

Study of available geologic maps and information (Figure 4) reveals that upper elevations of the site sit atop the Pennsylvanian-aged Hyden Formation. The Hyden Formation consists of sandstone, siltstone, shale and coal. The sandstone in the upper part of unit is generally 20-30 feet thick, with coal seams in the upper part of the unit as well. The Pikeville Formation lies at lower elevations of the site and consists of sandstone, siltstone, shale and coal as well. The generalized geologic map of the site is shown in Figure 4 and is make available by the Kentucky Geological Survey's interactive map service (accessed October, 2025).

2.2 Multichannel Analysis of Surface Waves

Since its introduction in the late 1990s, use of surface-wave techniques has rapidly increased for two reasons: (1) they provide the shear-wave velocity (*Vs*) of ground materials, which is one of the most important geotechnical parameters in civil engineering, and (2) they are easier to use than are other common seismic approaches (e.g., refraction, reflection, and surface-wave surveys).

Elastic moduli are commonly used in geotechnical engineering to describe the behavior of Earth materials under stress, which is ultimately related to such tasks as properly designing earthworks and structural foundations, risk assessment under specific site conditions, and monitoring various types of existing infrastructure for public safety. Among three primary types of moduli: Young's (E), shear (μ), and bulk (κ) moduli—the first two are most commonly used because of what they represent. Young's modulus simply describes the deformation tendency along the axis of stress, whereas the shear modulus describes the tendency for shape deformation (shearing) that, in turn, is related to the viscosity or rigidity of material. Young's and shear moduli are determined from the parameters of density (ρ), *Vs*, and Poisson's ratio (ó). *Vs* plays the most important role as it is included as squared terms in expressions. In addition, *Vs*, in reality, changes through a broader range than do density and Poisson's ratio. Therefore, accurate evaluation of *Vs* can be extremely valuable in geotechnical engineering. The shear modulus can be determined fairly accurately once *Vs* is determined. Alternatively, Young's modulus requires Poisson's ratio to obtain a comparable accuracy. The *Vs* information of ground materials is obtained by processing Rayleigh-type surface waves that are dispersive when travelling through a layered media (i.e., different frequencies travel at different speeds). This dispersion property is determined from a material's *Vs* (by more than 95%), P-wave velocity (*V*p) ($\leq$ 3%), and density (ρ) ($\leq$2%). By analyzing dispersion properties, we can therefore determine *Vs* accurately by assuming some realistic values for *V*p and ρ. The accurate evaluation of the dispersion property is most important with any surface-wave method in this sense.

[illegible] ie C[illegible] de[illegible]ini[illegible]ion [illegible] ri [illegible] re[illegible]rod[illegible]ed [illegible]e[illegible]o[illegible]

Site Class	Soil Profile Name	Average Properties in Top 100 feet (as per 2000 IBC section 1615.1.5) Soil Shear Wave Velocity, V_s	
		Feet/second	Meters/second
A	Hard Rock	$V_s > 5000$	$V_s > 1524$
B	Rock	$2500 < V_s \leq 5000$	$762 < V_s \leq 1524$
C	Very dense soil and soft rock	$1200 < V_s \leq 2500$	$366 < V_s \leq 762$
D	Stiff soil profile	$600 < V_s \leq 1200$	$183 < V_s \leq 366$
E	Soft soil profile	$V_s < 600$	$V_s < 183$

[illegible]i[illegible]e C[illegible]i[illegible]i[illegible]ion[illegible] [illegible]do[illegible]ed [illegible]ro[illegible] [illegible]e [illegible] [illegible] [illegible]i[illegible]e C[illegible] De[illegible]ini[illegible]ion[illegible] [illegible]i[illegible]ed in [illegible] In[illegible]ern[illegible]ion[illegible]B[illegible]i[illegible]ding [illegible]ode[illegible]In[illegible]ern[illegible]ion[illegible]Code Co[illegible]n[illegible]i[illegible]In[illegible]on [illegible]ge [illegible]

By using a transformation function, the surface-wave method converts raw field data in a time-offset (*t-x*) domain into a frequency-slowness velocity (*f-p*) domain. The remaining procedure extracts a dispersion curve that is to be used in a subsequent process in search for the 1-D *Vs* profile. An accurate dispersion analysis is obviously an important part of data processing, and this is because shear-wave velocity (Vs) information is a good indicator of a given material's stiffness. The surface-wave method is commonly applied in civil engineering to address mechanical aspects of ground materials for example, assessment of load-bearing capacity, ground behavior under continuous and prolonged vibration, and ground amplification and liquefaction potential. The surface-wave method outputs are relatable to soil profiles as are observable in Table 1 and can be related to blow counts or N values and CPT (Cone Penetrometer Testing) values (Table 2). Note that both tables 1 and 2 have been inserted for convenience of viewing on all MASW profiles.

Soft Soil	**Stiff Soil**	**Very Dense Soil and Soft Rock**	**Rock**
V_s<600 ft/s	600 < Vs< 1200 ft/s	1200 < Vs < 2500 ft/s	2500 < Vs< 5000 ft/s
Standard penetration resistance, N	Standard penetration resistance, N	Standard penetration resistance, N	Standard penetration resistance, N
N < 15	15 ≤ N ≤ 50	N > 50	N/A
Undrained shear strength (psf)	Undrained shear strength S_U (psf)	Undrained shear strength (psf)	Undrained shear strength (psf)
<1,000	$1{,}000 \leq S_U \leq 2{,}000$	$S_U > 2{,}000$	N/A

Table 2: Scale used in velocity profile with site classification, standard penetration values (N) and undrained shear strength. Values from IBC 2006 Table 1613.5.2 Site Class Definitions (section 1613.5.50).

MASW is a surface-wave seismic method for measuring in-situ shear-wave (S-wave) velocity profiles. The MASW method is used to determine shear-wave velocity profiles for the subsurface. The Rayleigh wave method has since been used for delineation of landslides and tunnel assessment, soil-compaction control, mapping the subsurface and estimating the strength of subsurface materials. Testing is performed at the surface using the same conventional seismograph and vertical P-wave geophones that are used for refraction studies. The seismic source consists of a weight-drop system such as a sledgehammer or assisted weight drop and/or the use of ambient seismic noise which is constantly being generated via cultural and natural sources. Depending on the material properties of the subsurface, MASW can determine shear-wave velocities down to a maximum of 100 meters (approximately 300 feet) depth. The data acquisition procedure consists of stacking three to five records for two to three seconds using a conventional seismograph and 4.5 or 10 Hertz (Hz), P-wave geophones. The wave-field transformation of the noise record reveals the shear-wave dispersion curve. The shear-wave dispersion curve is then picked from the wave-field transformation and forward modeled to determine the subsurface shear-wave velocity profile.

3.0 Procedures

Standard Operating Procedures (SOPs) for any geophysical project begins with a site safety check. Each site is evaluated for possible safety concerns and the surveys are modified to take these into account. Evaluation of the MASW data for the site was completed using the method described by Park (1999). A total of three seismic survey lines were conducted across the site. Seismic records were collected for 30 seconds with a two-millisecond sample rate. A sledgehammer, approximately 100 feet from geophone 1, struck a high-density poly-ethylene plate, triggering each record. Two records were collected at each shot station using a Seismic Source DAQ III data recorder and VibraScope Seismic software. Twenty-four, 4.5-hertz geophones, with 10-foot spacing between each geophone on a seismic land streamer were used for data collection. The land streamer was then moved 25 feet after the collection of every two records. The recorded data were exported to the Parkseis™ proprietary software for processing and modeling. Shear-wave velocities obtained from the forward modeling process are compiled into 1-D or 2-D shear-wave profiles and are included as a profile cross section to aid in interpretation.

Table 3 – MASW Lines Conducted

Field Name and Processed Name *	Report Figure	Sledgehammer Offset (feet)	Geophone 1 Position	Geophone 24 Position	Line Length (feet)
MASW Line 1	5	100	SW	NE	550
MASW Line 2	6	100	W	E	225
MASW Line 3	7	100	W	E	300

4.0 Summary of Findings

This site is located off highway US-23 in Jenkins, KY. The site was the location of former strip-mining activities and is underlain by the Hyden and Pikeville formations which feature sandstone, siltstone, shale, coal. Most of the soil at the surface is likely fill material left over from the former mining operation.

Study of the MASW profiles (Figures 5 through 7) suggests a rather thick variable layer of Class D, stiff soils, to Class C, very dense soil and soft rock, directly below the land surface. This layer of stiff to very dense soils is approximately 40-to-50-feet thick and contains areas of increased shear-wave velocity values (light blue/turquoise colors) indicating increased rock content in these areas. These lenses are likely a result of past mining activity, with varying material scattered throughout the subsurface. This upper layer of varying material is present across each MASW profile.

On each of the MASW profiles, approximately 40-to-50- feet below the surface, is a generally consistent and roughly 10-foot- thick layer of Class C, very dense soil and soft rock, before transitioning to a much more competent, undulatory layer of Class B, rock material at elevations ranging from 1,820 to 1,780 feet. CTL personnel's boring locations are marked along MASW Line 1 where relevant. According to discussions with the drilling crew while on site, the average depth to refusal was 50-to-60 feet, while on B-13, it was approximately 80 feet. This information correlates well with the MASW data for Line 1, where depth to the Class B, rock layer near B-13 is over 70 feet. Additional locations where rock appears to lie deeper within the subsurface are as follows: Line 1, stations 48 and from 180 to 260, Line 2, stations 0 to 30 and from 150 to 225, Line 3, stations 50 to 100 and 230 to 270.

Figure 8 is an overlay of all the MASW lines conducted across the site. Study of the profiles indicates thick layers of overburden and/or fill material with varying degrees of competency overlying an undulatory bedrock surface ranging from 50 feet below the surface to nearly 80 feet at select locations. A Google Earth KMZ file has been included supplemental to this report which contains each of the MASW profiles relative to the rest of the site.

5.0 Limitations

This study included a limited set of geophysical readings across limited portions of the site. The results and interpretations of the geophysical survey performed are considered generally reliable and were conducted in a manner generally consistent with practitioners in the field of geophysical engineering. The methods used in this investigation are considered reliable; however, localized subsurface variations may exist that have not been completely defined. The seismic results are not unique to geological features and more than one geologic feature or model may yield similar results. Therefore, properly conducted soil test borings and other exploratory techniques are necessary to more completely determine the subsurface conditions at the site.

The site features presented on the site base map are for informational purposes only and no representation is made as to the accuracy or completeness of this information. It is recommended that a practicing geosciences or geotechnical engineering professional be contacted prior to conducting verification drilling or excavating activities.

Figure 1 Vicinity Map

Figure 2 Site Map

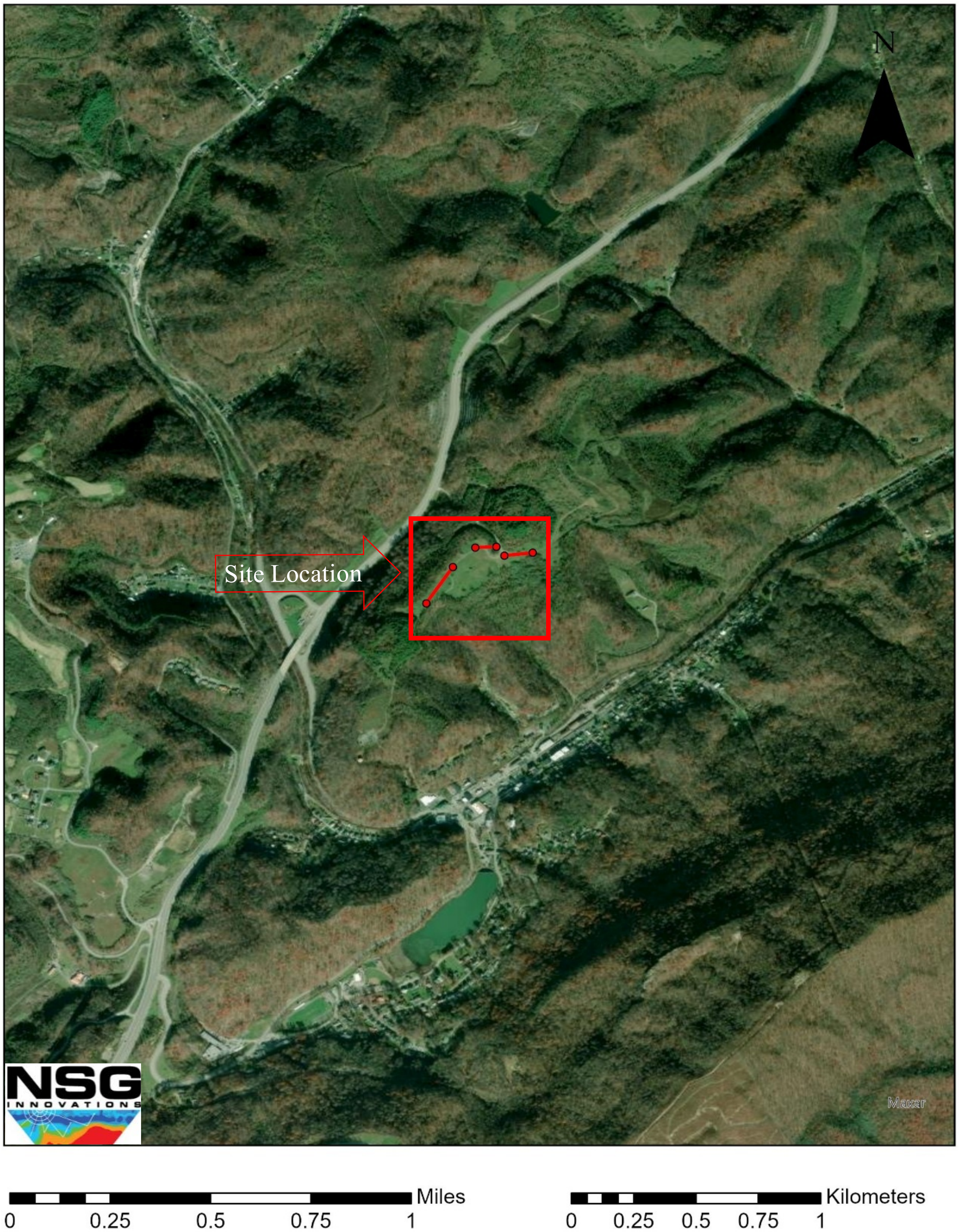


Figure 3 Line Location Map


N
Large Pile
of debris
Line 2
Line 3
Line 1
NSG
INNOVATIONS
Maxar
0 250 500 750 1,000 Feet
0 50 100 150 200 Meters

Figure 4 Geological Setting

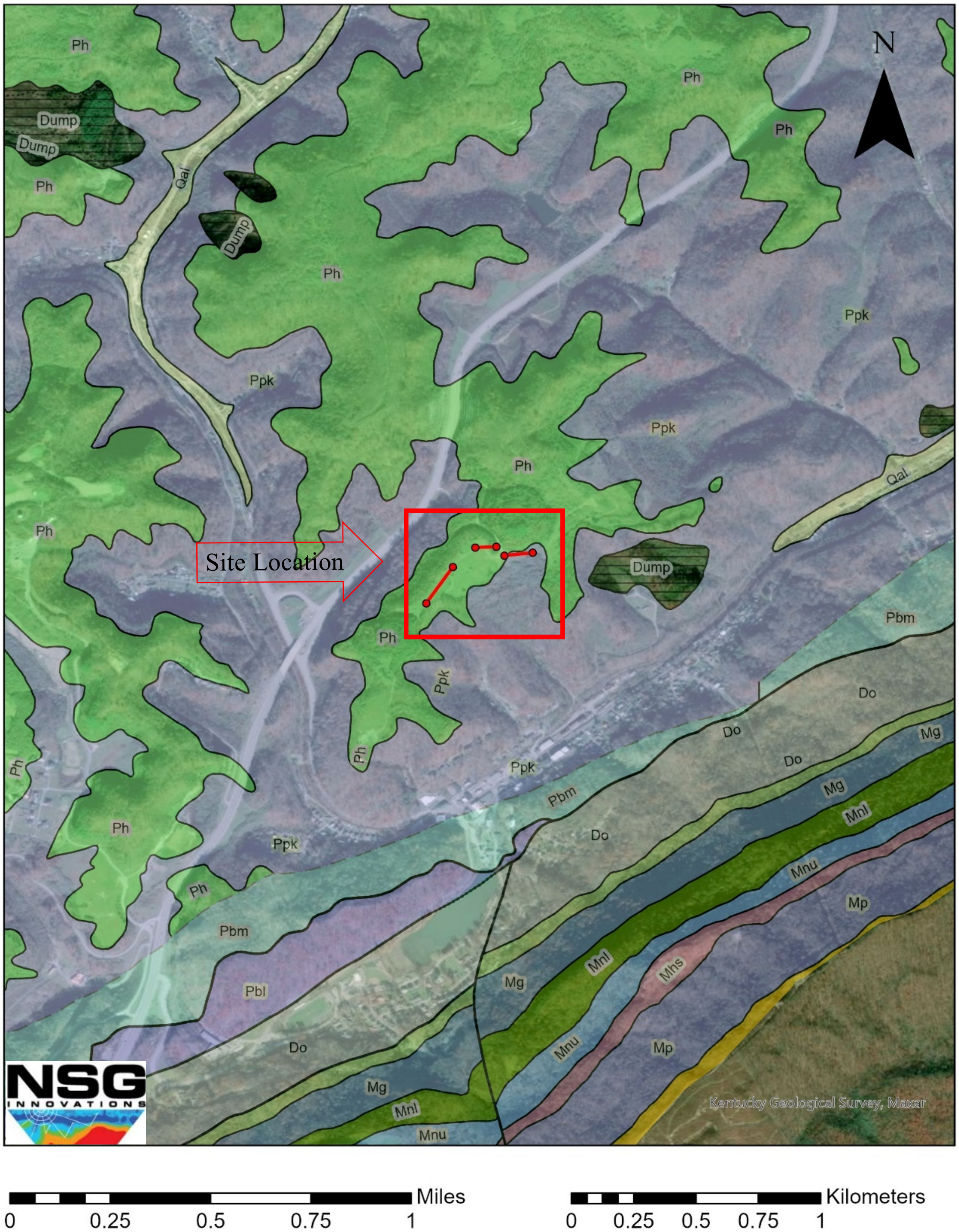


Figure 5 Line 1

Soft Soil	Stiff Soil	Very Dense Soil and Soft Rock	Rock
V_s<600 ft/s	600 < Vs< 1200 ft/s	1200 < Vs < 2500 ft/s	2500 < Vs< 5000 ft/s
Standard penetration resistance, N	Standard penetration resistance, N	Standard penetration resistance, N	Standard penetration resistance, N
N < 15	15 ≤ N ≤ 50	N > 50	N/A
Undrained shear strength (psf)	Undrained shear strength S_U (psf)	Undrained shear strength (psf)	Undrained shear strength (psf)
<1,000	1,000≤S_U≤2,000	S_U > 2,000	N/A

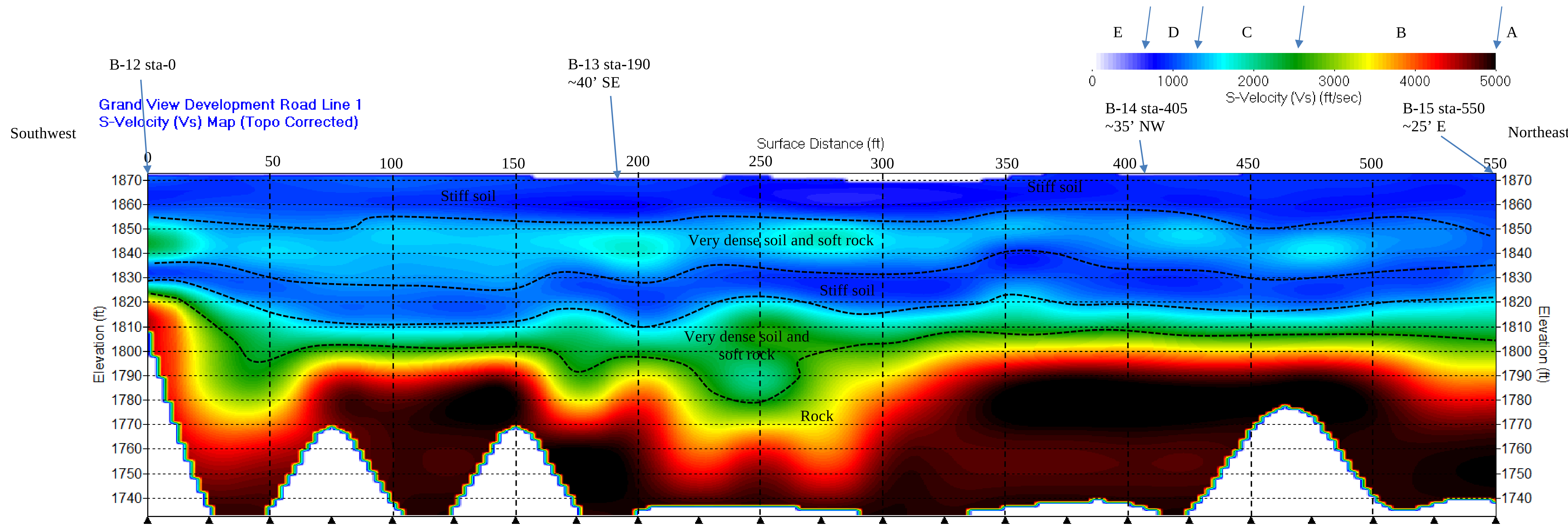
Table 2: Scale used in velocity profile with site classification, standard penetration values (N) and undrained shear strength. Values from IBC 2006 Table 1613.5.2 Site Class Definitions (section 1613.5.50).

MASW Profile L1
Figure 5

[illegible]

Site Class	Soil Profile Name	Average Properties in Top 100 feet (as per 2000 IBC section 1615.1.5) Soil Shear Wave Velocity, V_s	
		Feet/second	Meters/second
A	Hard Rock	$V_s > 5000$	$V_s > 1524$
B	Rock	$2500 < V_s \leq 5000$	$762 < V_s \leq 1524$
C	Very dense soil and soft rock	$1200 < V_s \leq 2500$	$366 < V_s \leq 762$
D	Stiff soil profile	$600 < V_s \leq 1200$	$183 < V_s \leq 366$
E	Soft soil profile	$V_s < 600$	$V_s < 183$

[illegible]



NSG Innovations, LLC Near Surface Geophysics 741 Greenlawn Ave., Bowling Green, KY	Figure 5, MASW Profile Line 1 Drawn By: Thomas Brackman Trent Edwards	Horizontal Scale (feet): as shown Vertical Scale (feet): as shown		MASW Survey CTL Engineering Grandview Dev. Road Jenkins, KY

Figure 6 Line 2

Soft Soil	Stiff Soil	Very Dense Soil and Soft Rock	Rock
V_s<600 ft/s Standard penetration resistance, N N < 15 Undrained shear strength (psf) <1,000	600 < Vs< 1200 ft/s Standard penetration resistance, N 15 ≤ N ≤ 50 Undrained shear strength S_U (psf) 1,000≤S_U≤2,000	1200 < Vs < 2500 ft/s Standard penetration resistance, N N > 50 Undrained shear strength (psf) S_U > 2,000	2500 < Vs< 5000 ft/s Standard penetration resistance, N N/A Undrained shear strength (psf) N/A

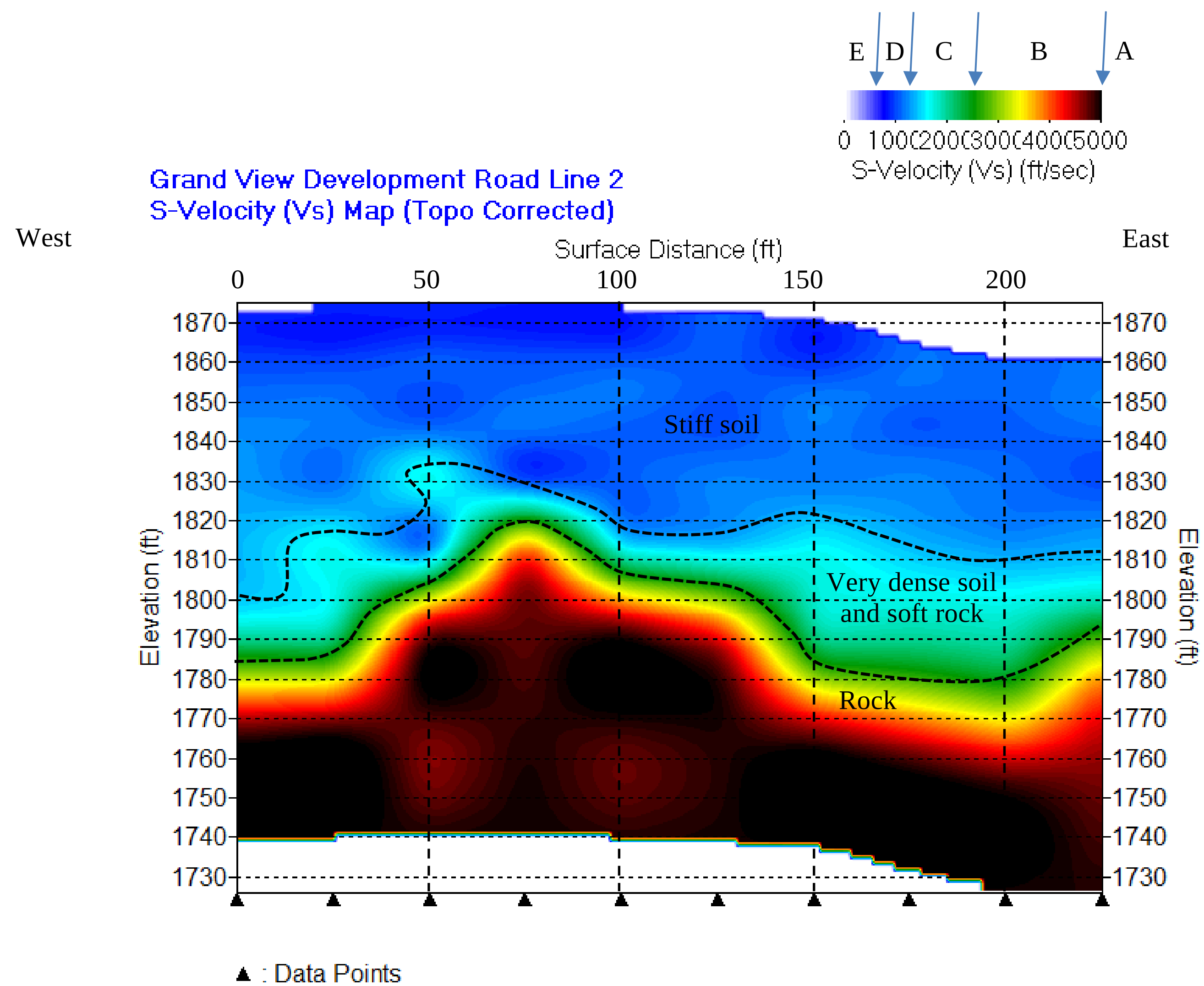
Table 2: Scale used in velocity profile with site classification, standard penetration values (N) and undrained shear strength. Values from IBC 2006 Table 1613.5.2 Site Class Definitions (section 1613.5.50).

MASW Profile L2
Figure 6

[illegible]

Site Class	Soil Profile Name	Average Properties in Top 100 feet (as per 2000 IBC section 1615.1.5) Soil Shear Wave Velocity, V_s	
		Feet/second	Meters/second
A	Hard Rock	$V_s > 5000$	$V_s > 1524$
B	Rock	$2500 < V_s \leq 5000$	$762 < V_s \leq 1524$
C	Very dense soil and soft rock	$1200 < V_s \leq 2500$	$366 < V_s \leq 762$
D	Stiff soil profile	$600 < V_s \leq 1200$	$183 < V_s \leq 366$
E	Soft soil profile	$V_s < 600$	$V_s < 183$

[illegible]



NSG Innovations, LLC
Near Surface Geophysics
741 Greenlawn Ave.,
Bowling Green, KY

Figure 6, MASW Profile Line 2
Drawn By: Thomas Brackman
Trent Edwards

Horizontal Scale (feet): as shown

Vertical Scale (feet): as shown

MASW Survey
CTL Engineering
Grandview Dev. Road
Jenkins, KY

Figure 7 Line 3

Soft Soil	Stiff Soil	Very Dense Soil and Soft Rock	Rock
V_s<600 ft/s Standard penetration resistance, N N < 15 Undrained shear strength (psf) <1,000	600 < Vs< 1200 ft/s Standard penetration resistance, N 15 ≤ N ≤ 50 Undrained shear strength S_U (psf) $1,000 \leq S_U \leq 2,000$	1200 < Vs < 2500 ft/s Standard penetration resistance, N N > 50 Undrained shear strength (psf) S_U > 2,000	2500 < Vs< 5000 ft/s Standard penetration resistance, N N/A Undrained shear strength (psf) N/A

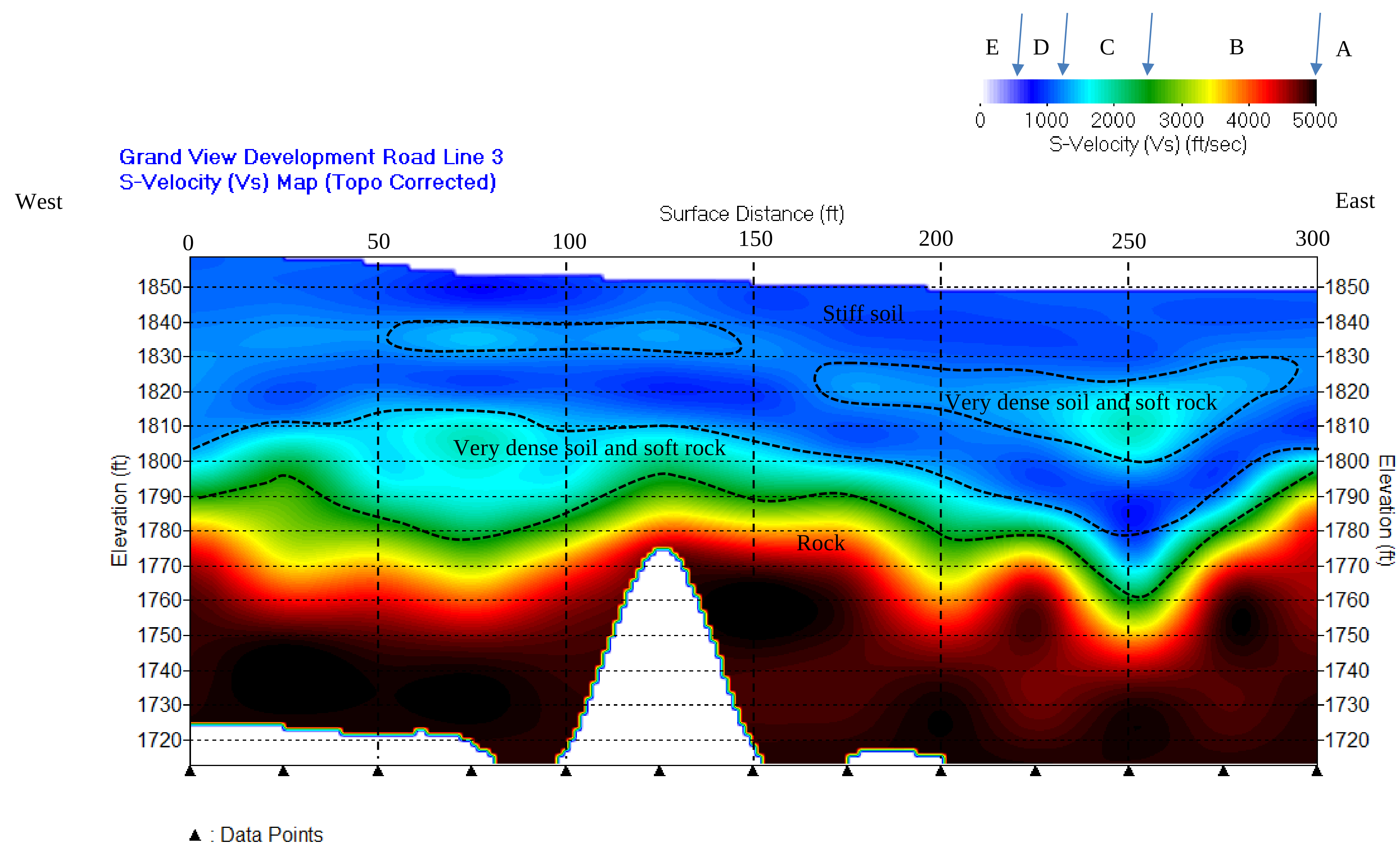
Table 2: Scale used in velocity profile with site classification, standard penetration values (N) and undrained shear strength. Values from IBC 2006 Table 1613.5.2 Site Class Definitions (section 1613.5.50).

MASW Profile L3
Figure 7

[illegible]

Site Class	Soil Profile Name	Average Properties in Top 100 feet (as per 2000 IBC section 1615.1.5) Soil Shear Wave Velocity, V_s	
		Feet/second	Meters/second
A	Hard Rock	V_s > 5000	V_s > 1524
B	Rock	$2500 < V_s \leq 5000$	$762 < V_s \leq 1524$
C	Very dense soil and soft rock	$1200 < V_s \leq 2500$	$366 < V_s \leq 762$
D	Stiff soil profile	$600 < V_s \leq 1200$	$183 < V_s \leq 366$
E	Soft soil profile	V_s < 600	V_s < 183

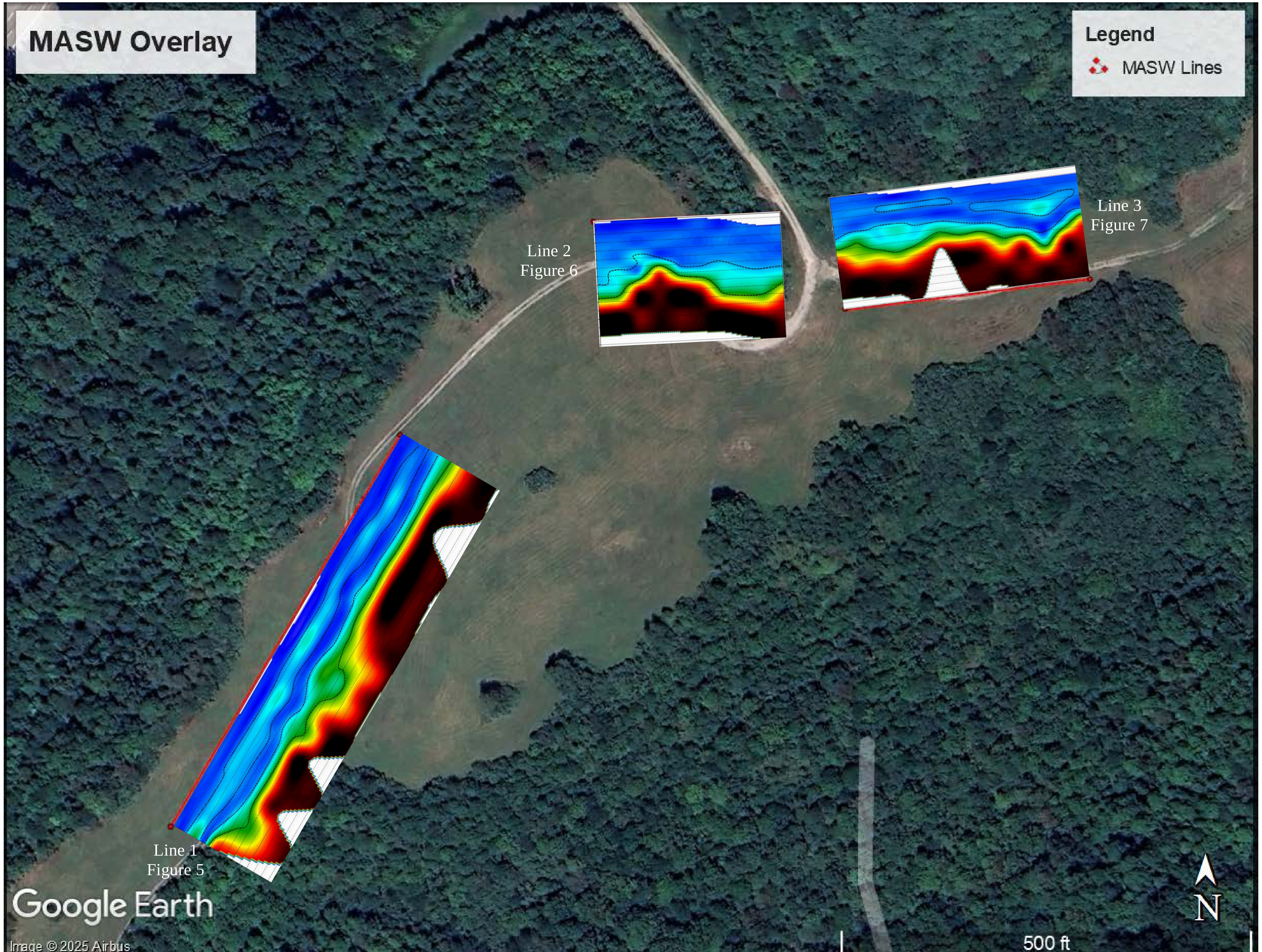
[illegible]



NSG INNOVATIONS	NSG Innovations, LLC Near Surface Geophysics 741 Greenlawn Ave., Bowling Green, KY	Figure 7, MASW Profile Line 3 Drawn By: Thomas Brackman Trent Edwards	Horizontal Scale (feet): as shown Vertical Scale (feet): as shown		MASW Survey CTL Engineering Grandview Dev. Road Jenkins, KY

Figure 8 MASW Overlay

MASW Overlay
Figure 8



NSG INNOVATIONS	NSG Innovations, LLC Near Surface Geophysics 741 Greenlawn Ave., Bowling Green, KY	Figure 8, MASW Overlay Drawn By: Thomas Brackman Trent Edwards	Horizontal Scale (feet): as shown Vertical Scale (feet): as shown		MASW Survey CTL Engineering Grandview Dev. Road Jenkins, KY

Laboratory Data Summary

PROJECT NAME: *Grandview Access Road*

PROJECT NUMBER: *25050086SHE*
R-019-2025

BORING NO.	SAMPLE DEPTH, FT.	SAMPLE TYPE*	USCS	AASHTO	NATURAL MOISTURE CONTENT, %	ATTERBERG LIMITS			MAX. DRY DENSITY PCF /OPTIMUM MOISTURE %	D50	MATERIAL FINER THAN NO, 200 %	SLAKE DURABILITY INDEX	JAR SLAKE	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LOSS ON IGNITION %
						L.L.	P.L.	P.I.							
B-1	4.5-6	ss			6.1										
B-1	7-8.5	ss	GC	A-2-6	7.1	30	19	11		6.063	20				
B-1	14.5-16	ss			12.7										
B-1	19.5-21	ss			15.6										
B-2	4-5.5	ss			6.8										
B-2	9-10.5	ss			4.6										
B-2	14-15.5	ss	SC	A-4	15.4	31	22	9		0.171	43				2.0
B-2	19-20.5	ss			10.8										
B-2	24-25.5	ss			15.2										
B-3	0-3.5	bag	SC-SM	A-4	10.3	24	19	5	116.6/12.6	0.123	42				
B-3	2-3.5	ss			9.2										
B-4	20.8	RC										95.2	6		
B-4	29	RC										98.6	5		
B-4	39.5-40	RC												2,054	
B-5	2-3.5	ss			9.1										
B-5	17.5	RC										69.1	2		
B-5	23.1	RC										97.7	6		
B-6	0-3.5	bag	GM	A-1-b	4.2				132.1/9.1						
B-6	1-2.5	jar			4.5										
B-6	4.5-5.9	ss	GM	A-1-b	5.3	0	0	0		1.852	20				
B-7	2-3.5	ss			4.0										
B-7	7-8.5	ss	GC	A-2-4	3.3	31	21	10		4.253	15				
B-8	4.5-6	ss			6.3										
B-8	7-8.5	ss			6.6										
B-8	14.5-16	ss			5.3										
B-8	19.5-21	ss			7.2										

Laboratory Data Summary

PROJECT NAME: *Grandview Access Road* **PROJECT NUMBER:** *25050086SHE*
R-019-2025

BORING NO.	SAMPLE DEPTH, FT.	SAMPLE TYPE*	USCS	AASHTO	NATURAL MOISTURE CONTENT, %	ATTERBERG LIMITS			MAX. DRY DENSITY PCF /OPTIMUM MOISTURE %	D50	MATERIAL FINER THAN NO, 200 %	SLAKE DURABILITY INDEX	JAR SLAKE	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LOSS ON IGNITION %
						L.L.	P.L.	P.I.							
B-8	24.5-26	ss	GC	A-2-4	6.9	27	18	9		4.779	18				
B-8	29.5-31	ss			15.8	31	21	10		0.963	33				
B-8	34.5-36	ss			10.3										
B-9	0-5	bag	SC	A-2-4	12.8				122.7/12.5						
B-9	0-5	jar			12.8										
B-9	2.5-4	ss	SC	A-2-4	10.3	31	21	10		0.963	33				
B-9	7-8.3	ss			10.1										
B-9	14.5-16	ss			5.9										
B-9	19.5-21	ss			9.6										
B-9	24.5-25.6	ss			3.8										
B-9	29.5-31	ss			14.4										
B-10	9.5-11	ss	SC	A-6	6.0	34	22	12		0.667	39				
B-10	14.5-16	ss			4.3										
B-10	19.5-21	ss			8.7										
B-10	24.5-26	ss			5.3										
B-10	29.5-31	ss			7.6										
B-10	34.5-36	ss			3.9										
B-10	39.5-41	ss			5.2										
B-11	6.8	RC										97.9	5		
B-12	4.5-6	ss			5.7										
B-12	14.5-16	ss			12.5										
B-12	19.5-20.8	ss	SC-SM	A-2-4	12.7	23	18	5		0.206	31				
B-13	1.5-3	ss			4.9										
B-13	9-10.3	ss			6.4										
B-13	14-15.5	ss			3.6										
B-13	19-20.5	ss	GM	A-1-b	6.0	0	0	0		3.686	17				

Laboratory Data Summary

PROJECT NAME: *Grandview Access Road*

PROJECT NUMBER: *25050086SHE*
R-019-2025

BORING NO.	SAMPLE DEPTH, FT.	SAMPLE TYPE*	USCS	AASHTO	NATURAL MOISTURE CONTENT, %	ATTERBERG LIMITS			MAX. DRY DENSITY PCF /OPTIMUM MOISTURE %	D50	MATERIAL FINER THAN NO, 200 %	SLAKE DURABILITY INDEX	JAR SLAKE	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LOSS ON IGNITION %
						L.L.	P.L.	P.I.							
B-13	34-35.3	ss			5.4										
B-13	39-40.5	ss			7.3										
B-13	49-50.5	ss			7.0										
B-13	59-60.5	ss			4.5										
B-13	69-70.5	ss			4.2										
B-13	79-79.8	ss			7.6										
B-14	5-6.5	ss	SM	A-1-b	8.0	0	0	0		0.510	23				
B-14	10-11.5	ss			6.6										
B-14	20-21.5	ss			8.7										
B-14	25-26.5	ss			8.5										
B-14	30-31.5	ss			9.7										
B-14	35-36.5	ss			5.2										
B-14	50-51.5	ss			10.1										
B-14	60-60.1	ss			5.7										
B-15	0-5	bag	GC	A-2-4	6.9				127.9/9.7						
B-15	0-5	jar			6.9										
B-15	4.5-6	ss	GC	A-2-4	9.7	29	20	9		0.923	32				
B-15	9.5-11	ss			7.9										
B-15	14.5-16	ss			7.0										
B-15	19.5-21	ss			11.7										
B-15	24.5-26	ss	GM	A-1-b	12.0	0	0	0		6.280	21				
B-15	29.5-31	ss			5.4										
B-15	34.5-35.2	ss			3.2										
B-15	39.5-41	ss			4.6										
B-15	49.5-49.7	ss			9.3										
B-16	9.5-11	ss			7.9										

Laboratory Data Summary

PROJECT NAME: *Grandview Access Road*

PROJECT NUMBER: *25050086SHE*
R-019-2025

BORING NO.	SAMPLE DEPTH, FT.	SAMPLE TYPE*	USCS	AASHTO	NATURAL MOISTURE CONTENT, %	ATTERBERG LIMITS			MAX. DRY DENSITY PCF /OPTIMUM MOISTURE %	D50	MATERIAL FINER THAN NO, 200 %	SLAKE DURABILITY INDEX	JAR SLAKE	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LOSS ON IGNITION %
						L.L.	P.L.	P.I.							
B-16	21-22.5	ss	SM	A-1-b	10.5	0	0	0		0.618	16				
B-16	26-27.5	ss			13.3										
B-16	31-32.5	ss			11.2										
B-17	4.5-6	ss			5.0										
B-17	9.5-11	ss			5.0										
B-17	14.5-16	ss			4.2										
B-17	19.5-21	ss	SC-SM	A-1-b	7.9	21	16	5		0.670	21				
B-17	24.5-26	ss			5.3										
B-17	29.5-31	ss			5.9										
B-17	34.5-36	ss			7.0										
B-17	39.5-41	ss			6.3										
B-17	49.5-51	ss			4.4										
B-18	4.5-5.3	ss			5.9										
B-18	9.5-11	ss	GC	A-2-4	4.9	24	16	8		2.895	19				
B-18	14.5-16	ss			7.4										
B-18	19.5-21	ss			7.2										
B-18	24.5-26	ss			14.4										
B-18	29.5-31	ss			11.8										
B-18	34.5-35.7	ss			5.8										
B-18	39.5-41	ss	SC	A-6	12.9	31	20	11		0.267	40				3.0
B-19	0-5	bag	GC-GM	A-1-b	5.4				130.5/7.3						
B-19	0-5	jar			5.4										
B-19	4.5-6	ss	GC-GM	A-1-b	4.4	23	17	6		2.592	20				2.2
B-19	9.5-11	ss			7.6										
B-19	14.5-16	ss			5.1										
B-19	24.5-26	ss			8.2										

Laboratory Data Summary

PROJECT NAME: *Grandview Access Road*

PROJECT NUMBER: *25050086SHE*
R-019-2025

BORING NO.	SAMPLE DEPTH, FT.	SAMPLE TYPE*	USCS	AASHTO	NATURAL MOISTURE CONTENT, %	ATTERBERG LIMITS			MAX. DRY DENSITY PCF /OPTIMUM MOISTURE %	D50	MATERIAL FINER THAN NO, 200 %	SLAKE DURABILITY INDEX	JAR SLAKE	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LOSS ON IGNITION %
						L.L.	P.L.	P.I.							
B-19	29.5-30.8	ss			10.3										
B-19	34.5-35.8	ss	SC	A-2-4	10.8	29	19	10		0.598	31				
B-20	4.5-6	ss			14.5										
B-20	9.5-11	ss			10.3										
B-20	14.5-16	ss			13.5										
B-20	19.5-21	ss			2.5										
B-20	24.5-26	ss			4.7										
B-20	29.5-31	ss			5.0										
B-20	34.5-36	ss			4.8										
B-21	2.5-4	ss	GC-GM	A-1-b	3.0	25	19	6		7.897	17				
B-21	10-11.5	ss			3.7										
B-21	15-16.1	ss			2.9										
B-30	4.5-6	ss			6.4										
B-30	9.5-11	ss			4.8										
B-30	14.5-16	ss			8.4										
B-30	19.5-21	ss	GC-GM	A-2-4	10.3	23	16	7		1.105	25				
B-30	29.5-30.3	ss			9.5										
B-30	35.6	RC										97.7	6		
B-30	41-41.5	RC												2,459	
B-30	49-49.5	RC												1,994	
B-30	63.8-64.3	RC												2,188	
B-30	73-73.5	RC												1,345	
B-30	81-81.5	RC												1,777	
B-30	87	RC										92.1	5		
B-30	100	RC										98.4	5		
B-30	107-107.5	RC												1,986	

Laboratory Data Summary

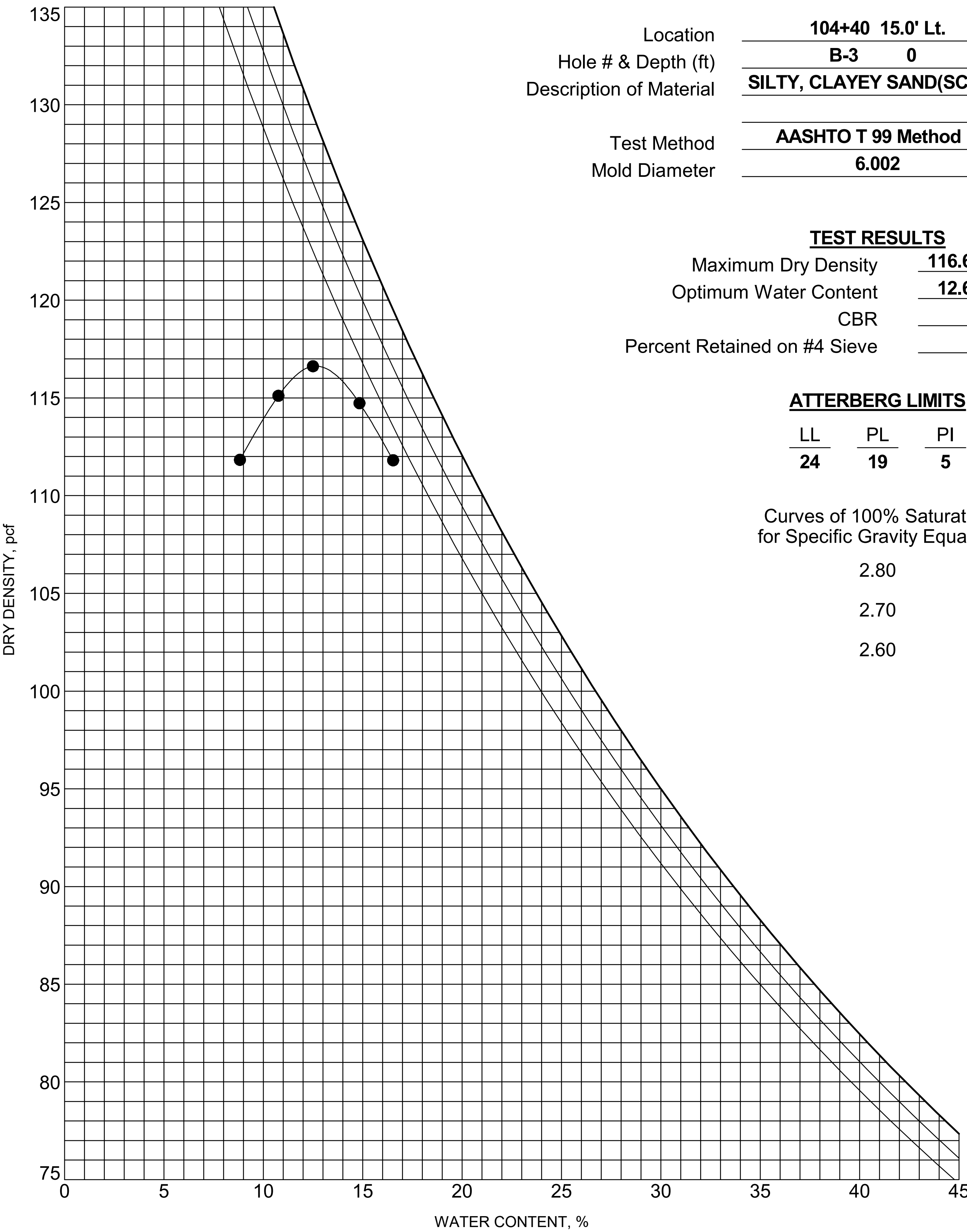
PROJECT NAME: *Grandview Access Road* **PROJECT NUMBER:** *25050086SHE*
R-019-2025

BORING NO.	SAMPLE DEPTH, FT.	SAMPLE TYPE*	USCS	AASHTO	NATURAL MOISTURE CONTENT, %	ATTERBERG LIMITS			MAX. DRY DENSITY PCF /OPTIMUM MOISTURE %	D50	MATERIAL FINER THAN NO, 200 %	SLAKE DURABILITY INDEX	JAR SLAKE	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LOSS ON IGNITION %
						L.L.	P.L.	P.I.							
B-31	4-5.5	ss			11.0										
B-31	9-10.5	ss	SC	A-2-4	11.0	24	16	8		0.235	35				
B-32	2.7-4.2	ss			7.5										
B-33	4.5-6	ss	GC-GM	A-1-b	7.9	21	16	5		4.311	18				
B-33	9.5-11	ss			7.5										
B-33	14.5-16	ss			6.7										
B-33	23.1	RC										98.7	6		
B-33	24.1-24.7	RC												2,230	
B-33	35-35.5	RC												2,295	
B-33	44-44.5	RC												2,064	
B-33	56-56.5	RC												1,990	
B-33	64.5-65	RC												1,985	
B-34	4-5.5	ss	GC	A-2-4	8.3	26	18	8		4.600	14				
B-35	2-3.5	ss			10.4										
B-35	7-8.5	ss			3.6										
B-35	14.5-16	ss	SC	A-6	12.9	39	22	17		0.134	47				
B-35	19.5-21	ss			8.5										
B-35	24.5-26	ss			8.3										
B-35	29.5-31	ss			7.1										
B-35	34.5-36	ss			4.3										
B-35	39.5-41	ss			9.6										
B-35	49.5-51	ss			3.6										

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

MOISTURE-DENSITY RELATIONSHIP

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***



Location	**104+40 15.0' Lt.**
Hole # & Depth (ft)	**B-3 0**
Description of Material	**SILTY, CLAYEY SAND(SC-SM)**
Test Method	**AASHTO T 99 Method D**
Mold Diameter	**6.002**

TEST RESULTS

Maximum Dry Density	**116.6** PCF
Optimum Water Content	**12.6** %
CBR	
Percent Retained on #4 Sieve	

ATTERBERG LIMITS

LL	PL	PI
24	**19**	**5**

Curves of 100% Saturation
for Specific Gravity Equal to:

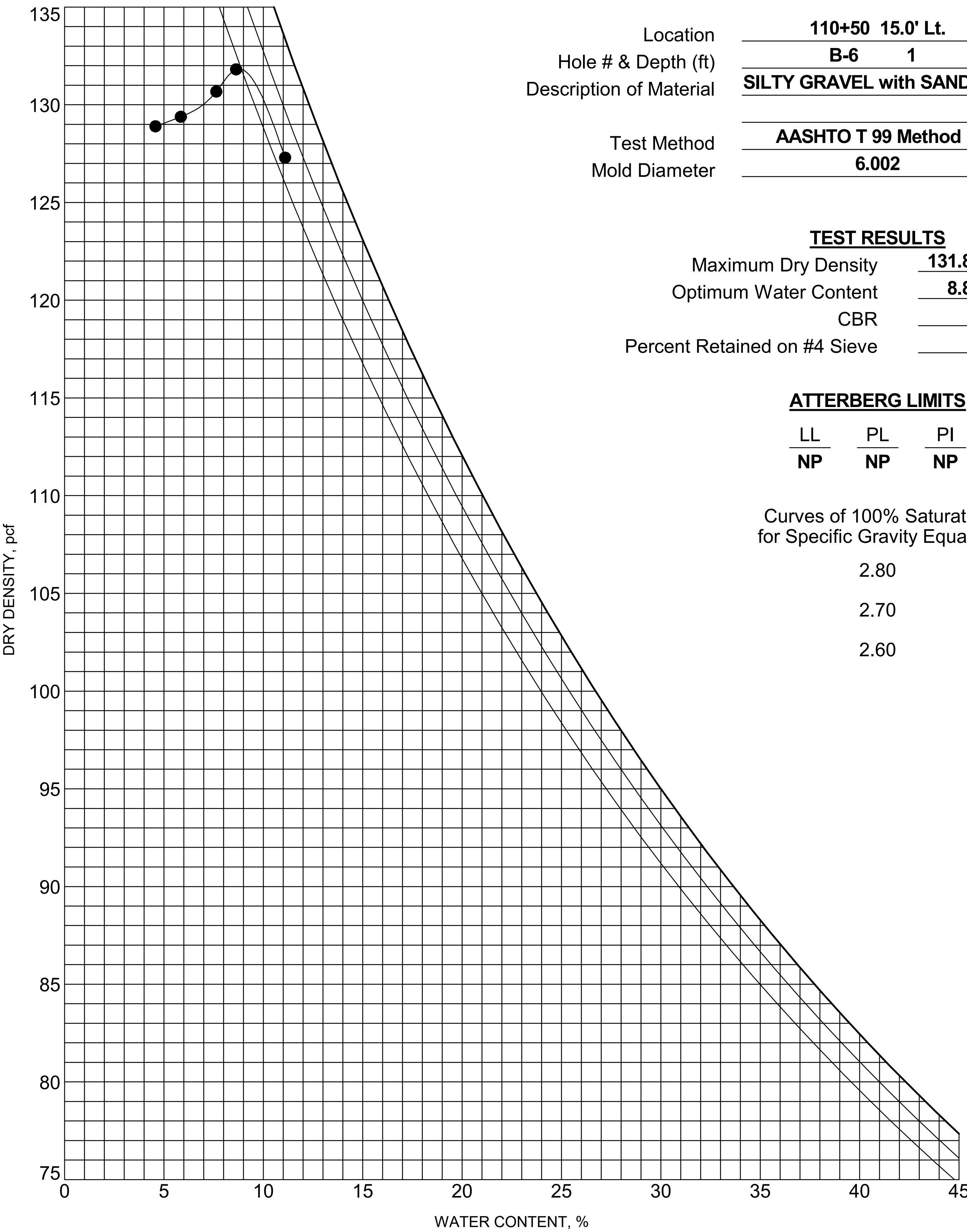
2.80

2.70

2.60

MOISTURE-DENSITY RELATIONSHIP

Project ID: **R-019-2025** Item Number: **12-00173.**	**Letcher - CR-0000**	Project Type: **Roadway Roadway** Project Manager: **Adam Ross**



Location	**110+50 15.0' Lt.**
Hole # & Depth (ft)	**B-6 1**
Description of Material	**SILTY GRAVEL with SAND(GM)**
Test Method	**AASHTO T 99 Method D**
Mold Diameter	**6.002**

TEST RESULTS

Maximum Dry Density	**131.8 PCF**
Optimum Water Content	**8.8 %**
CBR	
Percent Retained on #4 Sieve	

ATTERBERG LIMITS

LL	PL	PI
NP	**NP**	**NP**

Curves of 100% Saturation
for Specific Gravity Equal to:

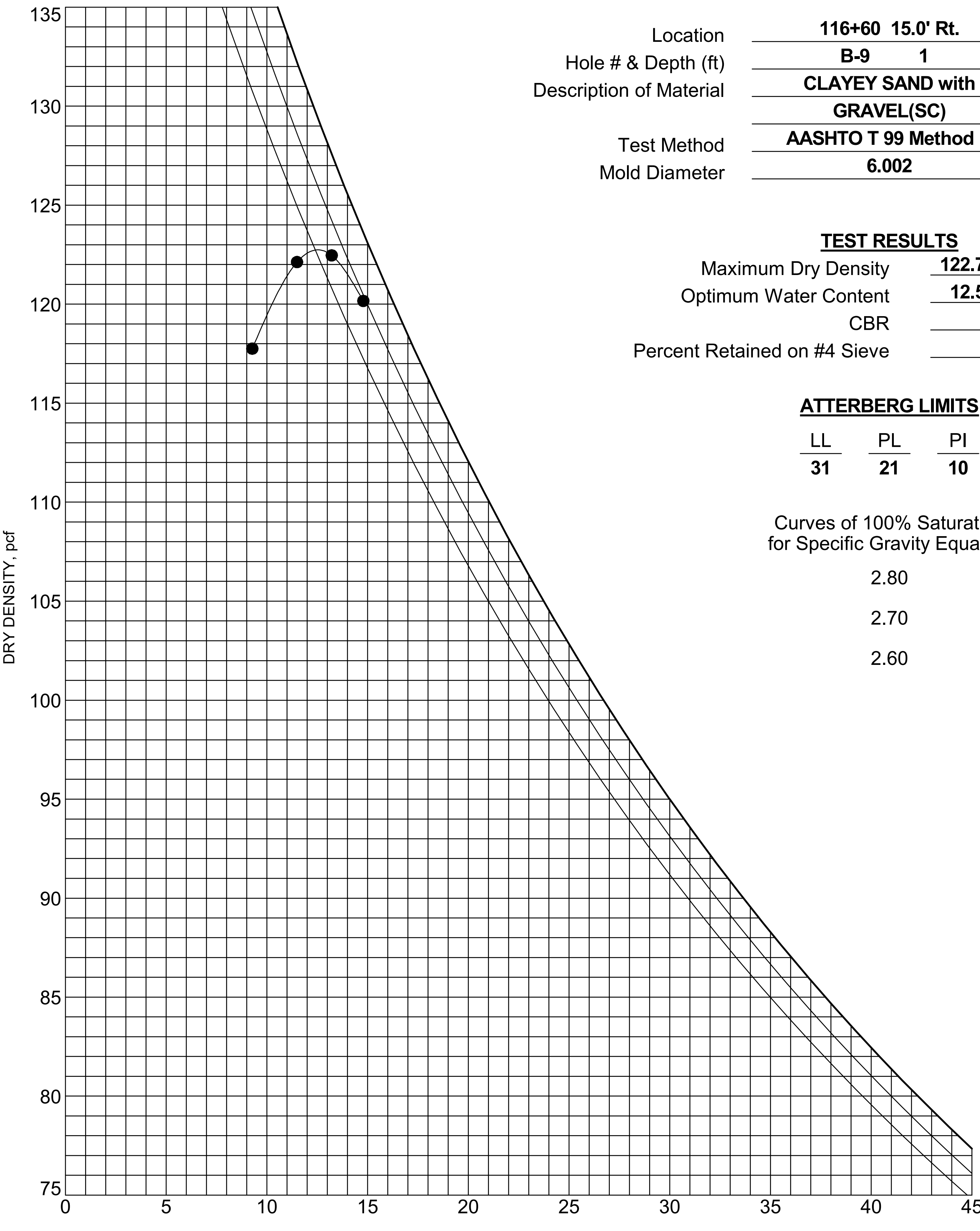
2.80

2.70

2.60

MOISTURE-DENSITY RELATIONSHIP

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***



Location	**116+60 15.0' Rt.**
Hole # & Depth (ft)	**B-9 1**
Description of Material	**CLAYEY SAND with GRAVEL(SC)**
Test Method	**AASHTO T 99 Method D**
Mold Diameter	**6.002**

TEST RESULTS

Maximum Dry Density	**122.7** PCF
Optimum Water Content	**12.5** %
CBR	
Percent Retained on #4 Sieve	

ATTERBERG LIMITS

LL	PL	PI
31	**21**	**10**

Curves of 100% Saturation
for Specific Gravity Equal to:

2.80

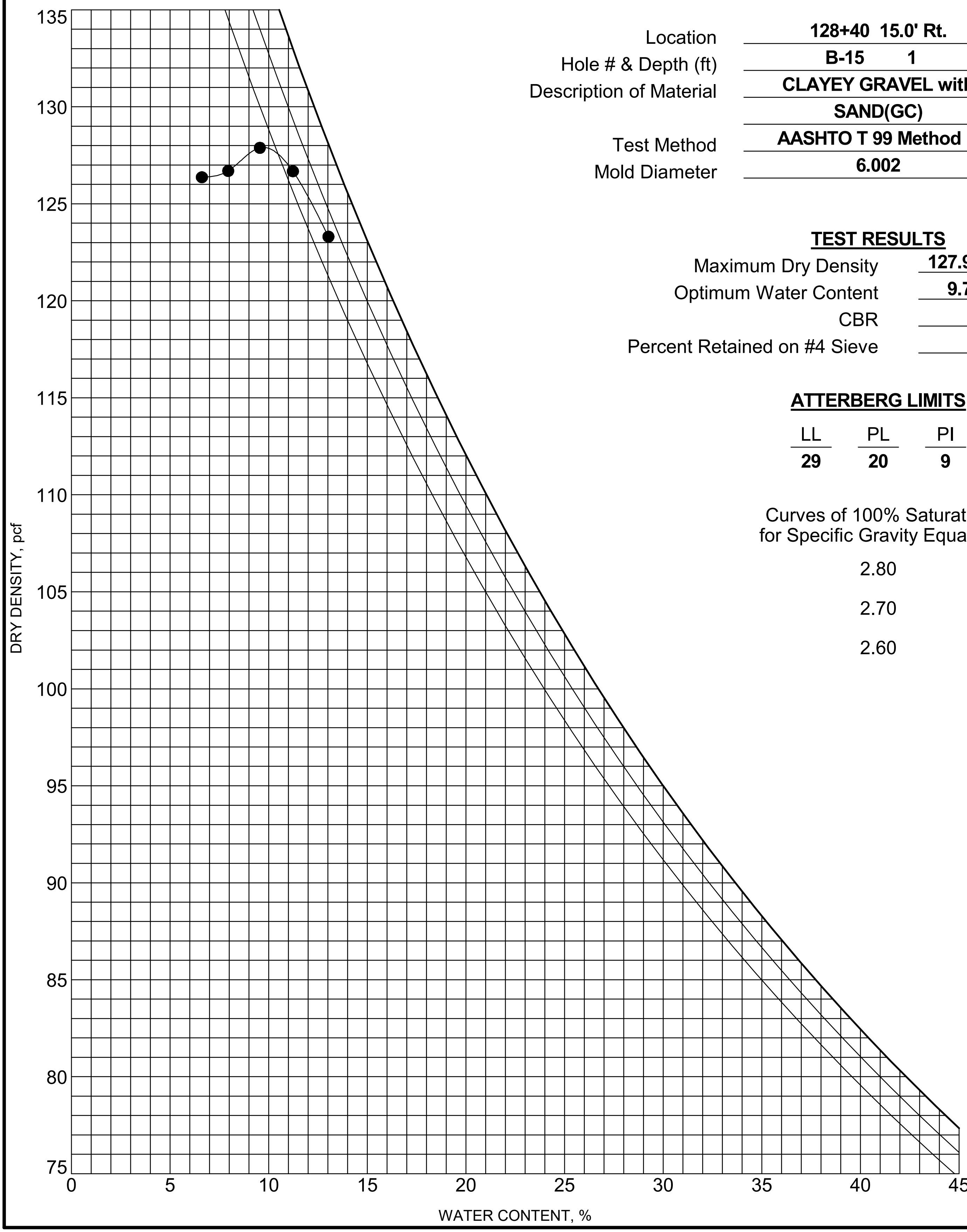
2.70

2.60

Drilling Firm: Horn & Associates Inc
For: Division of Structural Design
Geotechnical Branch

MOISTURE-DENSITY RELATIONSHIP

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***



Location	**128+40 15.0' Rt.**
Hole # & Depth (ft)	**B-15 1**
Description of Material	**CLAYEY GRAVEL with SAND(GC)**
Test Method	**AASHTO T 99 Method D**
Mold Diameter	**6.002**

TEST RESULTS

Maximum Dry Density **127.9 PCF**
Optimum Water Content **9.7 %**
CBR
Percent Retained on #4 Sieve

ATTERBERG LIMITS

LL	PL	PI
29	**20**	**9**

Curves of 100% Saturation
for Specific Gravity Equal to:

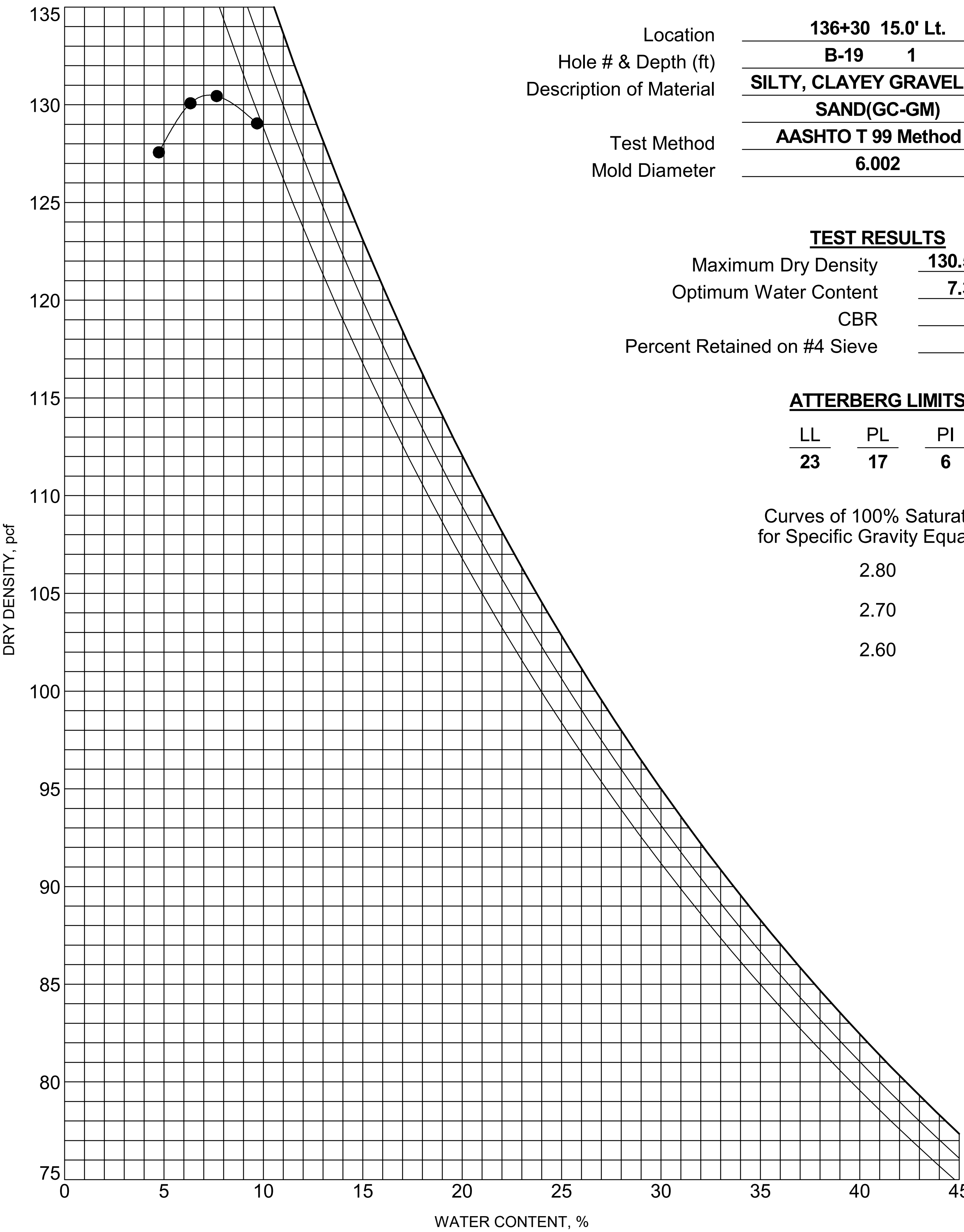
2.80

2.70

2.60

MOISTURE-DENSITY RELATIONSHIP

Project ID: ***R-019-2025*** Item Number: ***12-00173.***	***Letcher - CR-0000***	Project Type: ***Roadway Roadway*** Project Manager: ***Adam Ross***



Location	**136+30 15.0' Lt.**
Hole # & Depth (ft)	**B-19 1**
Description of Material	**SILTY, CLAYEY GRAVEL with SAND(GC-GM)**
Test Method	**AASHTO T 99 Method D**
Mold Diameter	**6.002**

TEST RESULTS

Maximum Dry Density	**130.5 PCF**
Optimum Water Content	**7.3 %**
CBR	
Percent Retained on #4 Sieve	

ATTERBERG LIMITS

LL	PL	PI
23	**17**	**6**

Curves of 100% Saturation
for Specific Gravity Equal to:

2.80

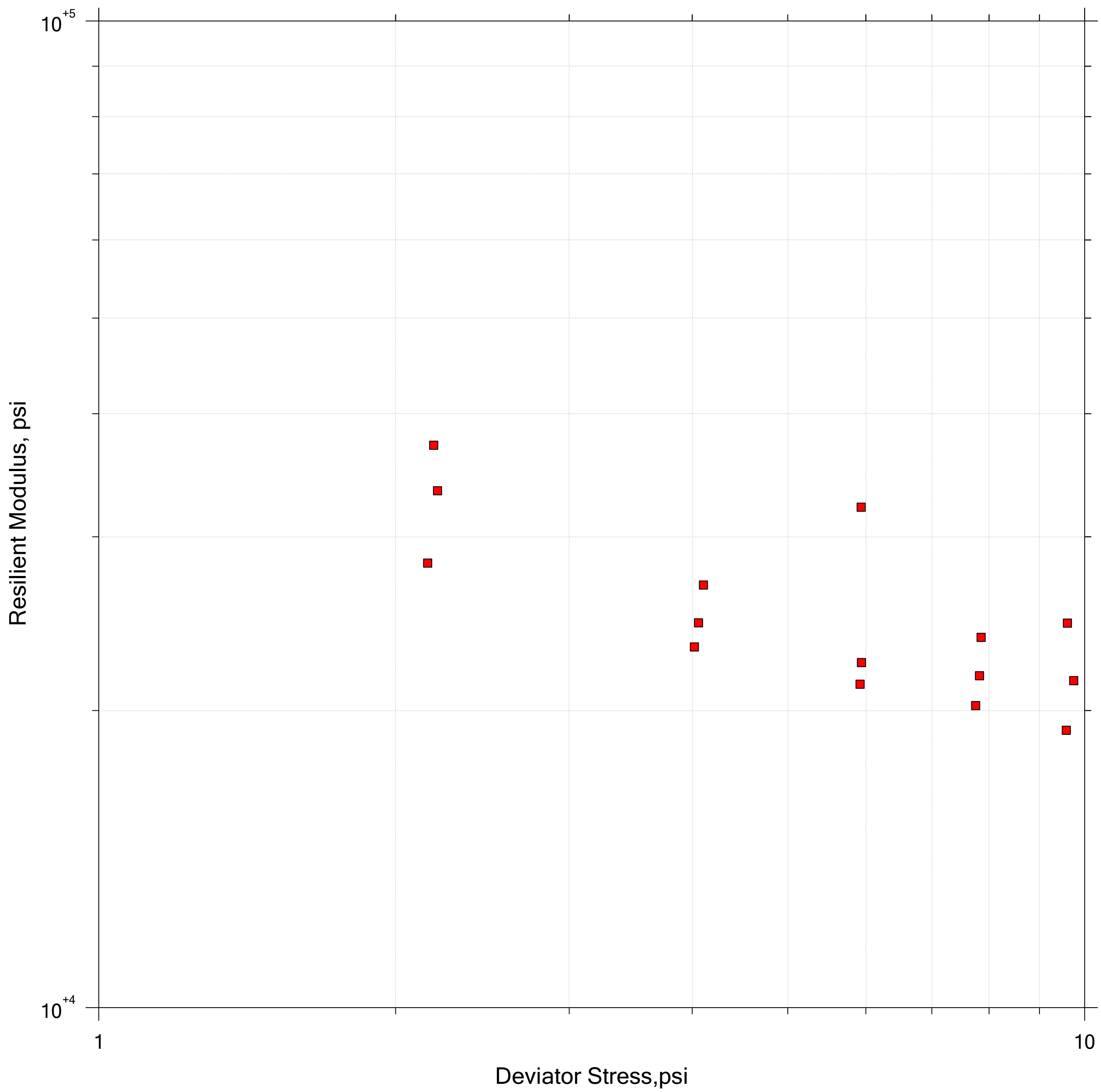
2.70

2.60

RM TEST

Summary Data

$Mr = 1093.1 * Pa * (B/Pa)^{0.335} * (Sd/Pa)^{-0.379}$ r = 0.9329



	Project Name: Grandview Access Road	Location:	Project Number: R-019-2025
	Boring Number: B-15	Tester: M. Bolton	Checker: J. Folsom
		Test Date: 12/01/25	Depth: 1.0 - 49.7
		Preparation: Remold	
	Description: SILTY GRAVEL (visual-manual)		
	Remarks: Remolded to 119.4 pcf at 10.2% MC (approximately 95% of MDD near optimum).		

RM TEST

Summary Data

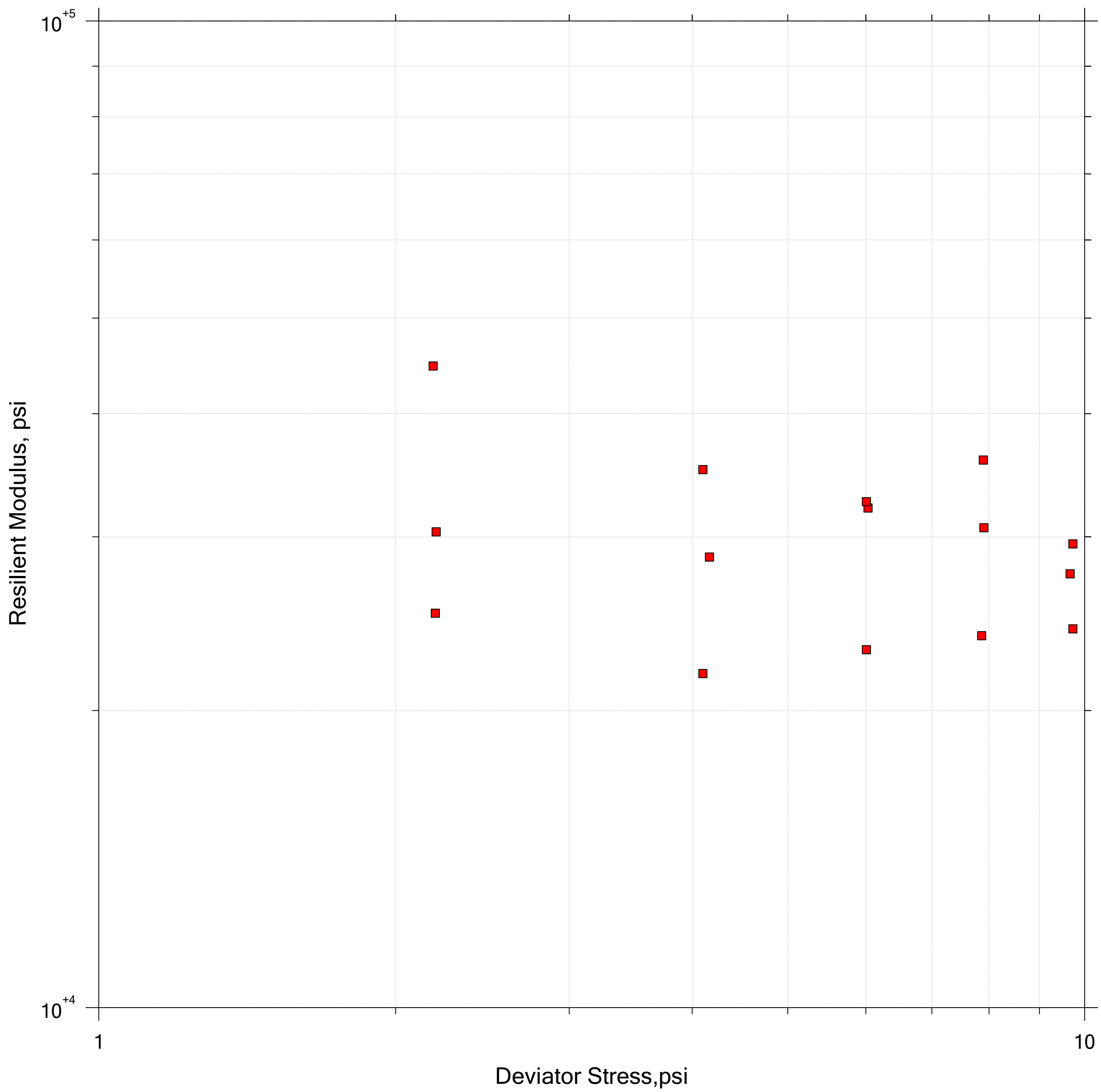
Confining Stress S3 psi	Nom. Max. Deviator Stress psi	Mean Deviator Stress psi	Std. Dev. Deviator Stress psi	Mean Bulk Stress psi	Mean Resilient Strain %	Std. Dev. Resilient Strain %	Mean Resilient Modulus psi	Std. Dev. Resilient Modulus psi
5.998	2.000	2.186	0.0344	20.18	0.01	0.00	37161.	6854.4
5.987	4.000	4.105	0.0817	22.07	0.01	0.00	26819.	728.44
5.996	6.000	5.933	0.0705	23.92	0.02	0.00	32159.	952.41
5.991	8.000	7.853	0.0305	25.83	0.03	0.00	23723.	456.60
5.984	10.00	9.609	0.1375	27.56	0.04	0.00	24536.	2348.0
3.976	2.000	2.206	0.0431	14.14	0.01	0.00	33414.	7067.7
3.984	4.000	4.058	0.0685	16.01	0.02	0.00	24553.	794.62
3.967	6.000	5.937	0.0746	17.84	0.02	0.00	22376.	284.25
3.973	8.000	7.824	0.0511	19.74	0.03	0.00	21689.	333.20
3.979	10.00	9.752	0.0419	21.69	0.04	0.00	21441.	196.06
1.965	2.000	2.155	0.0275	8.050	0.01	0.00	28227.	3122.4
1.944	4.000	4.019	0.0478	9.852	0.02	0.00	23198.	430.65
1.956	6.000	5.919	0.0962	11.79	0.03	0.00	21268.	246.26
1.964	8.000	7.752	0.1148	13.64	0.04	0.00	20232.	1858.6
1.964	10.00	9.580	0.0968	15.47	0.05	0.00	19108.	244.27

Project Name: Grandview Access Road	Location:	Project Number: R-019-2025
Boring Number: B-15	Tester: M. Bolton	Checker: J. Folsom
	Test Date: 12/01/25	Depth: 1.0 - 49.7
	Preparation: Remold	
Description: SILTY GRAVEL (visual-manual)		
Remarks: Remolded to 119.4 pcf at 10.2% MC (approximately 95% of MDD near optimum).		

RM TEST

Summary Data

$Mr = 1535.9 * Pa * (B/Pa)^{0.386} * (Sd/Pa)^{-0.22}$ r = 0.71136



	Project Name: Grandview Access Road	Location:	Project Number: R-019-2025
	Boring Number: B-19	Tester: M. Bolton	Checker: J. Folsom
		Test Date: 12/01/25	Depth: 1.0 - 36.0
		Preparation: Remold	
	Description: GRAVELLY LEAN CLAY (visual-manual)		
	Remarks: Remolded to 122.3 pcf at 7.1% MC (approximately 95% of MDD near optimum).		

RM TEST

Summary Data

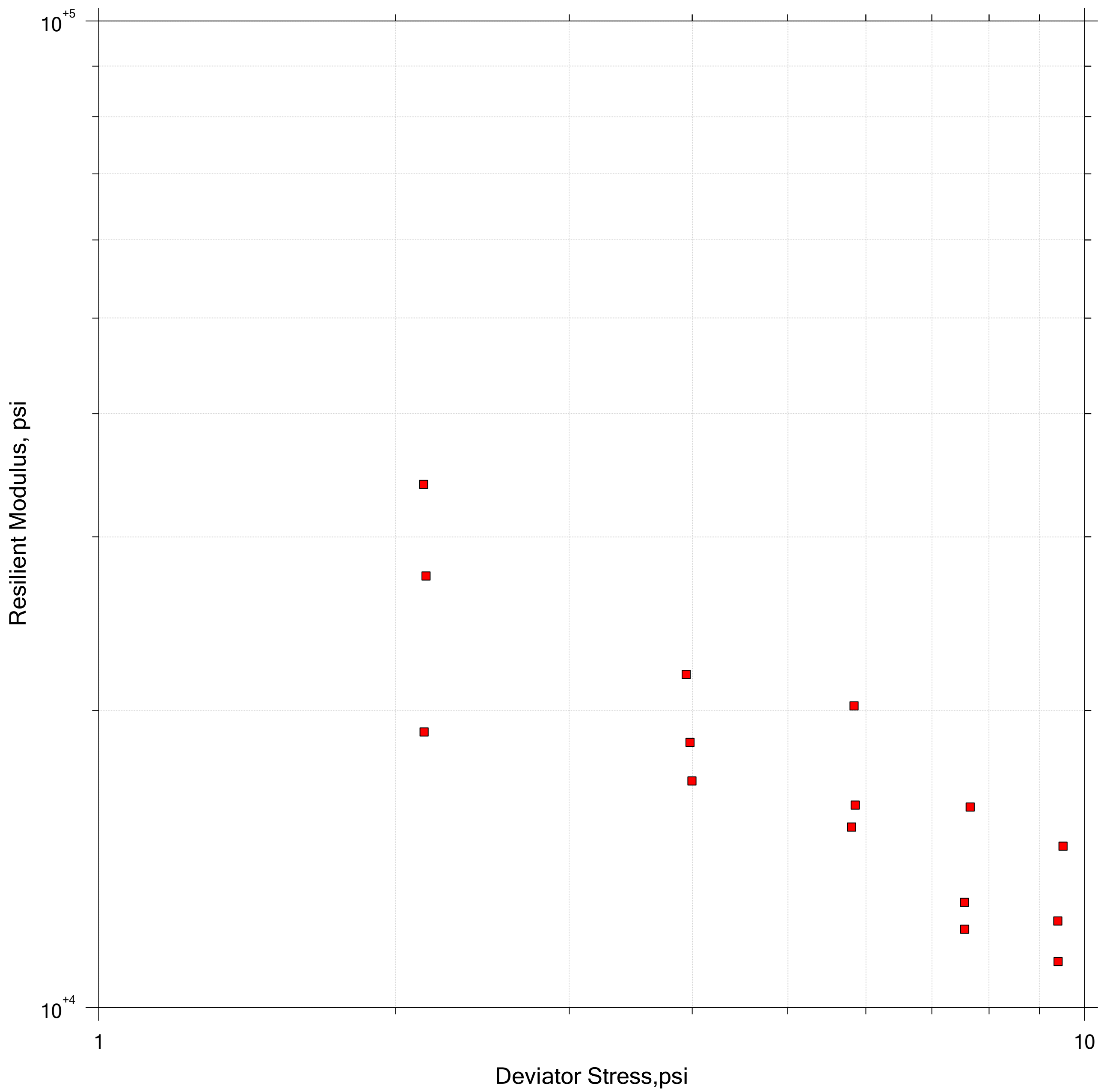
Confining Stress S3 psi	Nom. Max. Deviator Stress psi	Mean Deviator Stress psi	Std. Dev. Deviator Stress psi	Mean Bulk Stress psi	Mean Resilient Strain %	Std. Dev. Resilient Strain %	Mean Resilient Modulus psi	Std. Dev. Resilient Modulus psi
5.658	2.000	2.199	0.0280	19.17	0.01	0.00	30362.	2952.3
5.686	4.000	4.163	0.0280	21.22	0.01	0.00	28612.	755.22
5.639	6.000	6.030	0.0736	22.95	0.02	0.00	32092.	549.22
5.672	8.000	7.896	0.0545	24.91	0.02	0.00	35904.	617.66
5.655	10.00	9.730	0.0832	26.70	0.03	0.00	29511.	246.15
3.639	2.000	2.184	0.0545	13.10	0.00	0.00	44705.	11426.
3.654	4.000	4.101	0.0257	15.06	0.01	0.00	35101.	856.74
3.665	6.000	6.006	0.0850	17.00	0.02	0.00	32573.	678.64
3.654	8.000	7.907	0.0382	18.87	0.02	0.00	30649.	355.37
3.661	10.00	9.670	0.0911	20.65	0.03	0.00	27517.	446.95
1.625	2.000	2.194	0.0304	7.069	0.01	0.00	25108.	6426.2
1.637	4.000	4.101	0.0408	9.011	0.02	0.00	21805.	313.90
1.633	6.000	6.006	0.0676	10.91	0.02	0.00	23050.	334.67
1.644	8.000	7.863	0.1352	12.80	0.03	0.00	23819.	577.13
1.636	10.00	9.730	0.0555	14.64	0.04	0.00	24209.	341.47

Project Name: Grandview Access Road	Location:	Project Number: R-019-2025
Boring Number: B-19	Tester: M. Bolton	Checker: J. Folsom
	Test Date: 12/01/25	Depth: 1.0 - 36.0
	Preparation: Remold	
Description: GRAVELLY LEAN CLAY (visual-manual)		
Remarks: Remolded to 122.3 pcf at 7.1% MC (approximately 95% of MDD near optimum).		

RM TEST

Summary Data

$Mr = 585.72 * Pa * (B/Pa)^{0.362} * (Sd/Pa)^{-0.604}$ r = 0.93557



	Project Name: Grandview Access Road	Location:	Project Number: R-019-2025
	Boring Number: B-03	Tester: J. LaMothe	Checker: J. Folsom
		Test Date: 11/21/25	Depth: 1.0 - 3.7
		Preparation: Remold	
	Description: SILTY, CLAYEY SAND		
	Remarks: Remolded to 109.8 pcf at 12.3% MC (approximately 95% of MDD near optimum). 13% gravel, MPS 3/4", 45% sand.		

RM TEST

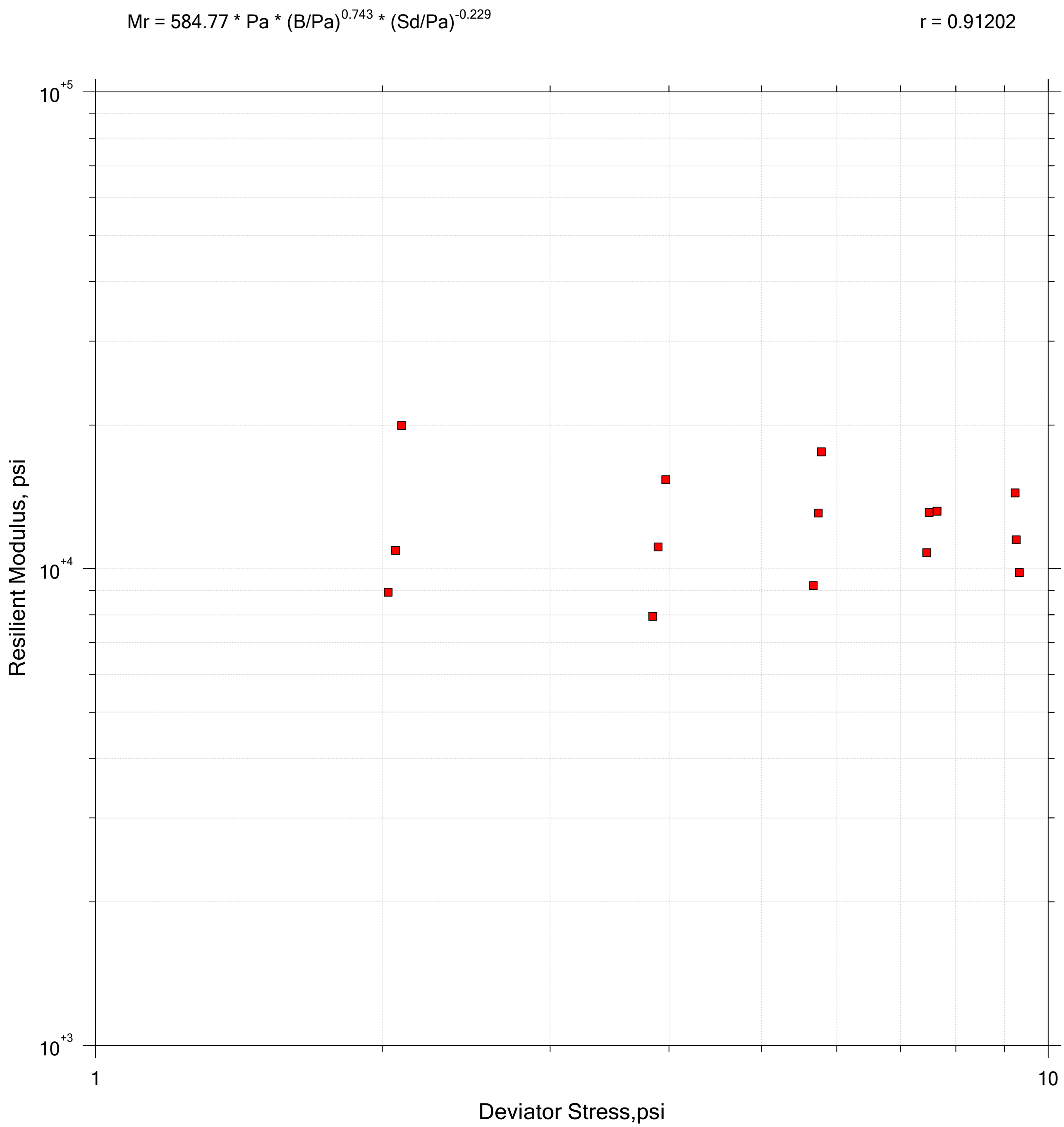
Summary Data

Confining Stress S3 psi	Nom. Max. Deviator Stress psi	Mean Deviator Stress psi	Std. Dev. Deviator Stress psi	Mean Bulk Stress psi	Mean Resilient Strain %	Std. Dev. Resilient Strain %	Mean Resilient Modulus psi	Std. Dev. Resilient Modulus psi
5.959	2.000	2.148	0.0496	20.03	0.01	0.00	27381.	4022.9
5.955	4.000	3.978	0.0608	21.84	0.02	0.00	18576.	497.49
5.962	6.000	5.836	0.0850	23.72	0.03	0.00	20222.	382.83
5.957	8.000	7.656	0.1192	25.53	0.04	0.00	15971.	300.34
5.967	10.00	9.508	0.0324	27.41	0.06	0.00	14574.	46.167
3.952	2.000	2.135	0.0206	13.99	0.01	0.00	33911.	4772.4
3.944	4.000	3.944	0.0676	15.78	0.02	0.00	21770.	1078.7
3.936	6.000	5.851	0.0337	17.66	0.03	0.00	16042.	161.97
3.951	8.000	7.552	0.0937	19.40	0.05	0.00	12784.	144.11
3.925	10.00	9.394	0.0779	21.17	0.07	0.00	12236.	405.83
1.947	2.000	2.138	0.0193	7.981	0.01	0.00	19034.	741.46
1.943	4.000	3.998	0.0226	9.827	0.02	0.00	16974.	224.84
1.936	6.000	5.801	0.0642	11.61	0.03	0.00	15243.	116.29
1.952	8.000	7.559	0.0541	13.41	0.06	0.00	12007.	334.72
1.952	10.00	9.402	0.0585	15.26	0.08	0.00	11133.	103.82

Project Name: Grandview Access Road	Location:	Project Number: R-019-2025
Boring Number: B-03	Tester: J. LaMothe	Checker: J. Folsom
	Test Date: 11/21/25	Depth: 1.0 - 3.7
:	Preparation: Remold	
Description: SILTY, CLAYEY SAND		
Remarks: Remolded to 109.8 pcf at 12.3% MC (approximately 95% of MDD near optimum). 13% gravel, MPS 3/4", 45% sand.		

RM TEST

Summary Data



	Project Name: Grandview Access Road	Location:	Project Number: R-019-2025
	Boring Number: B-06	Tester: J. LaMothe	Checker: J. Folsom
		Test Date: 11/21/25	Depth: 1.0 - 9.0
		Preparation: Remold	
	Description: SILTY GRAVEL (visual-manual)		
	Remarks: Remolded to 123.4 pcf at 9.0% MC (approximately 95% of MDD near optimum).		

RM TEST

Summary Data

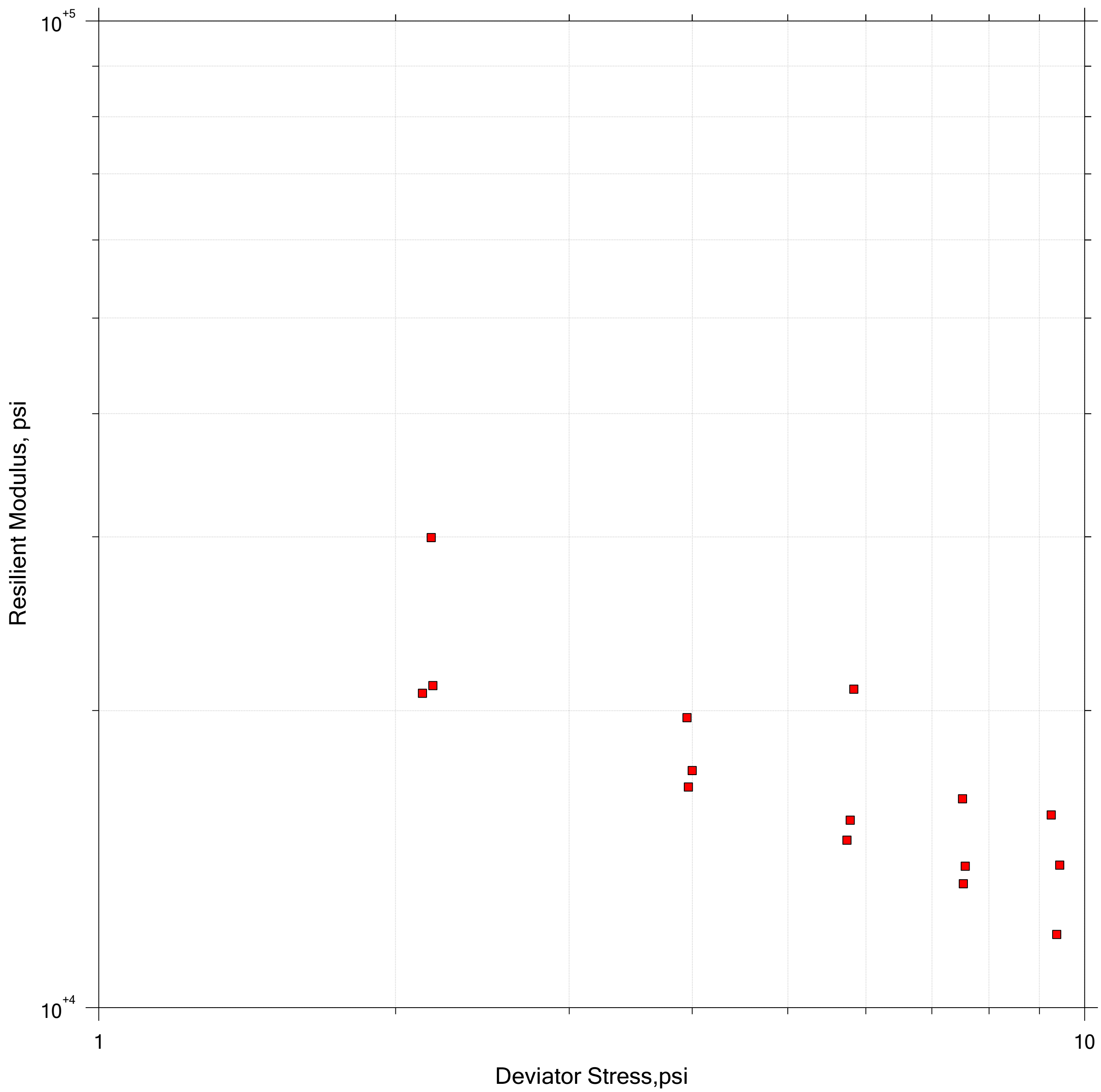
Confining Stress S3 psi	Nom. Max. Deviator Stress psi	Mean Deviator Stress psi	Std. Dev. Deviator Stress psi	Mean Bulk Stress psi	Mean Resilient Strain %	Std. Dev. Resilient Strain %	Mean Resilient Modulus psi	Std. Dev. Resilient Modulus psi
5.991	2.000	2.096	0.0211	20.07	0.01	0.00	19950.	4414.3
6.000	4.000	3.969	0.0361	21.97	0.02	0.00	15362.	167.38
5.974	6.000	5.782	0.0440	23.70	0.03	0.00	17576.	411.20
5.997	8.000	7.647	0.0553	25.64	0.05	0.00	13200.	99.312
6.004	10.00	9.235	0.1498	27.25	0.06	0.00	14419.	245.21
3.987	2.000	2.066	0.0144	14.03	0.02	0.00	10918.	2138.6
3.981	4.000	3.895	0.0438	15.84	0.03	0.00	11111.	343.95
3.990	6.000	5.739	0.0328	17.71	0.04	0.00	13080.	96.651
3.995	8.000	7.499	0.0684	19.48	0.05	0.00	13115.	123.63
3.988	10.00	9.257	0.1626	21.22	0.07	0.00	11499.	380.01
1.984	2.000	2.028	0.0157	7.979	0.02	0.00	8925.5	219.37
1.971	4.000	3.845	0.0359	9.757	0.04	0.00	7944.8	92.009
1.988	6.000	5.667	0.0464	11.63	0.06	0.00	9216.5	625.62
1.985	8.000	7.459	0.0775	13.41	0.06	0.01	10796.	961.13
1.991	10.00	9.328	0.0586	15.30	0.09	0.00	9805.1	162.95

Project Name: Grandview Access Road	Location:	Project Number: R-019-2025
Boring Number: B-06	Tester: J. LaMothe	Checker: J. Folsom
:	Test Date: 11/21/25	Depth: 1.0 - 9.0
	Preparation: Remold	
Description: SILTY GRAVEL (visual-manual)		
Remarks: Remolded to 123.4 pcf at 9.0% MC (approximately 95% of MDD near optimum).		

RM TEST

Summary Data

$Mr = 705.98 * Pa * (B/Pa)^{0.236} * (Sd/Pa)^{-0.439}$ r = 0.88509



	Project Name: Grandview Access Road	Location:	Project Number: R-019-2025
	Boring Number: B-09	Tester: M. Bolton	Checker: J. Folsom
		Test Date: 11/21/25	Depth: 1.0 - 32.4
		Preparation: Remold	
	Description: CLAYEY GRAVEL (visual-manual)		
	Remarks: Remolded to 115.9 pcf at 11.8% MC (approximately 95% of MDD near optimum).		

RM TEST

Summary Data

Confining Stress S3 psi	Nom. Max. Deviator Stress psi	Mean Deviator Stress psi	Std. Dev. Deviator Stress psi	Mean Bulk Stress psi	Mean Resilient Strain %	Std. Dev. Resilient Strain %	Mean Resilient Modulus psi	Std. Dev. Resilient Modulus psi
5.975	2.000	2.182	0.0347	20.11	0.01	0.00	21198.	3010.5
5.987	4.000	3.999	0.0354	21.96	0.02	0.00	17388.	254.95
5.993	6.000	5.834	0.0570	23.81	0.03	0.00	21029.	518.94
5.976	8.000	7.518	0.1163	25.45	0.04	0.00	16284.	134.69
5.990	10.00	9.252	0.0910	27.22	0.05	0.01	15680.	1712.0
3.971	2.000	2.174	0.0611	14.09	0.01	0.00	29945.	6262.2
3.974	4.000	3.951	0.0778	15.87	0.02	0.00	19675.	552.71
3.985	6.000	5.785	0.0580	17.74	0.03	0.00	15486.	255.91
3.980	8.000	7.567	0.0622	19.51	0.05	0.00	13908.	223.44
3.959	10.00	9.439	0.0289	21.31	0.06	0.00	13940.	85.586
1.966	2.000	2.130	0.0478	8.027	0.01	0.00	20827.	1744.1
1.954	4.000	3.962	0.0581	9.824	0.02	0.00	16731.	674.04
1.966	6.000	5.739	0.0690	11.64	0.04	0.00	14781.	216.33
1.970	8.000	7.535	0.1130	13.44	0.05	0.00	13354.	1524.7
1.960	10.00	9.373	0.0914	15.25	0.07	0.00	11859.	139.45

Project Name: Grandview Access Road	Location:	Project Number: R-019-2025
Boring Number: B-09	Tester: M. Bolton	Checker: J. Folsom
	Test Date: 11/21/25	Depth: 1.0 - 32.4
	Preparation: Remold	
Description: CLAYEY GRAVEL (visual-manual)		
Remarks: Remolded to 115.9 pcf at 11.8% MC (approximately 95% of MDD near optimum).		

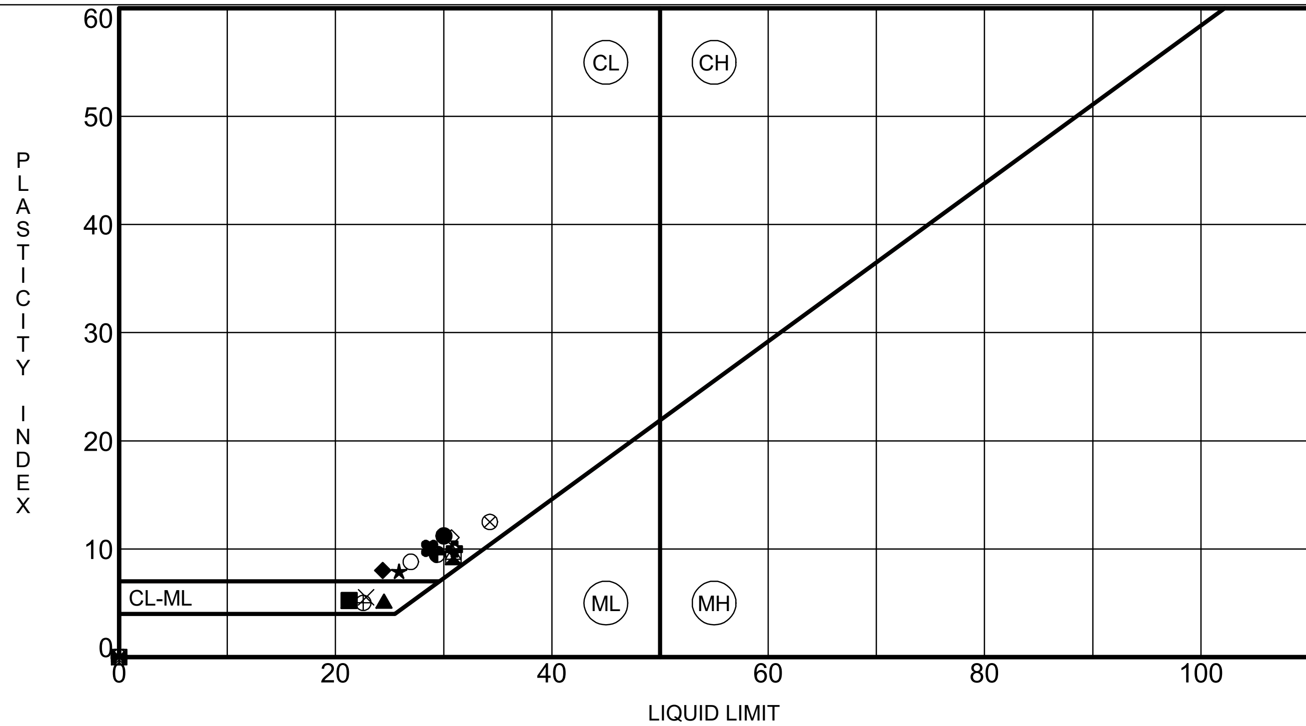
Logo

CTL Engineering of KY, Inc

ATTERBERG LIMITS' RESULTS

CLIENT ______ PROJECT NAME ______

PROJECT NUMBER ______ PROJECT LOCATION ______



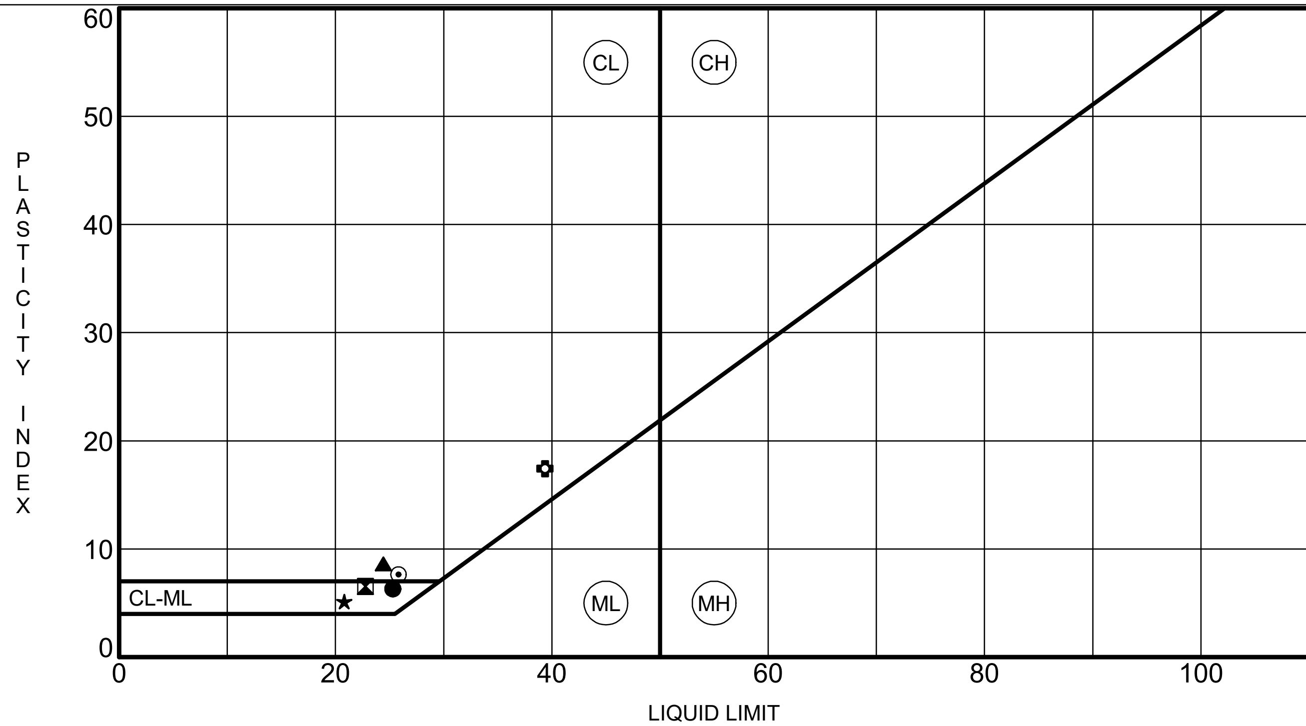
	Specimen Identification		LL	PL	PI	Fines	Classification
●	B-1	7.0	30	19	11	20	CLAYEY GRAVEL with SAND(GC)
⧗	B-2	14.0	31	22	9	43	CLAYEY SAND with GRAVEL(SC)
▲	B-3	0.0	24	19	5	42	SILTY, CLAYEY SAND(SC-SM)
★	B-5	2.0	26	18	8	39	CLAYEY SAND with GRAVEL(SC)
⊙	B-6	4.5	NP	NP	NP	20	SILTY GRAVEL with SAND(GM)
✿	B-7	7.0	31	21	10	15	CLAYEY GRAVEL with SAND(GC)
○	B-8	24.5	27	18	9	18	CLAYEY GRAVEL with SAND(GC)
△	B-9	2.5	31	21	10	33	CLAYEY SAND with GRAVEL(SC)
⊗	B-10	9.5	34	22	12	39	CLAYEY SAND with GRAVEL(SC)
⊕	B-12	19.5	23	18	5	31	SILTY, CLAYEY SAND(SC-SM)
□	B-13	19.0	NP	NP	NP	17	SILTY GRAVEL with SAND(GM)
⊛	B-14	5.0	NP	NP	NP	23	SILTY SAND with GRAVEL(SM)
◕	B-15	4.5	29	20	9	32	CLAYEY GRAVEL with SAND(GC)
☆	B-15	24.5	NP	NP	NP	21	SILTY GRAVEL with SAND(GM)
✣	B-16	21.0	NP	NP	NP	16	SILTY SAND with GRAVEL(SM)
■	B-17	19.5	21	16	5	21	SILTY, CLAYEY SAND with GRAVEL(SC-SM)
◆	B-18	9.5	24	16	8	19	CLAYEY GRAVEL with SAND(GC)
◇	B-18	39.5	31	20	11	40	CLAYEY SAND with GRAVEL(SC)
×	B-19	4.5	23	17	6	20	SILTY, CLAYEY GRAVEL with SAND(GC-GM)
✖	B-19	34.5	29	19	10	31	CLAYEY SAND with GRAVEL(SC)

ATTERBERG LIMITS' RESULTS

Logo CTL Engineering of KY, Inc

CLIENT ______ **PROJECT NAME** ______

PROJECT NUMBER ______ **PROJECT LOCATION** ______



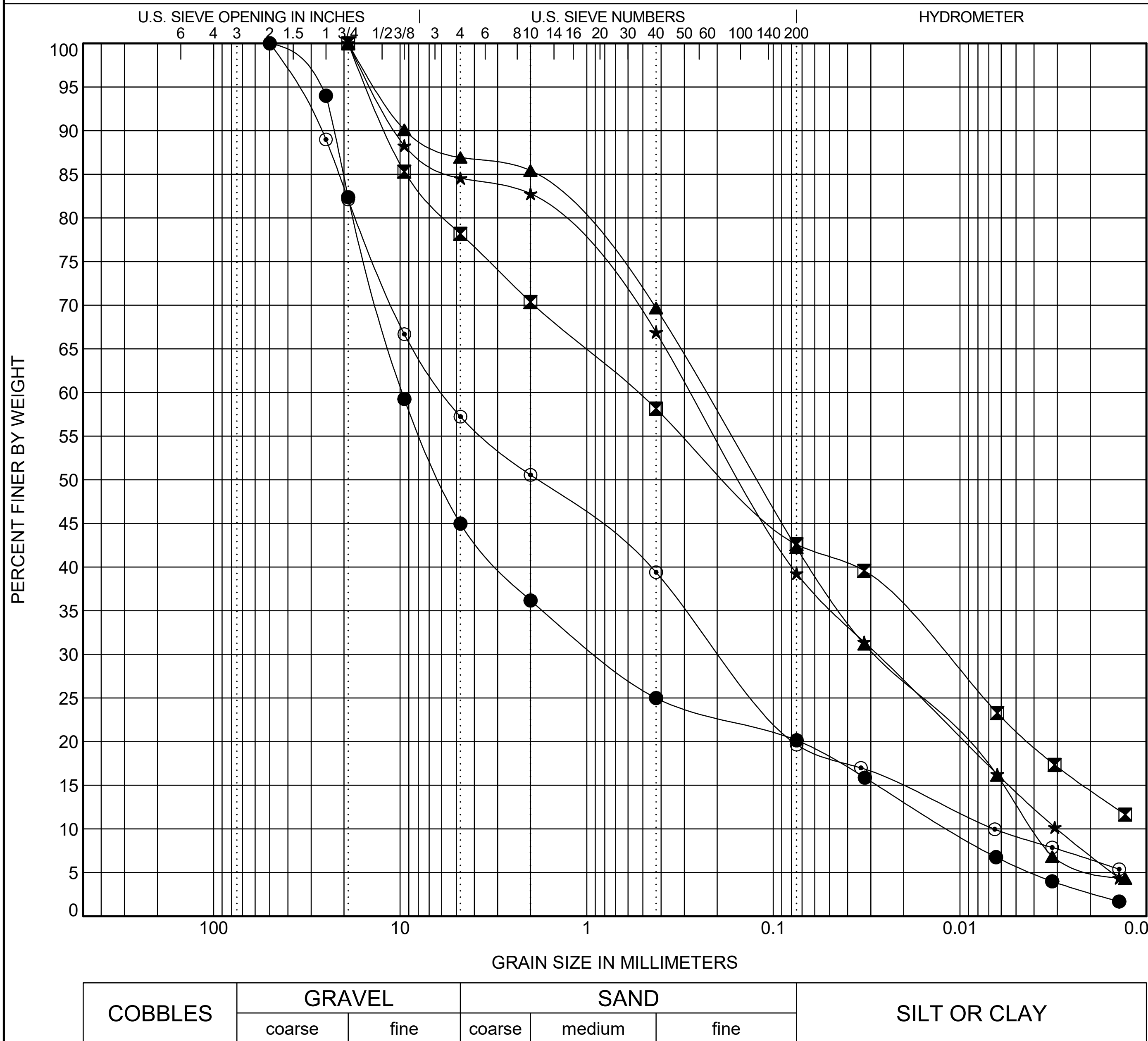
	Specimen Identification		LL	PL	PI	Fines	Classification
●	**B-21**	**2.5**	**25**	**19**	**6**	**17**	**SILTY, CLAYEY GRAVEL with SAND(GC-GM)**
⧗	**B-30**	**19.5**	**23**	**16**	**7**	**25**	**SILTY, CLAYEY GRAVEL with SAND(GC-GM)**
▲	**B-31**	**9.0**	**24**	**16**	**8**	**35**	**CLAYEY SAND with GRAVEL(SC)**
★	**B-33**	**4.5**	**21**	**16**	**5**	**18**	**SILTY, CLAYEY GRAVEL with SAND(GC-GM)**
⊙	**B-34**	**4.0**	**26**	**18**	**8**	**14**	**CLAYEY GRAVEL with SAND(GC)**
✿	**B-35**	**14.5**	**39**	**22**	**17**	**47**	**CLAYEY SAND with GRAVEL(SC)**

Logo CTL Engineering of KY, Inc

GRAIN SIZE DISTRIBUTION

CLIENT ____________ **PROJECT NAME** ____________

PROJECT NUMBER ____________ **PROJECT LOCATION** ____________



	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**B-1**	**7.0**	**CLAYEY GRAVEL with SAND(GC)**	**30**	**19**	**11**	**6.54**	**853.63**
⧗	**B-2**	**14.0**	**CLAYEY SAND with GRAVEL(SC)**	**31**	**22**	**9**		
▲	**B-3**	**0.0**	**SILTY, CLAYEY SAND(SC-SM)**	**24**	**19**	**5**	**0.88**	**57.18**
★	**B-5**	**2.0**	**CLAYEY SAND with GRAVEL(SC)**	**26**	**18**	**8**	**0.94**	**91.04**
⊙	**B-6**	**4.5**	**SILTY GRAVEL with SAND(GM)**	**NP**	**NP**	**NP**	**0.91**	**887.07**

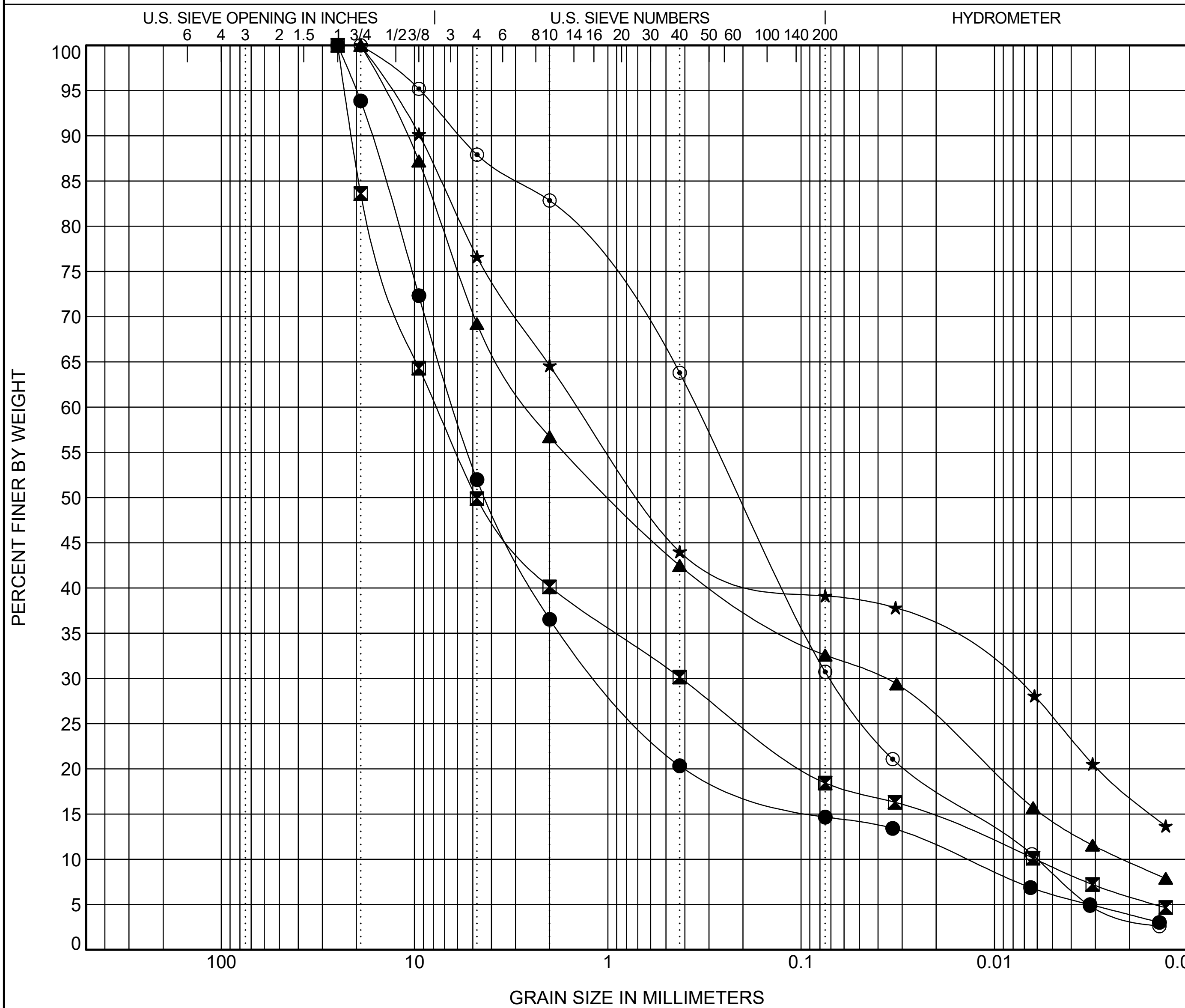
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-1**	**7.0**	**50**	**9.715**	**0.85**	**0.011**	**55.0**	**24.8**	**17.5**	**2.7**
⧗	**B-2**	**14.0**	**19**	**0.538**	**0.012**		**21.8**	**35.6**	**28.1**	**14.5**
▲	**B-3**	**0.0**	**19**	**0.231**	**0.029**	**0.004**	**13.1**	**44.7**	**36.7**	**5.5**
★	**B-5**	**2.0**	**19**	**0.276**	**0.028**	**0.003**	**15.5**	**45.3**	**32.3**	**7.0**
⊙	**B-6**	**4.5**	**50**	**5.82**	**0.186**	**0.007**	**42.8**	**37.6**	**13.2**	**6.4**

GRAIN SIZE DISTRIBUTION

Logo CTL Engineering of KY, Inc

CLIENT ______ PROJECT NAME ______

PROJECT NUMBER ______ PROJECT LOCATION ______



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-7	7.0	CLAYEY GRAVEL with SAND(GC)	31	21	10	12.90	438.51
⊠	B-8	24.5	CLAYEY GRAVEL with SAND(GC)	27	18	9	3.68	1264.90
▲	B-9	2.5	CLAYEY SAND with GRAVEL(SC)	31	21	10	0.26	1170.99
★	B-10	9.5	CLAYEY SAND with GRAVEL(SC)	34	22	12		
⊙	B-12	19.5	SILTY, CLAYEY SAND(SC-SM)	23	18	5	2.39	58.18

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-7	7.0	25	6.243	1.071	0.014	48.0	37.3	10.8	3.9
⊠	B-8	24.5	25	7.722	0.416	0.006	50.1	31.4	12.5	5.9
▲	B-9	2.5	19	2.508	0.038	0.002	30.8	36.7	22.9	9.7
★	B-10	9.5	19	1.415	0.009		23.4	37.5	22.0	17.1
⊙	B-12	19.5	19	0.348	0.071	0.006	12.1	57.2	27.2	3.6

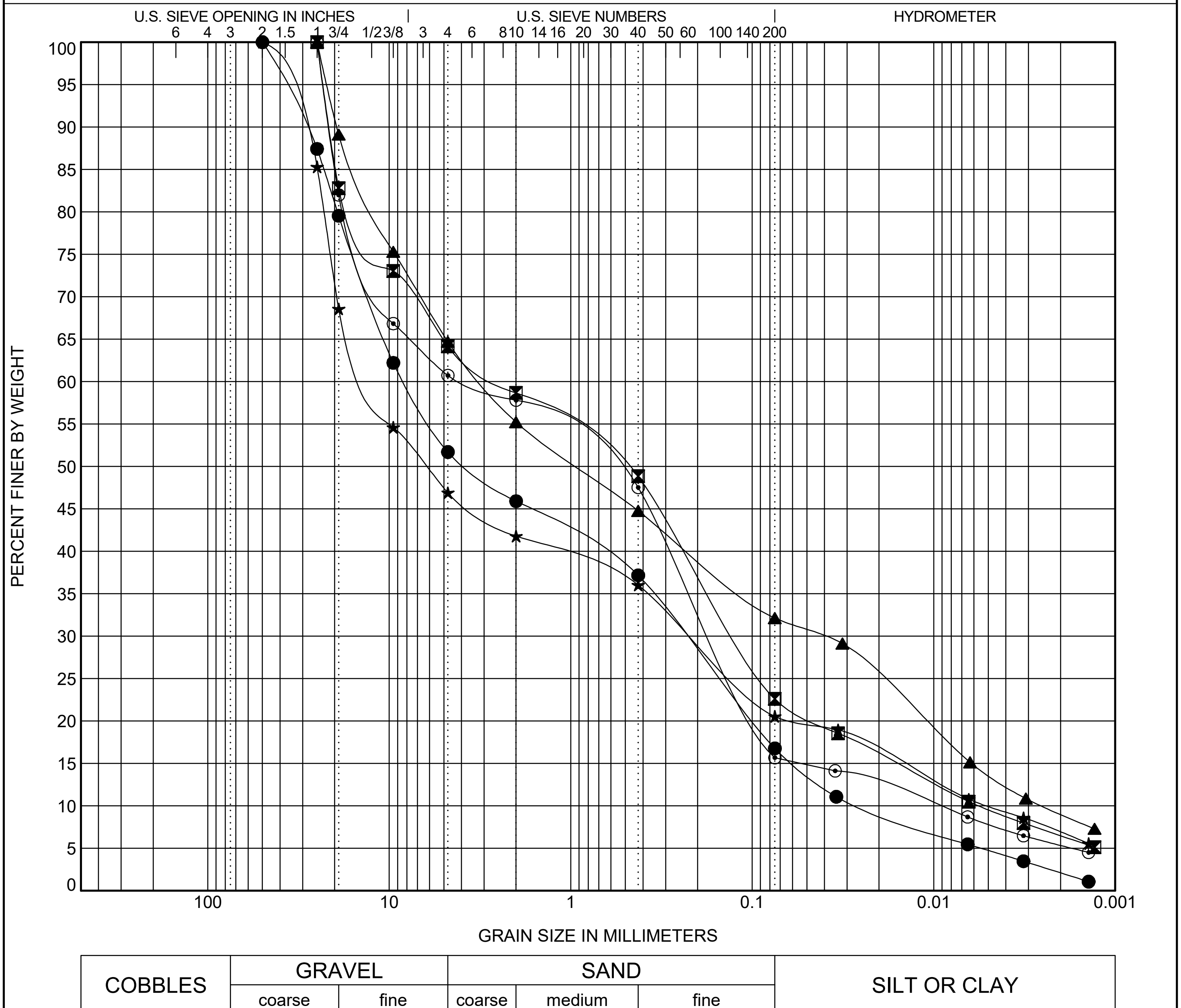
Logo

CTL Engineering of KY, Inc

GRAIN SIZE DISTRIBUTION

CLIENT ______ PROJECT NAME ______

PROJECT NUMBER ______ PROJECT LOCATION ______



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-13	19.0	**SILTY GRAVEL with SAND(GM)**	NP	NP	NP	0.26	327.57
⧗	B-14	5.0	**SILTY SAND with GRAVEL(SM)**	NP	NP	NP	1.09	442.54
▲	B-15	4.5	**CLAYEY GRAVEL with SAND(GC)**	29	20	9	0.21	1229.64
★	B-15	24.5	**SILTY GRAVEL with SAND(GM)**	NP	NP	NP	0.75	2482.71
⊙	B-16	21.0	**SILTY SAND with GRAVEL(SM)**	NP	NP	NP	0.72	393.36

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-13	19.0	50	8.214	0.231	0.025	48.3	34.9	14.7	2.1
⧗	B-14	5.0	25	2.47	0.122	0.006	35.8	41.6	16.1	6.5
▲	B-15	4.5	25	3.095	0.041	0.003	35.3	32.6	23.1	9.1
★	B-15	24.5	50	12.42	0.216	0.005	53.1	26.4	13.7	6.9
⊙	B-16	21.0	25	3.839	0.164	0.01	39.3	45.0	10.3	5.4

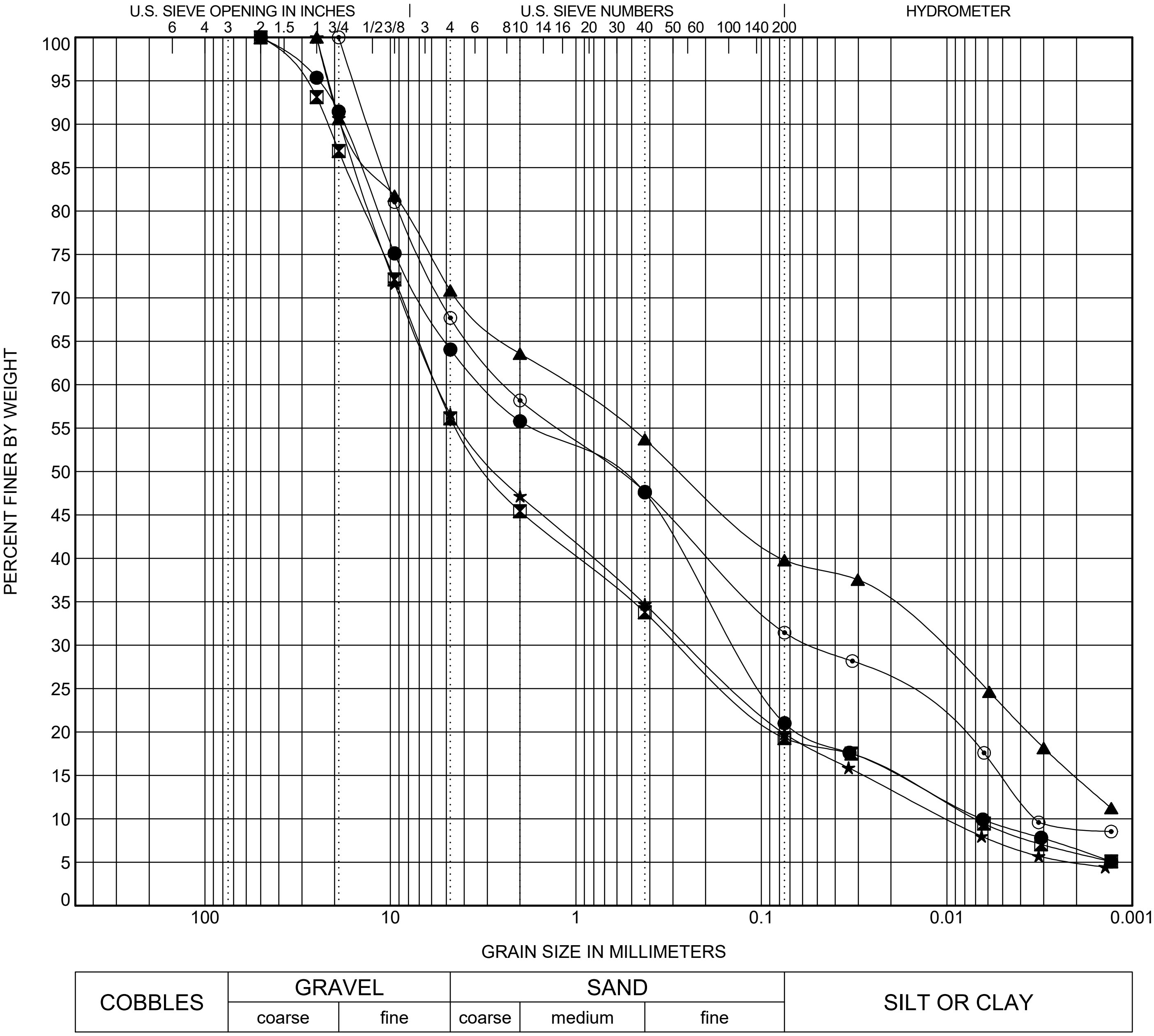
GRAIN SIZE R-019-2025.GPJ GINT US LAB.GDT 1/7/26

GRAIN SIZE DISTRIBUTION

CTL Engineering of KY, Inc

CLIENT ______________________ **PROJECT NAME** ______________________

PROJECT NUMBER ______________________ **PROJECT LOCATION** ______________________



	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**B-17**	**19.5**	**SILTY, CLAYEY SAND with GRAVEL(SC-SM)**	**21**	**16**	**5**	**0.90**	**477.24**
⧗	**B-18**	**9.5**	**CLAYEY GRAVEL with SAND(GC)**	**24**	**16**	**8**	**1.84**	**796.80**
▲	**B-18**	**39.5**	**CLAYEY SAND with GRAVEL(SC)**	**31**	**20**	**11**		
★	**B-19**	**4.5**	**SILTY, CLAYEY GRAVEL with SAND(GC-GM)**	**23**	**17**	**6**	**1.10**	**561.10**
⊙	**B-19**	**34.5**	**CLAYEY SAND with GRAVEL(SC)**	**29**	**19**	**10**	**0.34**	**711.78**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-17**	**19.5**	**50**	**3.108**	**0.135**	**0.007**	**35.9**	**43.0**	**14.6**	**6.4**
⧗	**B-18**	**9.5**	**50**	**5.618**	**0.27**	**0.007**	**43.9**	**36.8**	**13.2**	**6.1**
▲	**B-18**	**39.5**	**25**	**1.141**	**0.012**		**29.2**	**31.1**	**25.0**	**14.8**
★	**B-19**	**4.5**	**25**	**5.55**	**0.246**	**0.01**	**43.4**	**36.8**	**14.8**	**5.0**
⊙	**B-19**	**34.5**	**19**	**2.359**	**0.052**	**0.003**	**32.3**	**36.3**	**22.4**	**9.0**

GRAIN SIZE R-019-2025.GPJ GINT US LAB.GDT 1/7/26

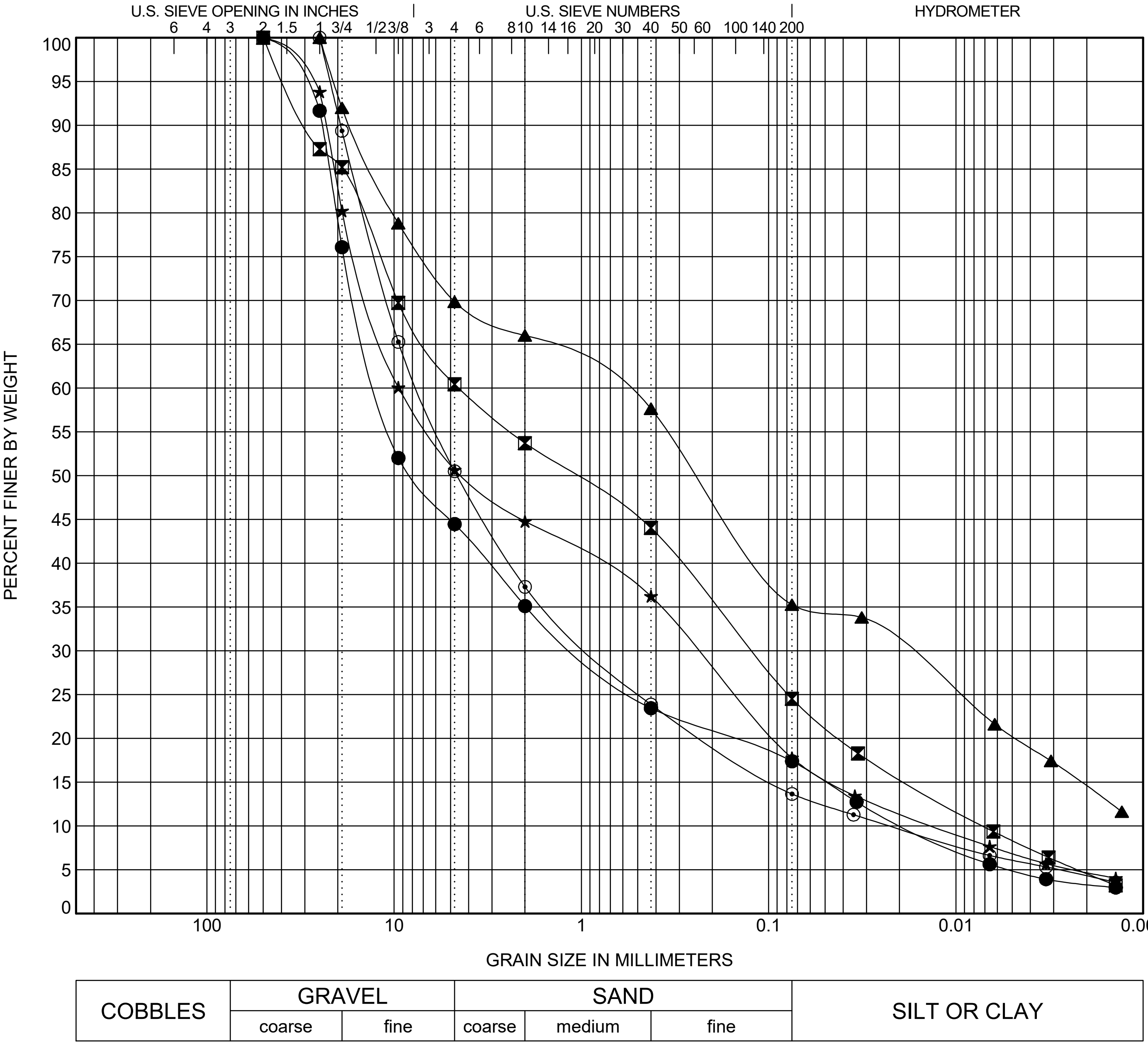
Logo

CTL Engineering of KY, Inc

GRAIN SIZE DISTRIBUTION

CLIENT ______ PROJECT NAME ______

PROJECT NUMBER ______ PROJECT LOCATION ______



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-21	2.5	**SILTY, CLAYEY GRAVEL with SAND(GC-GM)**	25	19	6	4.79	663.67
⧗	B-30	19.5	**SILTY, CLAYEY GRAVEL with SAND(GC-GM)**	23	16	7	0.47	632.94
▲	B-31	9.0	**CLAYEY SAND with GRAVEL(SC)**	24	16	8		
★	B-33	4.5	**SILTY, CLAYEY GRAVEL with SAND(GC-GM)**	21	16	5	0.46	732.25
⊙	B-34	4.0	**CLAYEY GRAVEL with SAND(GC)**	26	18	8	4.51	334.18

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-21	2.5	50	11.957	1.016	0.018	55.5	27.1	14.0	3.4
⧗	B-30	19.5	50	4.5	0.122	0.007	39.6	35.9	19.9	4.6
▲	B-31	9.0	25	0.658	0.019		30.2	34.6	20.8	14.5
★	B-33	4.5	50	9.451	0.237	0.013	49.3	32.9	13.1	4.7
⊙	B-34	4.0	25	7.422	0.862	0.022	49.5	36.8	9.4	4.3

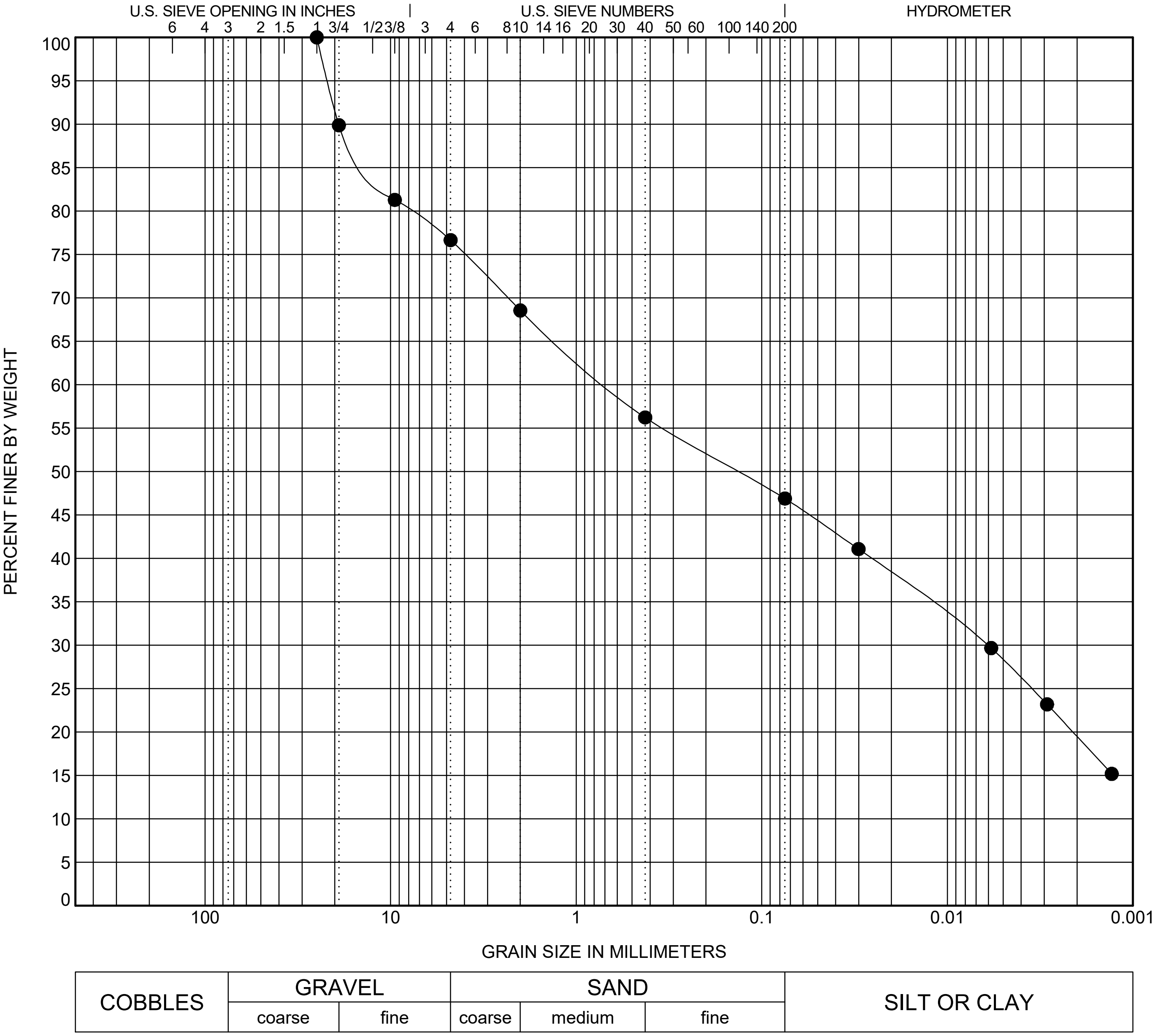
GRAIN SIZE R-019-2025.GPJ GINT US LAB.GDT 1/7/26

GRAIN SIZE DISTRIBUTION

Logo CTL Engineering of KY, Inc

CLIENT ____ **PROJECT NAME** ____

PROJECT NUMBER ____ **PROJECT LOCATION** ____



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**B-35**	**14.5**	**CLAYEY SAND with GRAVEL(SC)**	**39**	**22**	**17**		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-35**	**14.5**	**25**	**0.683**	**0.006**		**23.3**	**29.8**	**27.4**	**19.5**

Form No: TR-D2974
Revision No. 2
Revision Date: 03/7/2023

MOISTURE, ASH, AND ORGANIC MATTER

AASHTO T267

Method A ☑ *Method B* ☐

S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

Project #:	R-019-2025	Report Date:	12/15/25
Project Name:	Grandview Access Road	Test Date(s):	11/25/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065		

Boring No.:	B-2	Sample No.:	5	Sample Date:	10/13-10/20/25
				Depth (ft):	14.0 - 15.5

Sample Description: CLAYEY SAND WITH GRAVEL (SC), gray

Equipment Used:

Balance:	S&ME ID#: 32676	Readability:	0.01-g	Calibration Date:	01/14/25
Oven:	S&ME ID#: 24438			Calibration Date:	10/20/25
Muffle Furnace:	S&ME ID#: 24239			Calibration Date:	01/14/25

Moisture Content Determination

Oven Temperature	**105-115 °C**	*Tare #*	TIN
t	Tare Weight *(Dish plus Cover)*	*grams*	288.21
a	Mass of ***As-Received*** Specimen + Tare Wt.		558.49
b	Mass of Oven Dry Specimen + Tare Wt.	*grams*	522.44
w	Water Weight	*(a-b)*	36.05
A	Mass of As-Received Specimen	*(a-t)*	270.28
B	Mass of Oven Dry Specimen	*(b-t)*	234.23
% Moisture Content as a % of As Received or Total Mass		*(w/A)*100*	**13.3%**
% Moisture Content as a % of Oven-dried Mass		*(w/B)*100*	**15.4%**

Method A (440°C) or B (750°C): Ash Content and Organic Matter Determination

Furnace Temperature:	***454*** **°C** *(at test)*	*Tare #*	CERAMIC
t	Tare Weight *(Dish plus Cover)*	*grams*	86.73
b	Mass of Oven Dry Specimen + Tare Wt.	*grams*	133.65
c	Ash Weight + Tare Wt.	*grams*	132.69
C	Ash Weight	*c-t*	45.96
B	Mass of Oven Dry Specimen	*(b-t)*	46.92
D	***% Ash Content***	*(C/B)*100*	**98.0%**
	% Organic Matter	*100-D*	**2.0%**
	Duration of Specimen in Furnace	*minutes*	420

Notes / Deviations / References:

Jacob Folsom	[signature]	Laboratory Services Manager	12/16/25
Technical Responsibility	*Signature*	*Position*	*Date*

MOISTURE, ASH, AND ORGANIC MATTER

AASHTO T267

Method A ☑ *Method B* ☐

S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

Project #:	R-019-2025	Report Date:	12/15/25
Project Name:	Grandview Access Road	Test Date(s):	11/25/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065		

Boring No.:	B-18	Sample No.:	10	Sample Date:	10/13-10/20/25
				Depth (ft):	39.5 - 41.0

Sample Description: CLAYEY SAND WITH GRAVEL (SC), gray

Equipment Used:

Balance:	S&ME ID#:	32676	Readability:	0.01-g	Calibration Date:	01/14/25
Oven:	S&ME ID#:	24438			Calibration Date:	10/20/25
Muffle Furnace:	S&ME ID#:	24239			Calibration Date:	01/14/25

Moisture Content Determination

	Oven Temperature **105-115 °C**	*Tare #*	TIN
t	Tare Weight *(Dish plus Cover)*	*grams*	23.49
a	Mass of ***As-Received*** Specimen + Tare Wt.		362.49
b	Mass of Oven Dry Specimen + Tare Wt.	*grams*	323.67
w	Water Weight	*(a-b)*	38.82
A	Mass of As-Received Specimen	*(a-t)*	339.00
B	Mass of Oven Dry Specimen	*(b-t)*	300.18
% Moisture Content as a % of As Received or Total Mass		*(w/A)*100*	**11.5%**
% Moisture Content as a % of Oven-dried Mass		*(w/B)*100*	**12.9%**

Method A (440°C) or B (750°C): Ash Content and Organic Matter Determination

	Furnace Temperature: ***454*** **°C** *(at test)*	*Tare #*	CERAMIC
t	Tare Weight *(Dish plus Cover)*	*grams*	81.51
b	Mass of Oven Dry Specimen + Tare Wt.	*grams*	120.21
c	Ash Weight + Tare Wt.	*grams*	119.05
C	Ash Weight	*c-t*	37.54
B	Mass of Oven Dry Specimen	*(b-t)*	38.70
D	***% Ash Content***	*(C/B)*100*	**97.0%**
	% Organic Matter	*100-D*	**3.0%**
	Duration of Specimen in Furnace	*minutes*	420

Notes / Deviations / References:

Jacob Folsom	Jacob Folsom (signature)	Laboratory Services Manager	12/16/25
Technical Responsibility	*Signature*	*Position*	*Date*

Form No: TR-D2974
Revision No. 2
Revision Date: 03/7/2023

MOISTURE, ASH, AND ORGANIC MATTER

AASHTO T267

Method A ☑ *Method B* ☐

S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

Project #:	R-019-2025	Report Date:	12/15/25
Project Name:	Grandview Access Road	Test Date(s):	12/02/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065		
Boring No.:	B-19 Sample No.: 2	Sample Date:	10/13-10/20/25
		Depth (ft):	4.5 - 6.0

Sample Description: SILTY, CLAYEY GRAVEL WITH SAND (GC-GM), dark gray

Equipment Used:

Balance:	S&ME ID#:	32723	Readability:	0.01-g	Calibration Date:	01/14/25
Oven:	S&ME ID#:	24438			Calibration Date:	10/20/25
Muffle Furnace:	S&ME ID#:	24239			Calibration Date:	01/14/25

Moisture Content Determination

Oven Temperature	**105-115 °C**	*Tare #*	TIN
t	Tare Weight *(Dish plus Cover)*	*grams*	25.73
a	Mass of ***As-Received*** Specimen + Tare Wt.		696.40
b	Mass of Oven Dry Specimen + Tare Wt.	*grams*	668.25
w	Water Weight	*(a-b)*	28.15
A	Mass of As-Received Specimen	*(a-t)*	670.67
B	Mass of Oven Dry Specimen	*(b-t)*	642.52
	% Moisture Content as a % of As Received or Total Mass	*(w/A)*100*	**4.2%**
	% Moisture Content as a % of Oven-dried Mass	*(w/B)*100*	**4.4%**

Method A (440°C) or B (750°C): Ash Content and Organic Matter Determination

Furnace Temperature:	***454*** **°C** *(at test)*	*Tare #*	CERAMIC
t	Tare Weight *(Dish plus Cover)*	*grams*	86.71
b	Mass of Oven Dry Specimen + Tare Wt.	*grams*	134.75
c	Ash Weight + Tare Wt.	*grams*	133.68
C	Ash Weight	*c-t*	46.97
B	Mass of Oven Dry Specimen	*(b-t)*	48.04
D	***% Ash Content***	*(C/B)*100*	**97.8%**
	% Organic Matter	*100-D*	**2.2%**
	Duration of Specimen in Furnace	*minutes*	480

Notes / Deviations / References:

Jacob Folsom	[signature]	Laboratory Services Manager	12/16/25
Technical Responsibility	*Signature*	*Position*	*Date*

Form No. 2370-LEX-SDI2CYCLE-R
Revision No. : 6 e12/16 KYMETHOD
Revision Date: 04/11/24

Slake Durability Index Test

KM 64-513, Jar Slake by KM-64-513

S&ME, Inc. - Lexington 2020 Liberty Road Lexington, KY 40505

Project No: R-019-2025 Project Name: Grandview Access Road Report Date: 12/15/25

Core ID	Description	**Slake Durability Index, %**	Desc. Of Fragments	Jar Slake	Natural Moisture Content, %	Before 1st Wash	After 2nd Wash
B-04 20.8 - 21.3 ft.	gray sandstone	**95.2%**	I	6	0.5%		
B-04 29.0 - 29.5 ft.	gray sandstone	**98.6%**	I	5	0.3%		
B-05 17.5 - 18.0 ft.	dark gray shale	**69.1%**	II	2	1.1%		
B-05 21.3 - 21.8 ft.	dark gray sandstone	**97.7%**	I	6	0.6%		

Water Temperature, °C: Minimum: 19 Maximum: 20 Average: 20

Notes:

Reviewed by: J. Folsom 12/16/25

Form No. 2370-LEX-SDI2CYCLE-R
Revision No. : 6 e12/16 KYMETHOD
Revision Date: 04/11/24

Slake Durability Index Test

KM 64-513, Jar Slake by KM-64-513

ASTM D4644, Jar Slake by KM-64-513

Project No: R-019-2025 Project Name: Grandview Access Road Report Date: 12/15/25

Core ID	Description	**Slake Durability Index, %**	Desc. Of Fragments	Jar Slake	Natural Moisture Content, %	Before 1st Wash	After 2nd Wash
B-11 6.8 - 7.3 ft.	gray sandstone	**97.9%**	I	5	0.7%		
B-30 35.6 - 36.1 ft.	gray sandstone	**97.7%**	I	6	0.4%		
B-30 87.0 - 87.8 ft.	dark gray shale	**92.1%**	II	5	0.9%		
B-30 100.0 - 100.5 ft.	light gray sandstone	**98.4%**	I	5	0.4%		

Water Temperature, °C: Minimum: 19 Maximum: 20 Average: 20

Notes:

Reviewed by: J. Folsom 12/16/25

Form No. 2370-LEX-SDI2CYCLE-R
Revision No. : 6 e12/16 KYMETHOD
Revision Date: 04/11/24

Slake Durability Index Test

KM 64-513, Jar Slake by KM-64-513

ASTM D4644, Jar Slake by KM-64-513

Project No: R-019-2025 Project Name: Grandview Access Road Report Date: 12/15/25

Core ID	Description	**Slake Durability Index, %**	Desc. Of Fragments	Jar Slake	Natural Moisture Content, %	Before 1st Wash	After 2nd Wash
B-33 23.1 - 23.7 ft.	light gray sandstone	**98.7%**	I	6	0.5%		

Water Temperature, °C: Minimum: 19 Maximum: 20 Average: 20

Notes:

Reviewed by: J. Folsom 12/16/25

Form No. TR-D7012C-01
Revision No. : 1LexD
Revision Date: 06/19/25

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

KM64-523

Quality Assurance

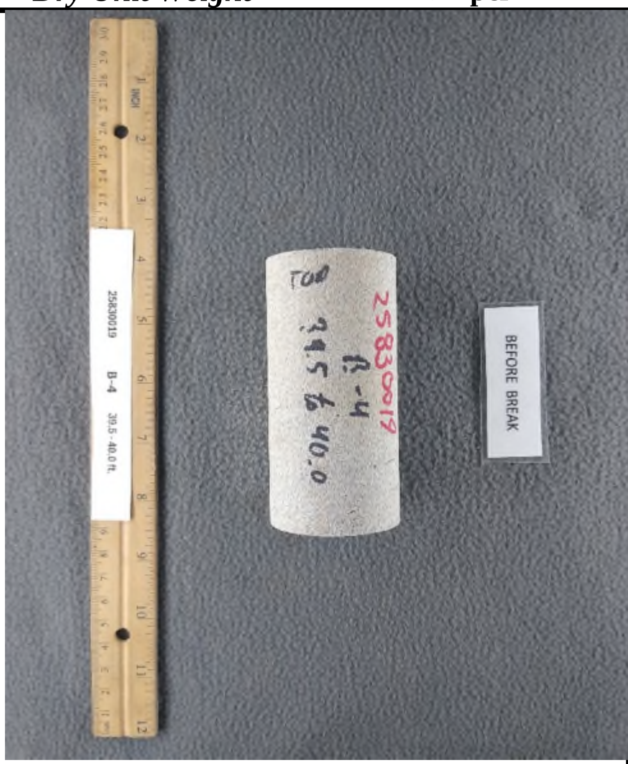
S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

Project No.:	R-019-2025	Report Date:	12/08/25
Project Name:	Grandview Access Road	Test Date(s):	12/05/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065	Received Date:	10/22/25
Location:	B-4	Depth, ft:	39.5 - 40.0
Sample Description:	Station 106+35,Offset 15, Elevation 1764 gray sandstone		

Angle of load relative to lithology: Approximately 20°

Test Results

Moisture Content	***0.1***	**%**	***Compressive Strength***	***2,054***	**ksf**
Dry Unit Weight	***153.7***	**pcf**		***14,263***	**psi**



Before Test

After Test

Strain rate: 0.015 in/min.

Notes / Deviations / References:

Jacob Folsom	________	Laboratory Services Manger	12/16/2025
Technical Responsibility	*Signature*	*Position*	*Date*

Form No. TR-D7012C-01
Revision No. : 1LexD
Revision Date: 06/19/25

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

KM64-523

Quality Assurance

S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

Project No.:	R-019-2025	Report Date:	12/08/25
Project Name:	Grandview Access Road	Test Date(s):	12/05/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065	Received Date:	10/22/25
Location:	B-30	Depth, ft:	41.0 - 41.5
Sample Description:	Station 105+60, Offset 205, Elevation 1836 gray sandstone		

Angle of load relative to lithology: Approximately 20°

Test Results

Moisture Content	***0.2***	**%**	***Compressive Strength***	***2,459***	**ksf**
Dry Unit Weight	***159.1***	**pcf**		***17,076***	**psi**

Before Test

After Test

Strain rate: 0.015 in/min.

Notes / Deviations / References:

Jacob Folsom	_________	Laboratory Services Manger	12/16/2025
Technical Responsibility	*Signature*	*Position*	*Date*

Form No. TR-D7012C-01
Revision No. 0
Devision Date: 06/25/15

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

ASTM D 7012 Method C

S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

Project Name: Grandview Access Road | Location: B-30 | Depth, feet: 41.0 - 41.5

Summary of Specimen Tolerances

Length/diameter target:	**MET**	Perpendicularity target:	**MET**
Side straightness target:	**MET**	Planeness target:	**MET**
Parallelism target:	**MET**		

*ASTM D4543-08 Standard Practice for Preparing Rock Core as Cylindrical Test Specimens and Verifying Conformance to Dimensional and Shape Tolerance, Section 1.2 - "Rock is a complex engineering material that can vary greatly as a function of lithology, stress history, weathering, moisture content, chemistry, and other natural geologic processes. As such, it is not always possible to obtain or prepare rock core specimens that satisfy the desirable tolerances given in this practice. Most commonly, this situation presents itself with weaker, more porous, and poorly cemented rock types and rock types containing significant or weak (or both) structural features. For these and other rock types which are difficult to prepare, all reasonable efforts shall be made to prepare a specimen in accordance with this practice and for the intended test procedure. However, when it has been determined by trial that this is not possible, the rock specimen will be prepared to the closest tolerance practicable and be considered the best effort and report it as such. If allowable or necessary for the intended test, capping the ends of the specimen as discussed in ASTM D7012 is permitted."

Length to Diameter Ratio

Length, inches: 3.98 Diameter, inches: 1.856

Ratio: 2.14 length to 1 diameter

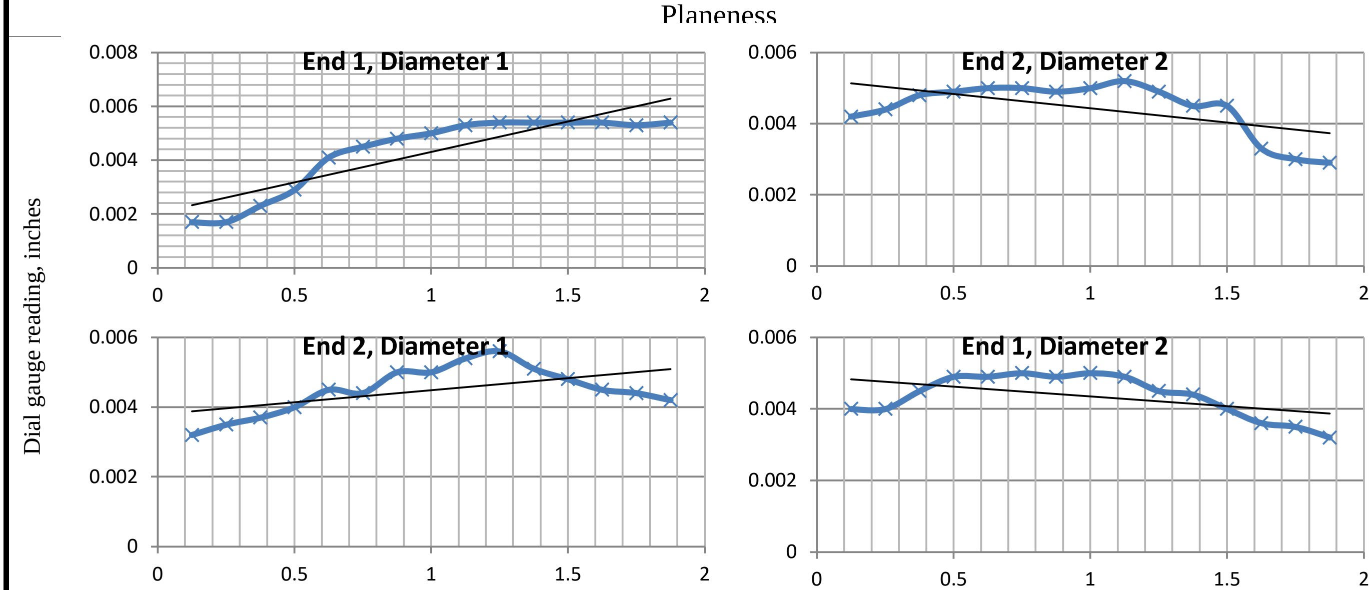
Target tolerance: L:D ratio between 2 to 1 and 2.5 to 1

Side Straightness

Maximum gap between side of core and reference plate, inches: < .02

Target tolerance: Maximum gap less than .02 inches

Planeness



Distance along diameter, inches

Maximum point-line deviation, inches: < .001

Target Tolerance: No individually measured point should deviate from the best fit line by more than .001 inches.

Parallelism

Slope difference, Diameter 1, degrees: 0.09

Slope difference, Diameter 2, degrees: 0.01

Target Tolerance: Difference between slopes on each end less than 0.25º

Perpendicularity

Maximum divergence from end surface perpendicularity to long axis: 0.10

Target Tolerance: Each diameter perpendicular to the long axis to within 0.25º

Note: specimens without straight sides cannot be machined to pass.

Test Information

Strain rate, in/min: 0.015

OR

Stress rate, lbs/sec:

Time to failure, min: 4.23

Temperature: room temperature

Form No. TR-D7012C-01
Revision No. : 1LexD
Revision Date: 06/19/25

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

KM64-523

Quality Assurance

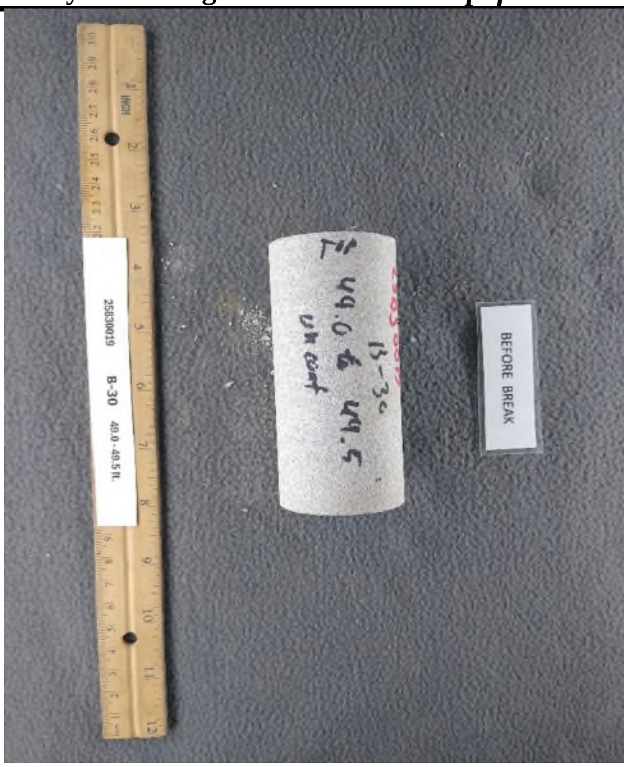
S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

Project No.:	R-019-2025	Report Date:	12/08/25
Project Name:	Grandview Access Road	Test Date(s):	12/05/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065	Received Date:	10/22/25
Location:	B-30	Depth, ft:	49.0 - 49.5
Sample Description:	Station 105+60, Offset 205, Elevation 1836		
	gray sandstone		

Angle of load relative to lithology: Approximately perpendicular

Test Results

Moisture Content	***0.1 %***	***Compressive Strength***	***1,994 ksf***
Dry Unit Weight	**154.1** ***pcf***		***13,850*** **psi**



Before Test

After Test

Strain rate: 0.015 in/min.

Notes / Deviations / References:

Jacob Folsom	________	Laboratory Services Manger	12/16/2025
Technical Responsibility	*Signature*	*Position*	*Date*

Form No. TR-D7012C-01
Revision No. : 1LexD
Revision Date: 06/19/25

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

KM64-523

Quality Assurance

S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

Project No.:	R-019-2025	Report Date:	12/08/25
Project Name:	Grandview Access Road	Test Date(s):	12/05/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065	Received Date:	10/22/25
Location:	B-30	Depth, ft:	63.8 - 64.3
Sample Description:	Station 105+60, Offset 205, Elevation 1836		
	gray sandstone		

Angle of load relative to lithology: Approximately 20°

Test Results

Moisture Content	***0.2***	%	***Compressive Strength***	***2,188***	ksf
Dry Unit Weight	***155.3***	pcf		***15,196***	psi

Before Test

After Test

Strain rate: 0.015 in/min.

Notes / Deviations / References:

Jacob Folsom	__________	Laboratory Services Manger	12/16/2025
Technical Responsibility	*Signature*	*Position*	*Date*

Form No. TR-D7012C-01
Revision No. : 1LexD
Revision Date: 06/19/25

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

KM64-523

Quality Assurance

S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

Project No.:	R-019-2025	Report Date:	12/08/25
Project Name:	Grandview Access Road	Test Date(s):	12/05/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065	Received Date:	10/22/25
Location:	B-30	Depth, ft:	73.0 - 73.5
Sample Description:	Station 105+60, Offset 205, Elevation 1836 light brown sandstone		

Angle of load relative to lithology: Approximately perpendicular

Test Results

Moisture Content	***0.3*** %	***Compressive Strength***	***1,345*** ksf
Dry Unit Weight	***147.9*** pcf		***9,338*** psi

Before Test

After Test

Strain rate: 0.015 in/min.

Notes / Deviations / References:

Jacob Folsom	________	Laboratory Services Manger	12/16/2025
Technical Responsibility	*Signature*	*Position*	*Date*

Form No. TR-D7012C-01
Revision No. : 1LexD
Revision Date: 06/19/25

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

KM64-523

Quality Assurance

S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

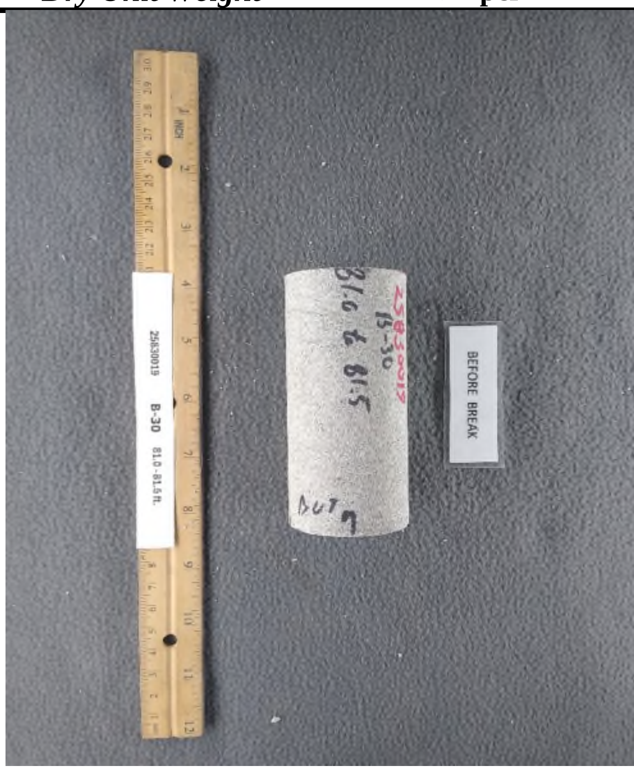
Project No.:	R-019-2025	Report Date:	12/09/25
Project Name:	Grandview Access Road	Test Date(s):	12/08/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065	Received Date:	10/22/25
Location:	B-30	Depth, ft:	81.0 - 81.5

Sample Description: Station 105+60, Offset 205, Elevation 1836
gray sandstone

Angle of load relative to lithology: Approximately perpendicular

Test Results

Moisture Content	***0.1*** %	***Compressive Strength***	***1,777*** ksf
Dry Unit Weight	***152.8*** pcf		***12,341*** psi



Before Test

After Test

Strain rate: 0.015 in/min.

Notes / Deviations / References:

Jacob Folsom	________	Laboratory Services Manger	12/16/2025
Technical Responsibility	*Signature*	*Position*	*Date*

Form No. TR-D7012C-01
Revision No. : 1LexD
Revision Date: 06/19/25

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

KM64-523

Quality Assurance

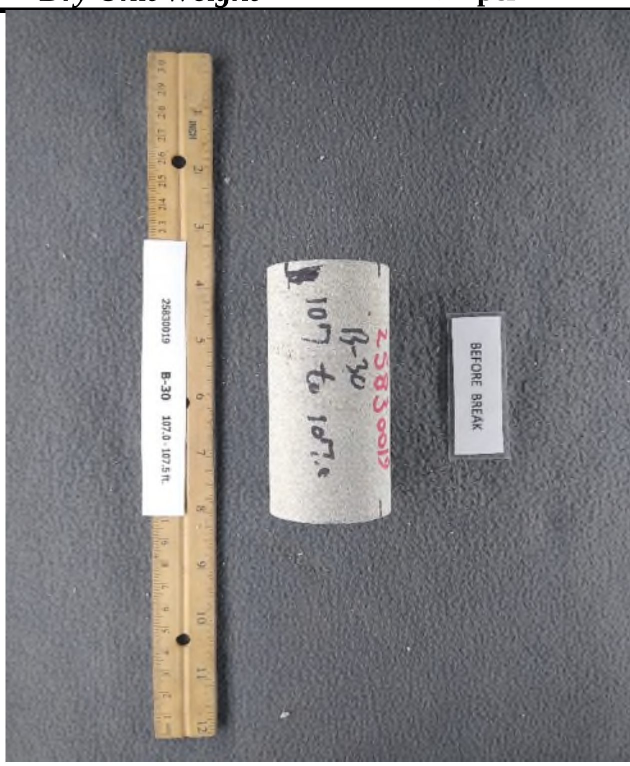
S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

Project No.:	R-019-2025	Report Date:	12/09/25
Project Name:	Grandview Access Road	Test Date(s):	12/08/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065	Received Date:	10/22/25
Location:	B-30	Depth, ft:	107.0 - 107.5
Sample Description:	Station 105+60, Offset 205, Elevation 1836 gray sandstone		

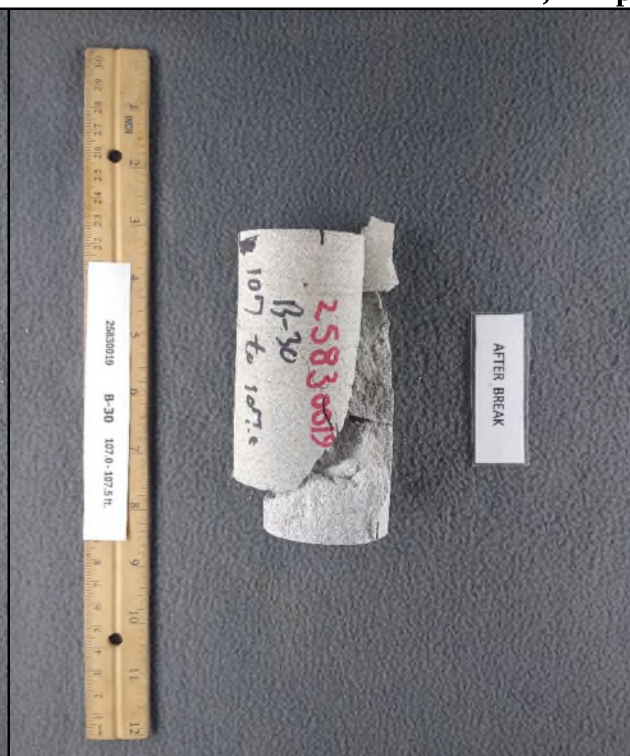
Angle of load relative to lithology: Approximately perpendicular

Test Results

Moisture Content	***0.1*** **%**	***Compressive Strength***	***1,986*** **ksf**
Dry Unit Weight	***154.9*** **pcf**		***13,790*** **psi**



Before Test



After Test

Strain rate: 0.015 in/min.

Notes / Deviations / References:

Jacob Folsom	__________	Laboratory Services Manger	12/16/2025
Technical Responsibility	*Signature*	*Position*	*Date*

Form No. TR-D7012C-01
Revision No. : 1LexD
Revision Date: 06/19/25

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

KM64-523

Quality Assurance

S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

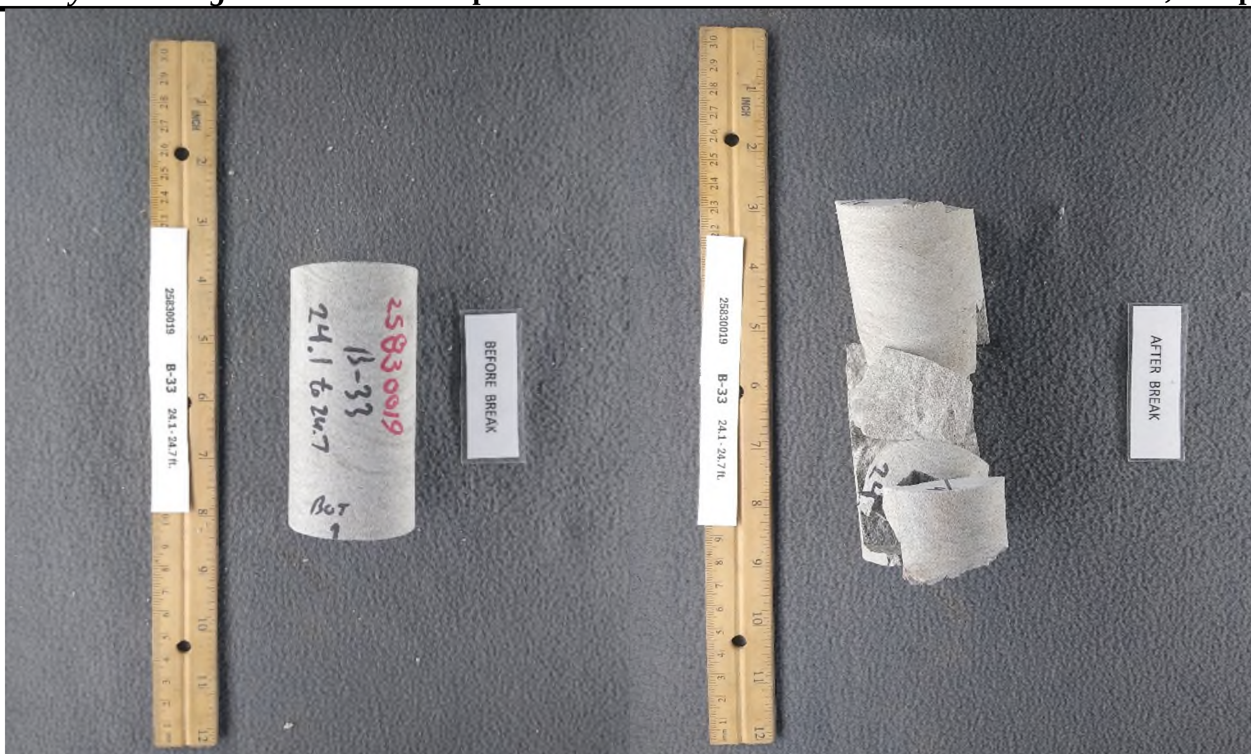
Project No.:	R-019-2025	Report Date:	12/09/25
Project Name:	Grandview Access Road	Test Date(s):	12/08/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065	Received Date:	10/22/25
Location:	B-33	Depth, ft:	24.1 - 24.7

Sample Description: Station 109+55, Offset 75, Elevation 1816
gray sandstone

Angle of load relative to lithology: Approximately perpendicular

Test Results

Moisture Content	***0.3*** **%**	***Compressive Strength***	***2,230*** **ksf**
Dry Unit Weight	***160.5*** **pcf**		***15,483*** **psi**



Before Test | **After Test**

Strain rate: 0.015 in/min.

Notes / Deviations / References:

Jacob Folsom	________	Laboratory Services Manger	12/16/2025
Technical Responsibility	*Signature*	*Position*	*Date*

Form No. TR-D7012C-01
Revision No. : 1LexD
Revision Date: 06/19/25

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

KM64-523

Quality Assurance

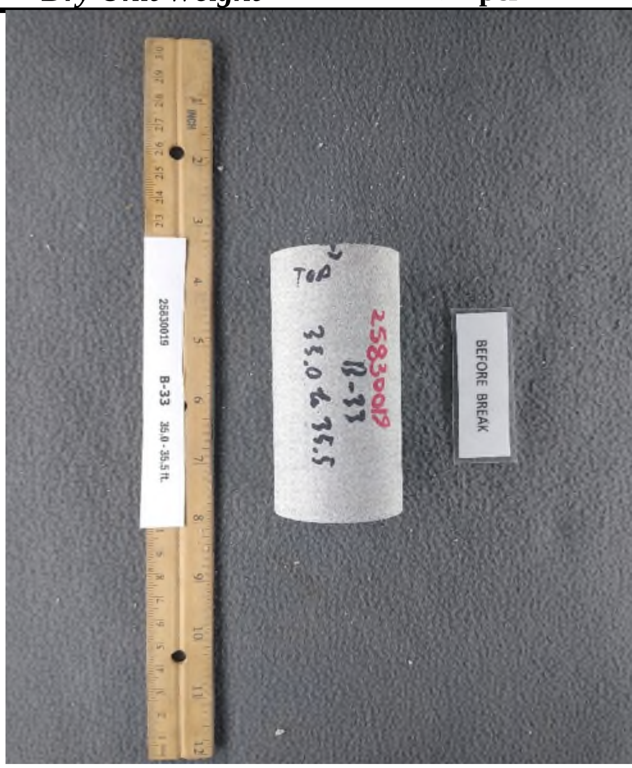
S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

Project No.:	R-019-2025	Report Date:	12/08/25
Project Name:	Grandview Access Road	Test Date(s):	12/05/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065	Received Date:	10/22/25
Location:	B-33	Depth, ft:	35.0 - 35.5
Sample Description:	Station 109+55, Offset 75, Elevation 1816		
	gray sandstone		

Angle of load relative to lithology: Approximately perpendicular

Test Results

Moisture Content	***0.2***	**%**	***Compressive Strength***	***2,295***	**ksf**
Dry Unit Weight	***156.5***	**pcf**		***15,935***	**psi**



Before Test

After Test

Strain rate: 0.015 in/min.

Notes / Deviations / References:

Jacob Folsom	_________	Laboratory Services Manger	12/16/2025
Technical Responsibility	*Signature*	*Position*	*Date*

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

Form No. TR-D7012C-01
Revision No. : 1LexD
Revision Date: 06/19/25

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

KM64-523

Quality Assurance

S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

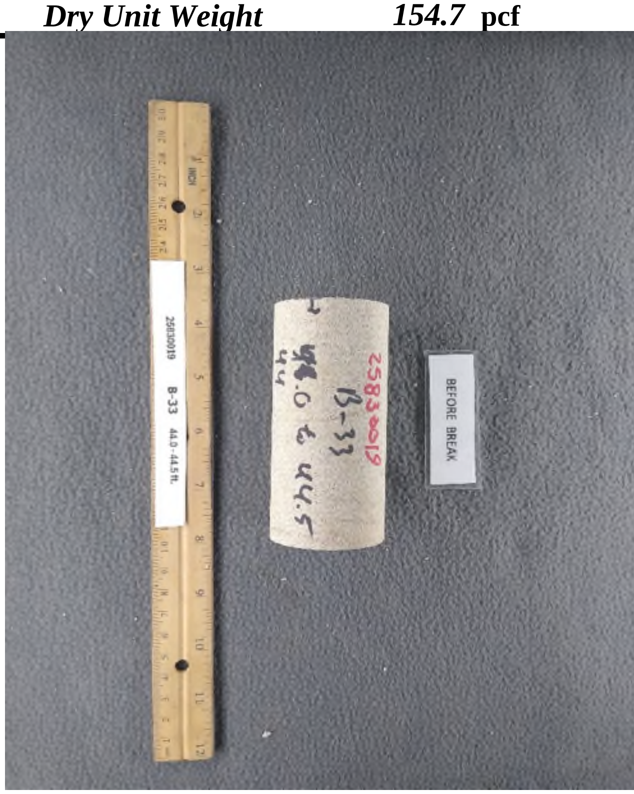
Project No.:	R-019-2025	Report Date:	12/09/25
Project Name:	Grandview Access Road	Test Date(s):	12/08/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065	Received Date:	10/22/25
Location:	B-33	Depth, ft:	44.0 - 44.5

Sample Description: Station 109+55, Offset 75, Elevation 1816
gray sandstone

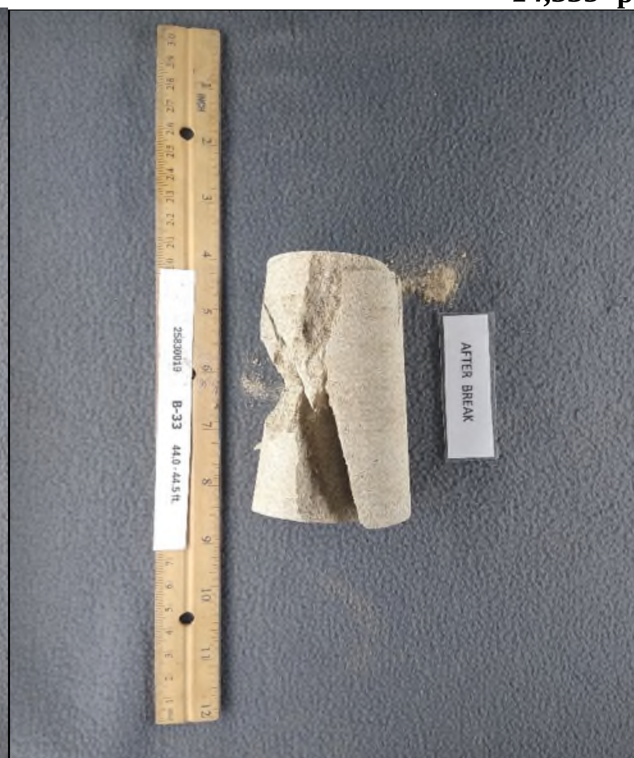
Angle of load relative to lithology: Approximately perpendicular

Test Results

Moisture Content	***0.3*** %	***Compressive Strength***	***2,064*** **ksf**
Dry Unit Weight	***154.7*** **pcf**		***14,335*** **psi**



Before Test



After Test

Strain rate: 0.015 in/min.

Notes / Deviations / References:

Jacob Folsom	_________	Laboratory Services Manger	12/16/2025
Technical Responsibility	*Signature*	*Position*	*Date*

Form No. TR-D7012C-01
Revision No. : 1LexD
Revision Date: 06/19/25

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

KM64-523

Quality Assurance

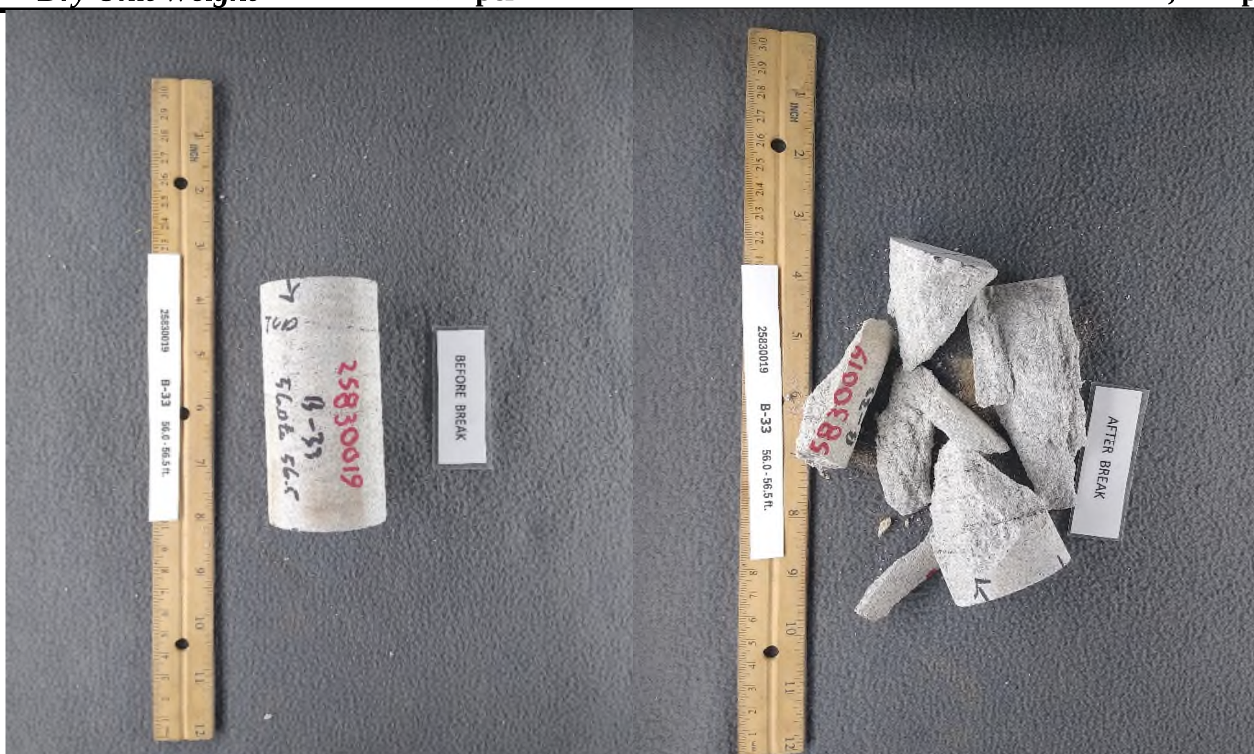
S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

Project No.:	R-019-2025	Report Date:	12/09/25
Project Name:	Grandview Access Road	Test Date(s):	12/08/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065	Received Date:	10/22/25
Location:	B-33	Depth, ft:	56.0 - 56.5
Sample Description:	Station 109+55, Offset 75, Elevation 1816		
	gray sandstone		

Angle of load relative to lithology: Approximately perpendicular

Test Results

Moisture Content	***0.1***	**%**	***Compressive Strength***	***1,990***	**ksf**
Dry Unit Weight	***152.1***	**pcf**		***13,819***	**psi**



Before Test | **After Test**

Strain rate: 0.015 in/min.

Notes / Deviations / References:

Jacob Folsom	_________	Laboratory Services Manger	12/16/2025
Technical Responsibility	*Signature*	*Position*	*Date*

Form No. TR-D7012C-01
Revision No. : 1LexD
Revision Date: 06/19/25

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

KM64-523

Quality Assurance

S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

Project No.:	R-019-2025	Report Date:	12/09/25
Project Name:	Grandview Access Road	Test Date(s):	12/08/25
Client Name:	CTL Engineering, Inc.		
Client Address:	1535 Old Finchville Rd, Shelbyville, KY 40065	Received Date:	10/22/25
Location:	B-33	Depth, ft:	64.5 - 65.0

Sample Description: Station 109+55, Offset 75, Elevation 1816
gray sandstone

Angle of load relative to lithology: Approximately 20°

Test Results

Moisture Content	***0.1*** **%**	***Compressive Strength***	***1,985*** **ksf**
Dry Unit Weight	***159.2*** **pcf**		***13,786*** **psi**

Before Test

After Test

Strain rate: 0.015 in/min.

Notes / Deviations / References:

Jacob Folsom	________	Laboratory Services Manger	12/16/2025
Technical Responsibility	*Signature*	*Position*	*Date*

Form No. TR-D7012C-01
Revision No. 0
Devision Date: 06/25/15

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

ASTM D 7012 Method C

S&ME, Inc. - Lexington: 2020 Liberty Road, Suite 105, Lexington, KY 40505

Project Name: Grandview Access Road   Location: B-33   Depth, feet: 64.5 - 65.0

Summary of Specimen Tolerances

Length/diameter target:	**MET**	Perpendicularity target:	**MET**
Side straightness target:	**MET**	Planeness target:	**MET**
Parallelism target:	**MET**		

*ASTM D4543-08 Standard Practice for Preparing Rock Core as Cylindrical Test Specimens and Verifying Conformance to Dimensional and Shape Tolerance, Section 1.2 - "Rock is a complex engineering material that can vary greatly as a function of lithology, stress history, weathering, moisture content, chemistry, and other natural geologic processes. As such, it is not always possible to obtain or prepare rock core specimens that satisfy the desirable tolerances given in this practice. Most commonly, this situation presents itself with weaker, more porous, and poorly cemented rock types and rock types containing significant or weak (or both) structural features. For these and other rock types which are difficult to prepare, all reasonable efforts shall be made to prepare a specimen in accordance with this practice and for the intended test procedure. However, when it has been determined by trial that this is not possible, the rock specimen will be prepared to the closest tolerance practicable and be considered the best effort and report it as such. If allowable or necessary for the intended test, capping the ends of the specimen as discussed in ASTM D7012 is permitted."

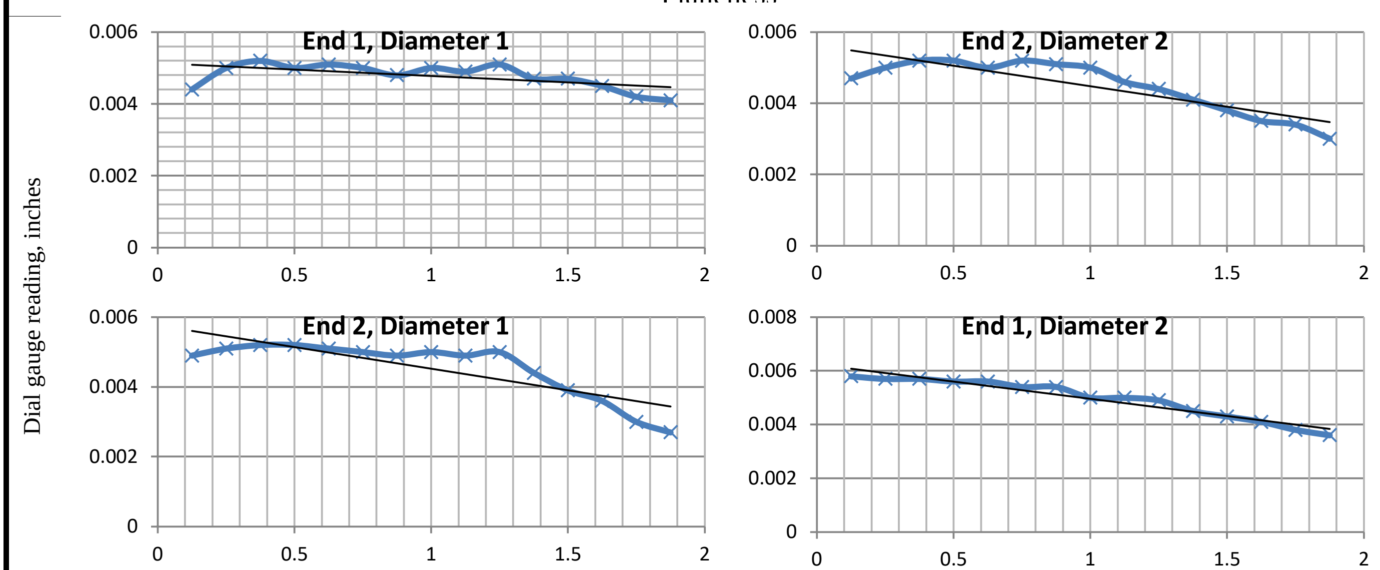
Length to Diameter Ratio

Length, inches: 4.19   Diameter, inches: 1.825
Ratio: 2.30   length to 1 diameter
Target tolerance: L:D ratio between 2 to 1 and 2.5 to 1

Side Straightness

Maximum gap between side of core and reference plate, inches: < .02
Target tolerance: Maximum gap less than .02 inches

Planeness



Distance along diameter, inches

Maximum point-line deviation, inches: < .001
Target Tolerance: No individually measured point should deviate from the best fit line by more than .001 inches.

Parallelism

Slope difference, Diameter 1, degrees: 0.05
Slope difference, Diameter 2, degrees: 0.01
Target Tolerance: Difference between slopes on each end less than 0.25°

Perpendicularity

Maximum divergence from end surface perpendicularity to long axis: 0.21

Target Tolerance: Each diameter perpendicular to the long axis to within 0.25°

Note: specimens without straight sides cannot be machined to pass.

Test Information

Strain rate, in/min: 0.015
OR
Stress rate, lbs/sec:
Time to failure, min: 5.28
Temperature: room temperature