Stantec

Report of Geotechnical Exploration
TN ERFO FS CHRKE804 2020-2(1)

Cherokee National Forest, Tennessee

Briar Creek Road(FSR188) – Ranger District – Unaka
Paint Mountain Road(FSR54) – Ranger District – Unaka
Flatwoods Road(FSR87) – Ranger District - Watauga

Prepared for:

U.S. Federal Highway Administration (FHWA)
Eastern Federal Lands Highway Division

September 25, 2024

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1.0 INTRODUCTION

The United States Department of Transportation, specifically the Federal Highway Administration (FHWA) – Eastern Federal Lands Highway Division, is planning to repair storm and flood damage to five locations in the eastern part of the Cherokee National Forest in Tennessee. The five slide locations are located in areas designated as Briar Creek Road (FS 188) in Washington Co., Flatwoods Road (FS 87) in Sullivan Co., and Paint Mountain Road (FS 54) in Greene Co. The damage along the five locations generally includes upslope and/or downslope landslides and slope instabilities. Figure 1 shows the approximate locations of the damaged areas.

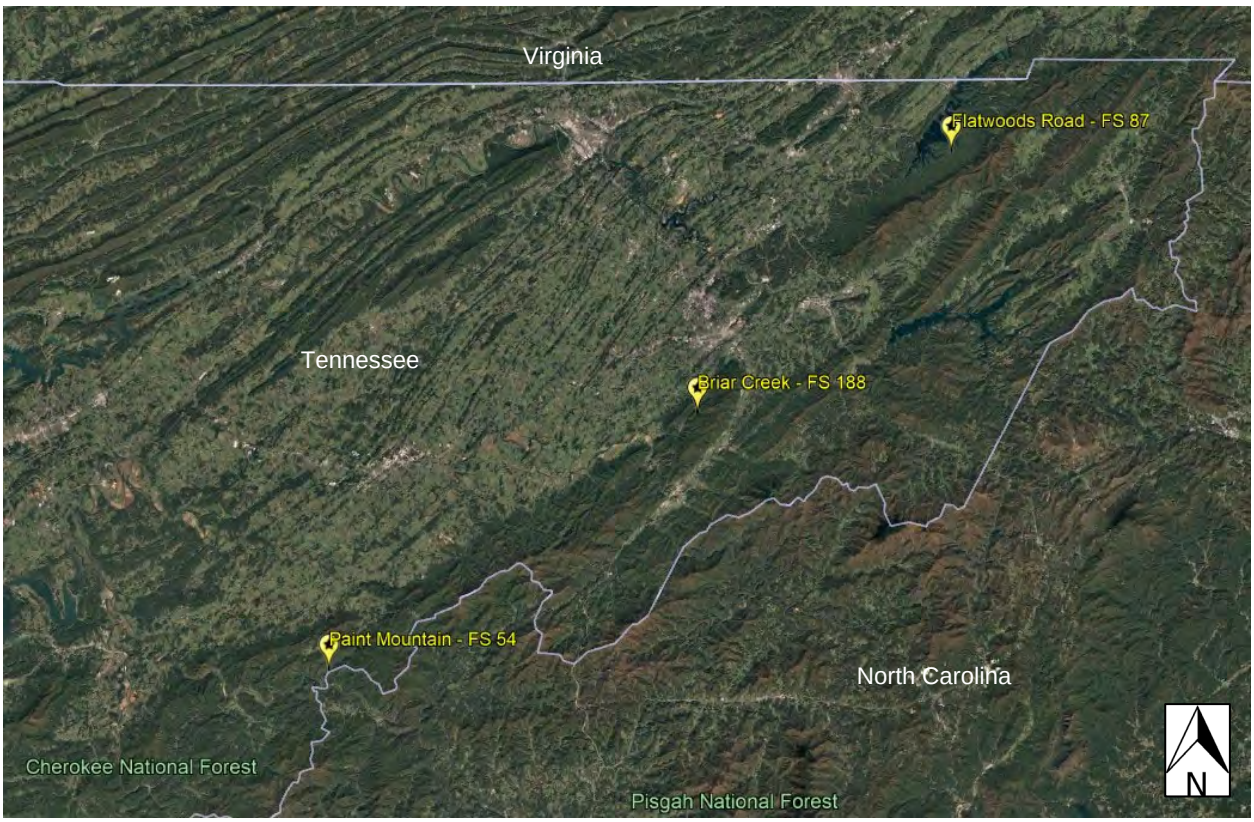


Figure 1. Aerial View
(Google Maps, 2024)

2.0 GEOLOGIC SETTING

The three areas, Briar Creek, Flatwoods, and Paint Mountain are located in the Appalachian Ridge and Valley Physiographic Region. This region consists of numerous linear parallel ridges and valleys that trend northeast to southwest, the general direction of the entire Appalachian range. Most of these ridges are low, but some of the higher ones are commonly called mountains. The overburden soils generally consist of relatively thin deposits of alluvial, colluvial, and material weathered from the parent bedrock. These soils are comprised of clay, silt, sand, and gravel along with weathered fragments of the parent rock. Slopes tend to be steep with ribbed topography reflecting underlying bedrock.

The *Geologic Map of Tennessee, East Sheet* (Tennessee Department of Conservation, 1966) indicates that the Flatwoods project site is underlain by Ordovician-age Sevier shale consisting of calcareous, bluish-gray shale; with thin gray limestone layers; sandstone, siltstone, and locally, conglomerate to the east. The Briar Creek area is underlain by Cambrian-age dark greenish-gray, silty and sandy, micaceous shale; with numerous layers of medium-grained, feldspathic, thinly bedded sandstone and gray feldspathic sandstone, arkose, conglomerate, graywacke, siltstone and shale. The Paint Mountain area is underlain by Cambrian-age dark greenish-gray, silty and sandy, micaceous shale; with numerous layers of medium-grained, feldspathic, thinly bedded sandstone. According to the Tennessee Landforms website, the state contains more than 54,000 sinkholes, of which over 40 percent are located in the Ridge and Valley Physiographic Region.

3.0 SUBSURFACE EXPLORATION PROGRAM

3.1 SUBSURFACE EXPLORATION

Stantec created an exploratory plan that included 11 test borings to depths of about 20 to 30 feet below the existing roadway surface at the specific slide areas. The Tennessee 811 One Call System was contacted by Stantec to locate and clear the public utilities. A Stantec field engineer provided oversight during the field exploration. Upon completion of the field work, Stantec surveyed the as-drilled locations of the test borings and provided ground surface elevations. The borings were advanced in general accordance with AASHTO guidelines. Borings were performed with a CME 45 truck-mounted drill rig using 3¼-inch inside diameter (ID) hollow stem augers to advance the borings through the overburden materials.

3.2 FIELD TESTING AND SAMPLING

Each boring was logged and sampled in the field by a geotechnical engineer. Soils were logged paying particular attention to the soil type, consistency, moisture content, and color. Standard penetration test (SPT) samples were obtained at selected 2½ foot intervals within the upper 20 feet until auger refusal was reached. The SPT is performed by advancing a 2-inch O.D. split-spoon sampler, in three 6-inch

increments, with a 140-pound automatic hammer dropping 30 inches at select depth intervals in the boring. The number of hammer blows needed to advance the sampler each 6-inch increment is recorded. The sum of the blow counts from the last two 6-inch increments is called the field N-value. Where auger refusal was encountered, rock coring was performed for depths of about 10 to 15 feet.

Where bedrock coring was performed, NQ-size equipment was used. Recovery, core loss, and rock quality designation (RQD) values were recorded as percentages for each coring run. The recovery is a measurement of the core sample obtained from a core run. The loss is the difference between the core run and the recovery. The RQD is measured by dividing the sum of all pieces of intact rock core longer than four inches in a run by the total length of the core run. These values are shown on the boring logs contained in Appendix B.

The borings were checked for the presence of groundwater during drilling. Groundwater levels were not recorded at completion due to the addition of water during rock coring. The borings were backfilled with soil cuttings upon completion and, where necessary, capped with a roadway patch.

3.3 LABORATORY TESTING

The soil and rock samples obtained from the borings were returned to Stantec's geotechnical laboratory for additional laboratory testing. Engineering classification testing was performed on samples reflecting each of the main soil horizons. The engineering classification tests conducted on the samples were sieve and hydrometer analysis (ASTM D 422) and Atterberg limits (ASTM D 4318). The samples were classified according to the Unified Soil Classification System (USCS) and the American Association of State Highway Transportation Officials (AASHTO) classification method. Soil corrosivity testing consisting of pH (ASTM D 4972) and electrical resistivity (ASTM G 187) was performed on select soil samples.

Samples of rock core were subjected to unconfined compressive (UC) strength testing (ASTM D 7012, Method C). Laboratory test results are presented in Appendix C.

Table 1. Summary of Soil Laboratory Test Results

Boring No.	Sample Depth (ft)	AASHTO Classification	USCS Classification	MC (%)	Gravel (%)	Sand (%)	Silt/Clay (%)
590-A	1.5-5.5	A-1-a (0)	GC-GM	2.2	55.1	29.8	15.1
590-A	9-14.7	A-1-a (0)	GC-GM	2.8	65.4	20.9	13.7
590-A	14.7-18	A-2-4 (0)	SC-SM	14.6	31.8	39.1	29.1
590-B	1.5-3	A-1-b (0)	GC-GM	6.6	40.5	37.5	22.0
599-B	0-4.4	A-1-b (0)	SC-SM	11.2	36.5	40.1	23.4
633-A	1-5	A-2-4 (0)	GW-GC	6.4	50.3	41.0	8.7
633-A	6-10	A-1-a (0)	SC-SM	6.5	39.6	46.3	14.1
633-A	11-15	A-2-4 (0)	SC-SM	6.5	28.8	52.9	18.3
633-A	16-20	A-1-b (0)	SM	8.7	35.9	50.3	13.8
633-B	1-5	A-1-a (0)	GW-GC	5.6	52.8	36.9	10.3
633-B	6-10	A-1-a (0)	GW-GC	7.7	50.4	38.1	11.5
633-B	11-17.5	A-2-4 (0)	GP-GM	13.7	50.5	38.4	11.1

Boring No.	Sample Depth (ft)	AASHTO Classification	USCS Classification	MC (%)	Gravel (%)	Sand (%)	Silt/Clay (%)
659-A	1-2.5	A-2-6 (0)	SC	11.6	20.0	49.0	31.0
659-A	3-6.7	A-2-4 (0)	GP-GC	5.1	48.3	40.4	11.3
659-B	1-7.5	A-2-6 (0)	GW-GC	11.7	70.2	22.3	7.5
660-A	1-2.5	A-2-4 (0)	GC	13.5	49.2	33.7	17.1
660-A	3.5-7.5	A-2-4 (0)	GM	--	45.3	40.0	14.7
660-B	1-5	A-2-6 (0)	GC	15.3	47.7	26.4	25.9
660-B	6-7.5	A-2-4 (0)	SM	11.3	4.2	62.0	33.8
660-B	8.5-15	A-2-4 (0)	GC	9.7	48.8	27.6	23.6
660-C	1-2.5	A-2-6 (0)	SC	13.6	30.4	40.5	29.1
660-C	3.5-5	A-2-4 (0)	SM	19.3	28.1	42.1	29.8

Table 2. Summary of Rock UCS Tests

Boring No.	Sample Depth (ft)	Compressive Strength	
		psi	ksf
590-A	25.6-26.0	11840	1705
590-A	29.3-29.8	8500	1224
599-A	17.3-17.7	10890	1568
599-B	6.7-7.1	13430	1934
599-B	14.2-14.6	11820	1702
659-A	20.5-20.9	2368	341
659-B	13.4-13.8	2094	301
659-B	16.7-17.1	853	123
660-A	15.5-15.9	2856	411
660-C	10.5-10.9	1278	184

4.0 SUBSURFACE CONDITIONS

4.1 GENERAL

Due to the steep terrain, Stantec performed all exploratory activities on the existing roadways. A summary of the borings is presented in Table 3. Exploration locations are shown on the site plans provided in Appendix A and the boring logs are provided in Appendix B.

Table 3. Summary of Borings

General Location	Boring No.	Latitude	Longitude	Ground Surface Elevation (feet)	Explored Depth (feet)
Briar Creek	599-A	36.2237035°	-82.402078°	2077.5	18.8
	599-B	36.2236205°	-82.401888°	2083.3	18.1
	633-A	36.229491°	-82.3784495°	2423.1	25.8
	633-B	36.2295384°	-82.3781653°	2419.7	20.0

General Location	Boring No.	Latitude	Longitude	Ground Surface Elevation (feet)	Explored Depth (feet)
Flatwoods	659-A	36.514508°	-82.0391154°	1776.5	24.0
	659-B	36.5145938°	-82.038985°	1775.5	18.8
	660-A	36.5148247°	-82.0383457°	1773.3	20.0
	660-B	36.5148014°	-82.0385896°	1773.6	21.2
	660-C	36.5146842°	-82.0388809°	1774.8	14.5
Paint Mountain	590-A	35.9470755°	-82.8970807°	1320.6	30.5
	590-B	35.9472179°	-82.8969801°	1323.1	7.2
	590-B2	35.947184°	-82.8970079°	1322.1	30.0

The surface conditions along the roads for Briar Creek and Paint Mountain typically consisted of a crushed aggregate road base, while Flatwoods consisted of 2 to 3.5 inches of asphalt.

The subsurface conditions at the five slope/wall locations generally consisted of varying thicknesses of granular soils overlying relatively shallow bedrock. Most of the samples tested were of relatively low plasticity (i.e., predominately granular). SPT N-values ranged from 6 to over 50 blows per foot. Some of the blow counts and subsequent N-values may be misleading due to the larger particle sizes encountered (i.e., gravel, cobbles, and boulders). Moisture contents of the samples ranged from 2 to 26 percent with the majority of values between 4 and 14 percent. Corrosivity tests were performed on select soil samples with pH values ranging from 4.2 to 7.6 and soil resistivity values ranging from about 8100 to 29,200 ohms-cm. Typically, a pH value of 4.5 or less or a resistivity less than 2000 ohms-cm is indicative of an aggressively corrosive environment.

The borings encountered auger refusal at depths of about 2 to 20 feet below the ground surface. Auger refusal is a point in the drilling process where if the driller were to continue drilling then there is a greater chance that significant damage to the augers or the drill rig is likely to occur. Rock coring was generally performed where auger refusal was encountered. Rock Quality Designation (RQD) values ranged from 0 to 70 percent with the majority of values between 0 and 40 percent.

Groundwater observations made during drilling generally indicate no static groundwater level above bedrock. Groundwater levels were not taken upon completion of drilling due to the addition of drilling fluids during the coring process. Boreholes were not left open for extended periods of time and were backfilled upon completion of drilling due to their location on the existing roadway and for safety concerns.

4.2 BRIAR CREEK

4.2.1 MP 599 (Borings 599-A, 599-B)

Natural Deposits

Natural deposits at the boring locations consisted of gravel with silt and sand (GP-GM) and silty, clayey sand with gravel (SC-SM) extending to depths of 2.5 to 4 feet below the existing ground surface. The relative density of these materials ranged from loose to medium dense. Bedrock was encountered below these materials.

Auger Refusal

Auger refusal was encountered in bedrock at depths of 2.5 to 4.3 feet below the existing ground surface.

Rock Coring

Rock coring was performed to depths of 18.1 to 18.8 feet below the existing ground surface and encountered sandy shale and dolostone. Unconfined compressive strength tests of the dolostone ranged from 10,890 to 13,430 psi.

Groundwater

No groundwater was encountered during exploration activities.

4.2.2 MP 633 (Borings 633-A, 633-B)

Natural Deposits

Natural deposits at the boring locations consisted of gravel with clay and sand (GW-GC), silty, clayey sand with gravel (SC-SM), silty sand with gravel (SM), and gravel with silt and sand (GP-GM) extending to depths of 19 and 20 feet below the existing ground surface. The relative density of these materials ranged from loose to very dense. Bedrock was encountered in Boring 633-A at a depth of 19 feet.

Auger Refusal

Auger refusal was encountered in bedrock at a depth of 20 feet below the existing ground surface at Boring 633-A. Bedrock was not encountered in Boring 633-B.

Rock Coring

Rock coring was performed to a depth of 25.8 feet in Boring 633-A and encountered sandstone overlying sandy shale.

Groundwater

No groundwater was encountered during exploration activities.

4.3 FLATWOODS

4.3.1 MP 659 (Borings 659-A, 659-B)

Natural Deposits

Natural deposits at the boring locations consisted of clayey sand with gravel (SC) and gravel with clay and sand (GP-GC and GW-GC) extending to depths of 5.5 to 8 feet below the existing ground surface. The relative density of these materials ranged from loose to medium dense. Bedrock was encountered below these materials.

Auger Refusal

Auger refusal was encountered in bedrock at depths of 8 to 8.8 feet below the existing ground surface.

Rock Coring

Rock coring was performed to depths of 18.8 to 24 feet below the existing ground surface and encountered siltstone, shale, and shale interbedded with siltstone. Unconfined compressive strength tests of the shale and shale interbedded with siltstone ranged from 853 to 2368 psi.

Groundwater

No groundwater was encountered during exploration activities.

4.3.2 MP 660 (Borings 660-A, 660-B, 660-C)

Natural Deposits

Natural deposits at the boring locations consisted of clayey gravel with sand (CL), silty gravel with sand (GM), clayey gravel with sand (GC and GM), and silty sand (SM), silty and clayey sand with gravel (SC), and silty and clayey gravel with sand (GC-GM) extending to depths of 7 to 14.9 feet below the existing ground surface. The relative density of these materials ranged from medium dense to very dense. Bedrock was encountered below these materials.

Auger Refusal

Auger refusal was encountered in bedrock at depths of 8 to 14.5 feet below the existing ground surface.

Rock Coring

Rock coring was performed to depths of 14.5 to 21.2 feet below the existing ground surface and encountered siltstone interbedded with sandstone, siltstone, limestone, and shale interbedded with limestone. An unconfined compressive strength test of the limestone was 2856 psi and for the shale interbedded with limestone was 1278 psi.

Groundwater

No groundwater was encountered during exploration activities.

4.4 PAINT MOUNTAIN

4.4.1 MP 590 (Borings 590-A, 590-B, B-2)

Natural Deposits

Natural deposits at the boring locations consisted of silty, clayey gravel with sand (GC-GM), silty, clayey sand with gravel (SC-SM), and gravel with sand (GM) extending to depths of 7.2 to 17.5 feet below the existing ground surface. The relative density of these materials was medium dense. Significant boulders were encountered in Borings 590-B and 590-B2 to depths of 20 feet below the existing ground surface. The relative density of these materials ranged from medium dense to dense. Bedrock was encountered below these materials.

Auger Refusal

Auger refusal was encountered on boulders and in bedrock at depths of 7.2 to 17.5 feet below the existing ground surface.

Rock Coring

Rock coring was performed to depths of 30 to 30.5 feet below the existing ground surface and encountered siltstone interbedded with sandstone, siltstone, sandstone interbedded with dolostone, sandy dolostone, and shale interbedded with limestone. Unconfined compressive strength tests of the sandy dolostone were 11,840 psi and 8500 psi for the shale interbedded with limestone.

Groundwater

No groundwater was encountered during exploration activities.

5.0 ANALYSIS AND RECOMMENDATIONS

5.1 GENERAL

In February and April of 2020, a series of heavy rain events caused significant roadway damage within the Cherokee National Forest. The damaged roadways reduce/prevent roadway public access into various points of the Cherokee National Forest. Damages include large landslides, roadway and shoulder washouts, clogged or damaged culverts, and other miscellaneous conditions. The FHWA has contracted with Stantec to perform geotechnical explorations laboratory testing and provide design recommendations for remediation of slopes in the affected areas. Three areas designated as Briar Creek, Flatwoods, and Paint Mountain contain a total of five specific slide locations.

The geotechnical explorations were performed on the existing roadways either uphill or downhill of the particular landslide. The lack of access to the uphill and downslope areas of the slides, due to safety and environmental concerns, generally limited exploration activities in these areas. Observation of the slopes along the respective alignments and the overall condition of the roadways indicates the adjacent hillsides to be generally stable. From our observations the downhill slope failures do not appear to be directly impacting the existing roadways, i.e., no distress or apparent cracking in the roadway surface or sinking of the shoulder. From the photographs provided and those taken during exploratory activities it appears that most of the slide activity is surficial in nature and not a deep-seated failure. The recommendations that follow are based on the information discussed in this report, and the interpretation of the subsurface conditions encountered at the site during our fieldwork.

5.2 SEISMIC HAZARD ANALYSIS

The three project sites are mapped generally within the East Tennessee Seismic Zone (ETSZ). Most earthquakes in the ETSZ generally occur in the highly tilted and folded rock layers and are thought to originate in the Precambrian basement structures not related to Appalachian orogeny. The ETSZ is located mainly in the Valley and Ridge province of the southern Appalachians and is the second-most seismically active area in the eastern United States, after the New Madrid seismic zone. The seismic hazard of the ETSZ is difficult to assess, as there are no obvious surface faults found previously except a few recent paleo seismic field surveys, and no recorded historical earthquakes of magnitude greater than 5 (C. Daniels, et al).

In accordance with AASHTO Section 3.10, the overburden soils at the three sites, Briar Creek, Flatwoods, and Paint Mountain, were classified by their stiffness for Site Class. Stantec conducted a review of the soil profile data for the borings completed for this exploration. Using the boring from each area with the deepest overburden profile, Stantec analyzed the soil and bedrock profile using the average Standard Penetration Test (Method B) over the upper 100 feet of profile in accordance with AASHTO Section 3.10.3.1. In general, the soil profile over a depth of about 100 feet consists of layers of granular soils (2.5 to 20 feet) overlying bedrock. The granular soils were typically medium dense to very dense. Based on the analysis each of the three areas can be classified as **Site Class C**. Stantec used this site

class designation along with the values from the national ground motion maps (PGA, S_s, S_1) to obtain the applicable site factors (F_{pga}, F_a, F_v). Applying the site factors and resulting acceleration coefficients indicates that these sites may be designed within **Seismic Zone 1**.

5.3 SLOPE STABILIZATION RECOMMENDATIONS

Several slope remediation methods were suggested in the provided information for the various sites. These consisted of “hard faced” options such as gabion walls, soil nails and steel mesh netting, soil nails and shotcrete cover, and a rockery wall. Stantec discussed several “softer faced, green” options with an FHWA geotechnical representative and recommended vegetated MSE wall systems and vegetated Geocell slope coverings. These systems are more flexible, generally easier to construct, and less expensive than typical hard faced wall systems.

Stantec created several cross sections along the various alignments to evaluate the stability of existing slopes. Based on our visual observations along the roadway the existing soil slopes appear to be relatively stable. Most soil slopes do not appear to be excessively steep (steeper than 1H:1V) and given the relatively shallow depth to bedrock the soil cover is expected to be relatively thin. Based on the numerous rock outcroppings and boulders visible both up and down slopes and the size and density of foliage, we estimate the overburden soils on slopes to be approximately 2 to 3 feet thick or less where bedrock is shallow. The overburden soils on slopes are likely residual in nature i.e., weathered from the parent bedrock and similar to what was encountered in the borings. In addition to the laboratory test results, Stantec used correlations from FHWA manuals to estimate the soil parameters used in the stability analyses. References are listed in Section 6.

Typically for highway work a minimum factor of safety of 1.3 (1.1 for seismic) would be considered acceptable for slope stability. However, slope stability analyses do not typically account for the presence of boulders, rock out cropping in the slope, or vegetation such as underbrush and trees that have root balls that may anchor into the top of rock. These also help with slope stabilization but cannot be quantified within the analysis.

5.3.1 Briar Creek

Briar Creek Road consists of two sites at MP 599 and MP 633. The slide at MP 599 is assumed to be 100 feet long and 15 feet high. The slide at MP 633 is assumed to be 160 feet long and 12 feet high. Both slide locations are downhill of their respective roadways.

5.3.1.1 MP 599

Based on site observations and photographs, the slide at MP 599 appears to be surficial. From our constructed cross sections, the slope appears to be roughly 1H:1V. From Borings 599-A and B the overburden thickness ranges from about 2.5 to 4 feet below the roadway surface. Bedrock consisted of weathered and fractured dolostone. Stantec assumed that the slope overburden is roughly the same as the overburden thickness at the roadway. Based on this assumption, then any proposed gravity wall system installation would require the excavation of bedrock, which would be considered expensive. Soil

nails/rock bolts would also be an expensive remediation and may require benching into the existing slope to construct. Since the apparent slope failure appears to be surficial, Stantec recommends using a geocell product to rebuild and protect the slope after grading has removed the scarp. A geocell solution provides a way to grow and maintain a vegetated slope as steep as 1H:1V. A geocell solution should also reduce the risk of erosion and future slides at this location. Stantec contacted a geocell supplier to determine the feasibility of this technique and provide a preliminary estimate. As geocell products tend to be supplier specific and supplier designed (propriety design), we have included some preliminary information in Appendix F to assist in the decision-making process. We would anticipate that regrading and the application of a “green type” of slope remediation would be more desirable and cost effective than extensive excavation and a conventional wall system.

5.3.1.2 MP 633

Based on site observations and photographs, the slide at MP 633 appears to be surficial as well and the slope appears to be roughly 1H:1V. From Borings 633-A and B the overburden soils range from 19 to 20 feet below the existing roadway surface. However, bedrock was not encountered in Boring 633-B. Based on the elevation where bedrock was encountered in Boring 633-A (elev. 2404.1), we anticipate that bedrock should be about 2 to 3 feet below the bottom of Boring 633-B. A retaining wall type structure was suggested for this location. Given the depth of the overburden soils at these locations, Stantec recommends using an MSE wall type structure with a vegetated face to repair the face of the slope and reduce the risk of future incidents.

An MSE wall type structure with a maximum height of 12 feet should be sufficient to remediate the slide area and provide for a slightly wider roadway width. A wall batter of approximately 18 degrees (~3V:1H) with a 5-foot bench should fit within the confines of the existing slope and roadway. Design and analysis of the proposed MSE wall is presented in Section 5.4 below.

5.3.2 Flatwoods

Flatwoods Road consists of two sites next to each other at MP 659 and MP 660. The slide at MP 659 is assumed to be 80 feet long and 65 feet high and is located upslope of the road. The slide at MP 660 is assumed to be 225 feet long and 10 feet high and located downhill of the road.

5.3.2.1 MP 659

The slide location at MP 659 is upslope from the roadway. A section approximately 65 feet high by 80 feet wide has been completely denuded due to the topsoil and foliage sloughing off the hillside. From photographs and site observations by the field engineer the hillside appears to be comprised of highly weathered bedrock and shallow pockets of soils weathered from the parent rock. Given the steepness of the slope, roughly 1H:1V, and that the slope has been exposed for roughly 4 years, the overall condition appears to be stable and there is little evidence of erosion. There was no access to the top of the slope, therefore, Borings 659-A and B were performed on the road at the toe of the slope. Bedrock was encountered at depths of 5.5 and 8 feet and consisted of siltstone and shale.

A suggested remediation method for this slope included soil nails and a steel mesh netting. Stantec recommends using a geocell product to rebuild and protect the slope after any necessary grading is complete. A geocell solution provides a way to grow and maintain a vegetated slope as steep as 1H:1V. A geocell should also reduce the risk of erosion and future slides/sloughing at this location. Stantec contacted a geocell supplier to determine the feasibility of this technique and provide a preliminary estimate. As geocell products tend to be supplier specific and supplier designed (propriety design), we have included some preliminary information in Appendix F to assist in the decision-making process. We would anticipate that regrading and the application of a “green type” of slope remediation would be more desirable and cost effective than an anchor and steel mesh system.

5.3.2.2 MP 660

Based on site observations and photographs, the slide at MP 660 appears to be surficial and the slope appears to be roughly 1.25H:1V. From Borings 660-A, B, and C the overburden soils range from 7 to 15 feet below the existing roadway surface. The overburden soils generally consisted of medium dense to dense silty clayey sand and clayey gravel. Bedrock consisted of siltstone, limestone, and shale. A retaining wall type structure was suggested for this location. Given the depth of the overburden soils at these locations, Stantec recommends using an MSE wall type structure with a vegetated face to repair the face of the slope and reduce the risk of future incidents.

An MSE wall type structure with a maximum height of 12 feet should be sufficient to remediate the slide area and provide for a slightly wider roadway width. A wall batter of approximately 18 degrees (~3V:1H) with a 5-foot bench should fit within the confines of the existing slope and roadway. Design and analysis of the proposed MSE wall is presented in Section 5.4 below.

5.3.3 Paint Mountain

The Paint Mountain site consists of one slide location at MP 590. From site observations and photographs, the slide at MP 590 appears to be mostly surficial and, from the cross sections, the slope appears to be roughly ¾H to 1H:1V. From Borings 590-A, B, and B2 the overburden soils range from 17.5 to 20 feet below the existing roadway surface with numerous cobbles and boulders. Bedrock consisted of sandstone, dolostone, shale and siltstone. A 20-foot-tall rockery wall was suggested at this location, however, the design footprint for a rockery wall will encroach on the existing roadway. A rockery wall uses large, stacked stones to create the wall face and body with a roughly 12-inch wide granular backfill zone behind the stacked stone. This type of wall system does not lend itself to supporting surcharge loads (i.e., traffic) on the stacked stones or granular backfill. Additionally, the Rockery Design and Construction Guidelines, FHWA-CFL/TD-06-006 (2006) recommends that rockery walls not exceed 12 to 15 feet unless a tiered wall system is used. A tiered wall system would require a larger wall footprint. Given the depth of the overburden soils at this location, Stantec recommends using an MSE wall type structure with a vegetated face to repair the face of the slope and reduce the risk of future incidents. In addition, there is a 15-inch corrugated metal pipe that exits the downstream side of the hillside. The upstream side is buried. Stantec recommends that the existing pipe be backfilled with a non-shrink grout and a new culvert pipe be placed at a suitable upstream depth to carry drainage beneath

the road. The outfall of the culvert pipe may need to extend from the face of the slope in order to reduce the risk of erosion of the wall.

An MSE wall type structure with a height of 15 feet should be sufficient to remediate the slide area and maintain the existing roadway width. A wall batter of approximately 14 degrees (~4V:1H) with a 5-foot bench should fit within the confines of the existing slope and roadway. Design and analysis of the proposed MSE wall is presented in Section 5.4 below.

5.4 MSE RETAINING WALLS

Three MSE type retaining walls are planned at MP 633, MP 660, and MP 590. The MSE wall was chosen based on its flexibility, ease of construction, relative low cost compared to other wall systems, and the ability to vegetate the wall face. Analysis of the MSE walls were performed in general accordance with AASHTO LRFD Bridge Design Specifications, 9th edition, 2020. The maximum wall height was determined based on the top of wall elevation (near the roadway), the height of the slide, and an embedment depth of 3-feet. In review of online sources, the frost depth for the eastern Tennessee area is approximately 2 feet. Since all three walls are to be located on an existing slope a bench was located at the toe of the wall. The bench also provides support for bearing and slope stability. The wall batter was determined based on the need to fit the proposed wall in the existing slope and not infringe upon the existing roadway width.

In evaluating the design for a "gravity-type" reinforced soil retaining wall (MSE), the external and internal stability should be analyzed. The internal stability analysis will be performed by the wall internal reinforcement designer. The external stability analysis for eccentricity, sliding, bearing resistance and global stability considered the subsurface conditions, the height of the MSE wall and an initial minimum reinforced length of 0.7 times the height of the wall. The reinforcement length was increased/decreased in increments of 0.5 feet to meet external stability requirements. Stantec utilized the computer program MSEW+ in the analysis of the MSE walls. Global stability was analyzed using Slope/W by GeoStudio, 2019. The MSE wall analyses are presented in Appendix E.

Stantec compared and estimated the friction angle values of the existing soils using three different methods from: 1) NAVFAC 7.01, 1986, 2) Peck, Hanson, and Thornburn from Wolff, 1989, and 3) Peck, Hanson, and Thornburn from Kulhawy & Mayne,1990. Based on corrected N-values the internal friction angles ranged from about 31 to 45 degrees and higher. In Stantec's opinion some of the higher values may be attributed to larger particle sizes (large gravel, cobbles, and boulders) in the soil matrix, therefore, internal friction angles were limited to a maximum of 36 degrees. Since the encountered soils are granular, the soil parameters for short term (undrained conditions) and long term (drained conditions) are essentially the same. A groundwater table was not encountered, likely due to the granular soils, fractured bedrock, and sloping terrain. The tables below summarize the soil parameters used in the analysis of MSE walls and global stability.

In accordance with the AASHTO 11.10.5.3, the reinforced fill portion of the wall must have an internal friction angle (φ) equal to 34 degrees, a cohesion of 0, and an estimated unit weight of 120 pounds per

cubic foot (pcf). The retained soil must have a minimum internal friction angle (φ) equal to 30 degrees, a cohesion of 0, and an estimated unit weight of 120 pcf. The existing soils can likely be reused as retained and embankment fill, provided they meet the minimum parameters as summarized in the table below and any additional requirements by the MSE wall manufacturer. If differing conditions are discovered during construction, Stantec should be contacted to verify that the design is valid for the actual conditions.

Table 4. Soil Parameters for MSE Walls

Soil Fill Type	Unit Weight (pcf)	Short Term/Long Term	
		Friction Angle (φ')	Cohesion (c')
Bedrock	160	40	4000
Embankment Fill	120	32	0
Reinforced Fill	120	34	0
Retained Fill	120	30	0
Free Draining Base	120	34	0

Table 5. Existing Subsurface Soil Parameters

Wall Location	Depth range above wall base (feet) / Depth range below wall base (feet)	Soil Type	Unit Weight (pcf)	Short Term/Long Term	
				Friction Angle (φ)	Cohesion (c)
MP 633	0-12	Gravel w/clay and sand	120	36	0
	12-20	Gravel w/silt and sand	120	36	0
MP 660	0-12	Clayey Gravel w/sand	120	34	0
	12-15	Clayey Gravel w/sand	120	34	0
MP 590	0-15	Silty Clayey Gravel w/sand	120	35	0
	15-17	Silty Clayey Sand w/gravel	120	32	0

For external stability, the following four standard modes of failure are typically evaluated:

1) sliding using a resistance factor ($\phi = 1$)
2) limiting eccentricity (overturning)
3) bearing resistance using a static resistance factor ($\phi = 0.65$)
4) global stability using a static resistance factor ($\phi = 0.75$)
5) bearing resistance using a seismic resistance factor ($\phi = 0.9$)
6) global stability using a seismic resistance factor ($\phi = 0.9$)

The load factors and geotechnical resistance factors used in the analyses are presented with the analyses in Appendix E. With LRFD analysis methodology, the goal is to have the factored resistance greater than the factored load. The term capacity to demand ratio, CDR, is used to quantify the ratio of the factored resistance to the factored load. CDR values of one or greater indicate acceptable results. The global stability analyses display the results as a factor of safety. The inverse of the factor of safety is equivalent to the resistance factor. For global stability, a factor of safety (FOS) greater than 1.3 is recommended.

A limitation with the MSEW+ program occurs in the calculation of bearing resistance. The program utilizes only one set of soil parameters in the calculation of bearing resistance (those at the bearing elevation) instead of all the parameters for a soil profile. To compensate for this limitation, a limit equilibrium bearing resistance analysis was performed when an MSEW+ bearing resistance CDR value was less than 1. This allows consideration of the layered subsurface profile beneath the base of the wall, including the presence of shallow bedrock. For a limit equilibrium bearing capacity analysis an area equivalent to the unit width footprint of the wall is loaded with an applied bearing pressure. The resulting failure surface models a classic bearing capacity failure surface and the resulting factor of safety is used to “dial in” the applied bearing pressure that results in a factor of safety of 1.0. Because of the shallow bedrock at MP 633 and MP 660 the necessary applied bearing pressure to reach a factor of safety of 1.0 is very high. Stantec cut off the bearing capacity analysis at the point where the failure surfaces started to enter the bedrock. The CDR for bearing capacity is equal to the factored bearing resistance from the limit equilibrium analysis divided by the factored load from the MSEW+ analysis. The global stability and limit equilibrium bearing resistance analyses utilized the respective profiles from the table above. Tables 6 and 7 presents a summary of the external stability analyses (static and seismic) performed for the MSE walls.

Table 6. Summary of External Stability Analysis - Static

MSE Wall Analysis Condition		Sliding	Limiting Eccentricity	Bearing	Global Stability
Wall Location & Backslope	**Approx. Height & Reinforcement Length (L)**	CDR ≥ 1	e/L ≤ 0.333	CDR ≥ 1	FOS ≥ 1.3
MP 633	Wall Height: 12 ft L=12 ft	2.16	0.0052	3.96 [a]	1.36
MP 660	Wall Height: 12 ft L=10 ft	1.78	0.0271	3.67 [a]	1.56
MP 590	Wall Height: 15 ft L=12 ft	1.75	0.0385	3.23 [a]	1.47

a - Bearing required the use of limit equilibrium bearing analysis.

Table 7. Summary of External Stability Analysis - Seismic

MSE Wall Analysis Condition		Sliding	Limiting Eccentricity	Bearing	Global Stability
Wall Location & Backslope	**Approx. Height & Reinforcement Length (L)**	CDR ≥ 1	e/L ≤ 0.333	CDR ≥ 1	FOS ≥ 1.1
MP 633	Wall Height: 12 ft L=12 ft	1.86	0.0911	1.31	1.10
MP 660	Wall Height: 12 ft L=10 ft	1.54	0.1401	4.58 [a]	1.31
MP 590	Wall Height: 15 ft L=12 ft	1.43	0.1589	4.05 [a]	1.25

a - Bearing required the use of limit equilibrium bearing analysis.

The analyses assume proper drainage is maintained and that no hydrostatic water pressure is developed behind the walls. Therefore, for naturally occurring soils, consideration should be given to the installation of a permanent subsurface drainage system located at or near the base of the MSE walls. It is important that the drainage system be protected by a filter fabric to prevent fines from clogging the pipe.

5.5 CONSTRUCTION CONSIDERATIONS

5.5.1 General Considerations

Based on the information obtained at the boring locations and our understanding of the proposed construction, we anticipate that shallow excavations and grading will likely not encounter groundwater. However, if perched groundwater is encountered or surface water run-off enters shallow excavations during construction, it can likely be removed by using a pump and filtered sump possibly in combination with collection trenches. We also recommend that excavated soil not be stockpiled immediately adjacent to the top of an excavation, nor should equipment be allowed to operate close to unsupported excavations. The Contractor is responsible for maintaining stable excavations. In addition, all excavations should conform with Occupational Safety and Health Administration (OSHA) requirements. Cohesive soil, if encountered on this project, should be classified as Type A or B, depending on its strength characteristics. The granular soils should be classified as Type C (according to OSHA) and should be treated accordingly.

5.5.2 Wall Construction

In general, engineered fill for walls and embankments should be placed in horizontal lifts not exceeding 8 inches in loose lift thickness and compacted to at least 95 percent of the modified Proctor density (ASTM D 1557). It should also be noted that the acceptable thickness of loose lifts of engineered fill and/or the number of passes required by the compaction equipment to achieve compaction to the density recommended in this report will be a function of the type of compaction equipment and techniques used, the soil type, as well as proper control of the soil moisture content and the season in which construction

takes place. In addition, periodic field density tests should be performed during fill placement to determine the adequacy of the compactive effort. Large high energy compaction equipment is not recommended as it may cause hillside instability either above or below the proposed wall. Given that granular soils were predominantly encountered at the boring locations and based on relative densities ranging from medium dense to very dense, we anticipate little to negligible post construction settlement should occur.

6.0 REFERENCES

American Association of State Highway and Transportation Officials (AASHTO), Load and Resistance Factor Design (LRFD) Bridge Design Specifications, 9th Edition, 2020.

Clara Daniels, Zhigang Peng, A 15-year-long catalog of seismicity in the Eastern Tennessee Seismic Zone (ETSZ) using matched filter detection, Earthquake Research Advances, Volume 3, Issue 1, 2023, 100198, ISSN 2772-4670, https://doi.org/10.1016/j.eqrea.2022.100198.

NAVFAC Soil Mechanics Design Manual 7.01, September 1986.

Federal Highway Administration (FHWA), Geotechnical Engineering Circular (GEC) No. 5, Evaluation of Soil and Rock Properties, FHWA-IF-02-034, April 2002.

Federal Highway Administration (FHWA), Soils and Foundations Reference Manual – Volume I, FHWA-NHI-06-088, December 2006.

7.0 CLOSING

This evaluation has been conducted in accordance with generally accepted soil and foundation engineering practices. The conclusions and recommendations contained in this report are based on the field observations and subsurface information from the exploratory borings performed for this project. It is important to recognize that subsurface conditions can vary over relatively short distances. The boring/sounding logs and related information depict approximate subsurface conditions only at the specific boring locations noted and at the time of drilling. Conditions at other locations may differ from those occurring at the boring locations. Also, the passage of time may result in a change in the subsurface conditions at the boring locations.

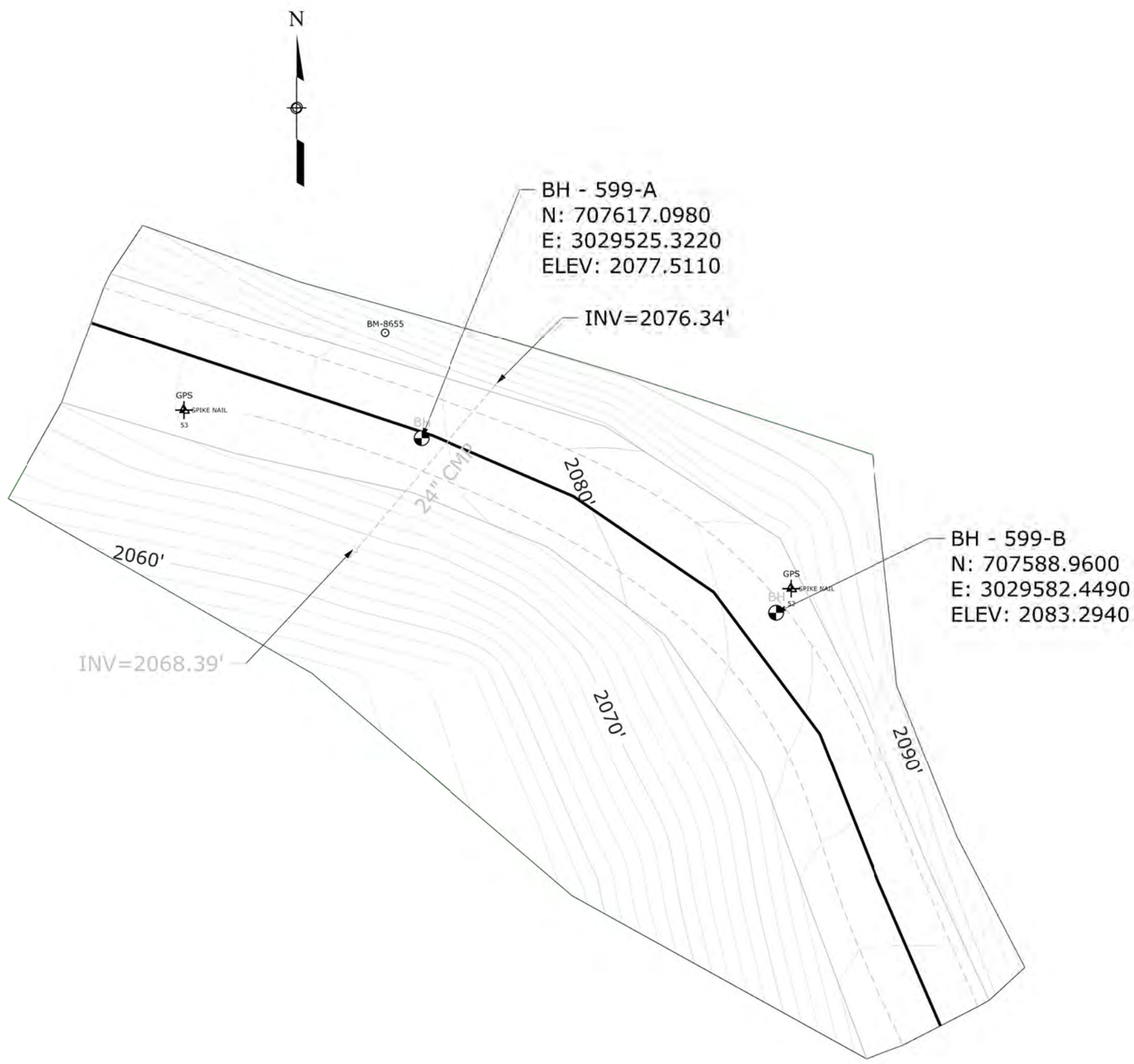
Closing
September 25, 2024

Construction operations involving wall and slope construction and other earthwork should be performed in the presence of a qualified engineer who is experienced in observation and testing of these operations. The engineer should operate under the direct supervision of a Professional Engineer experienced in geotechnical engineering.

Darren Pleiman, P.E.
Senior Geotechnical Engineer

Eric Kistner, P.E.
Principal

APPENDIX A
Exploration Location Plans



MP 599 - EXISTING SITE

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PROJECT	SHEET NUMBER
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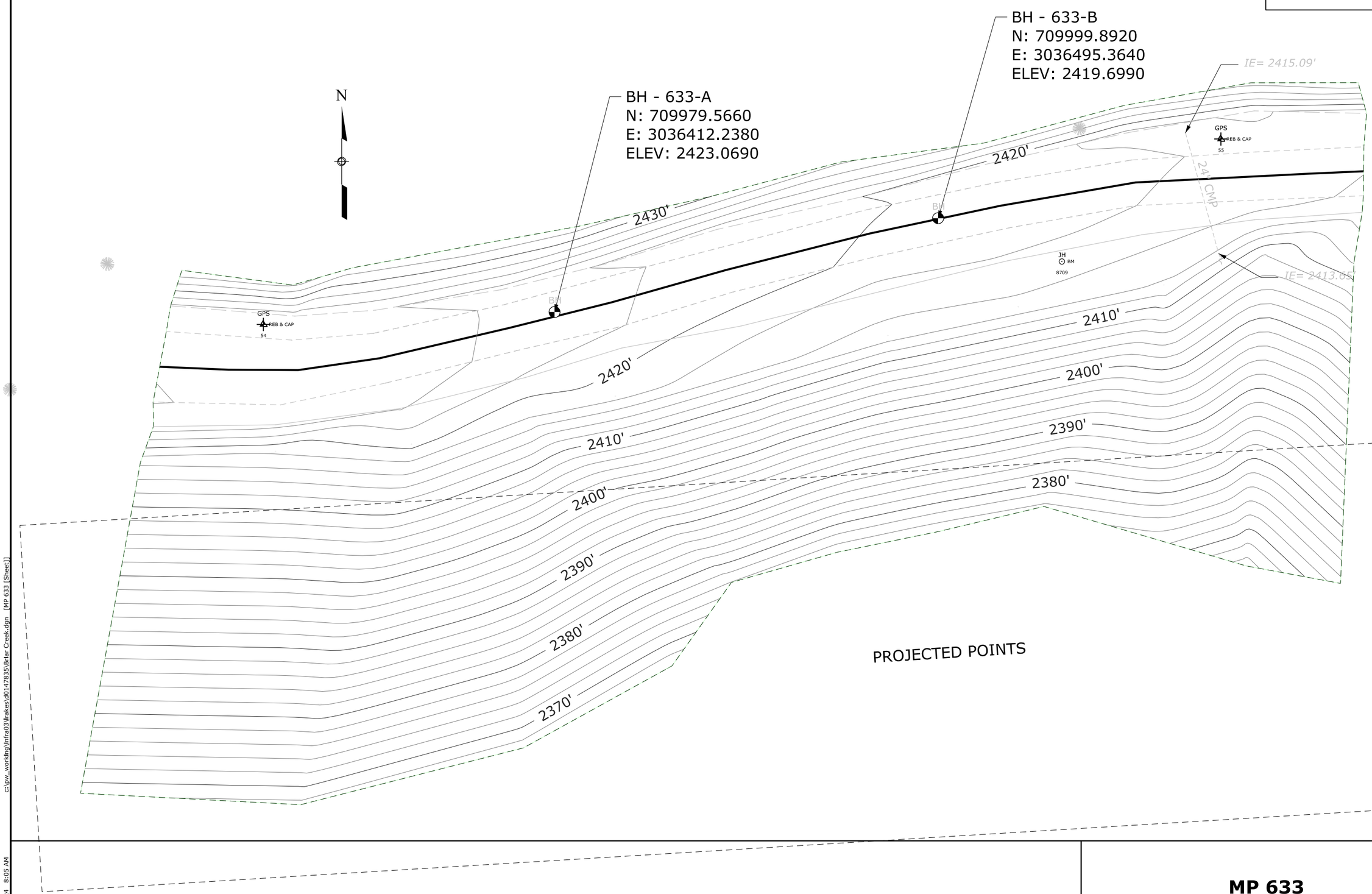

MP 633

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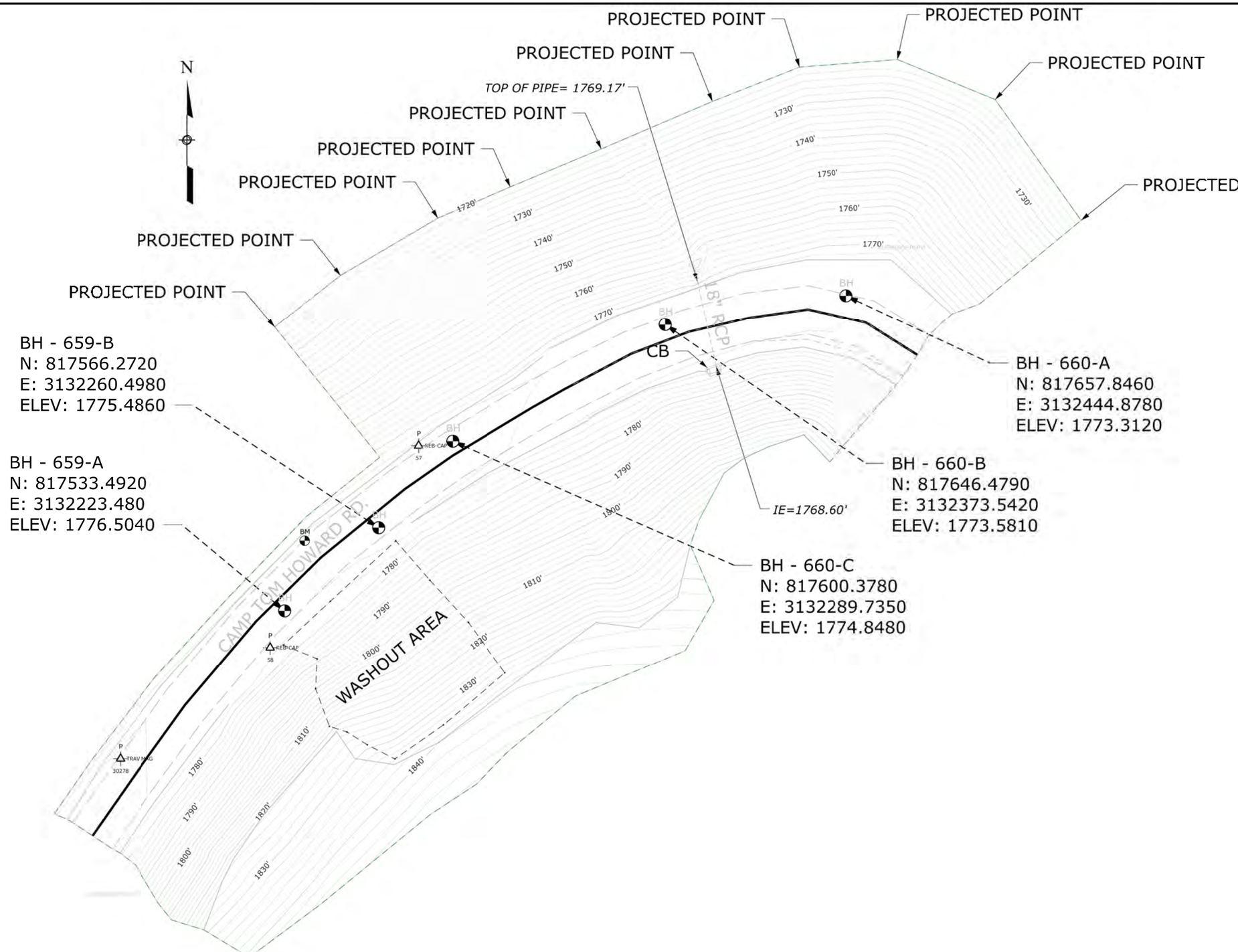
26 June 2024 8:05 AM

NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
	MP 659



MP 659 & 660

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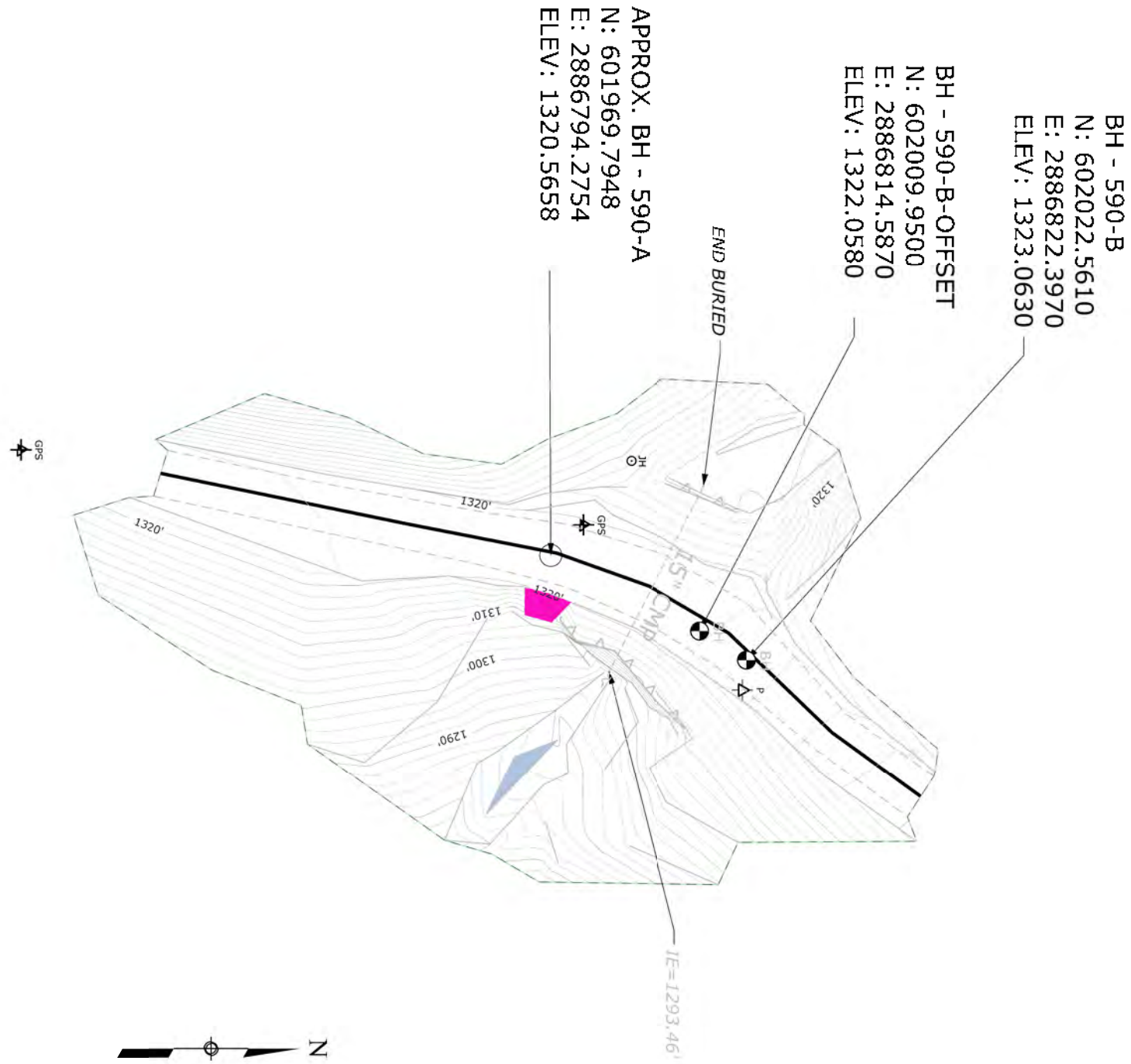
25 June 2024 11:10 AM

MP 590



PROJECT NUMBER	
Plan 1	

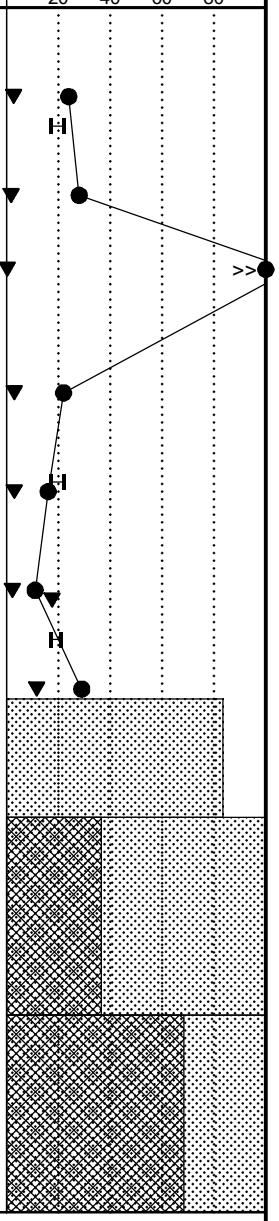
APPENDIX B
Boring Logs

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY DIVISION

BORING LOG 590-A

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Sheet: 1 of 1
Project Location: Cherokee National Forest, TN
Surface Elevation: 1320.6 ft
Datum: NAVD88
Groundwater Depth:
Latitude: 35.9470755° Longitude: -82.8970807°
Datum: NAD83
While Drilling: No Groundwater Encountered
State Plane Coors: N 601969.7948 ft E 2886794.2754 ft
At Completion: ---
Date Started: 4/7/24 Date Completed: 4/7/24
After Drilling: ---
Driller/Company: A. Clements/Stantec
Drill CME-45
Notes:
Hammer Type: 140 lbs Automatic
Hammer Efficiency: 87.1 %
Boring backfilled with soil cuttings.
Logger/Company: Y. Oumoussi/Stantec
Weather: Sunny

Elevation (ft)	Depth (ft)	Graphic Log	MATERIAL DESCRIPTION	Drilling Method	Type	No.	Field Blow Count (Recovery) Core Rec., RQD, and Frac. Freq.	Test Results
1320			GRAVEL - 3 INCHES 0.3 ft / El. 1320.3 ft					
			SILTY, CLAYEY GRAVEL WITH SAND (GC-GM), brown with light gray, medium dense, dry. Possible boulders/cobbles from 0.5 to 6.5'	3-1/4" HSA		SS-1	10-13-11 (13" = 73%)	Difficult drilling from 2.5 to 8.5 ft Mostly sandstone fragments
	5					SS-2	10-12-16 (6" = 33%)	
1315			6.5 ft / El. 1314.1 ft					
			SANDSTONE BOULDER, light gray. 8.5 ft / El. 1312.1 ft			SS-3	50/3" (3" = 100%)	
			SILTY, CLAYEY FRAGMENTS WITH SAND (GC-GM), brown with light gray, medium dense, dry to damp, contains few iron oxide stains.			SS-4	14-14-8 (2" = 11%)	
	10					SS-5	5-10-6 (12" = 67%)	Mostly sandstone fragments
1310			15 ft / El. 1305.6 ft			SS-6	7-7-4 (12" = 67%)	Water seepage at 15.0 ft
	15		SILTY, CLAYEY SAND WITH GRAVEL (SC-SM), brown, medium dense, moist to very moist. Moderately organic from 15.0 to 15.5' Contains some iron oxide stains from 17.0 to 17.5'			SS-7	4-6-23 (12" = 67%)	Mostly sandstone fragments from 17.0 to 17.5 ft
1305			17.5 ft / El. 1303.1 ft					
			SANDSTONE INTERBEDDED WITH DOLOSTONE, fine to medium grained, gray becoming brown with gray, weak to very weak, highly weathered, highly fractured, soft to medium hard, contains many iron oxide stains.	NQ CORE		RC-1	Rec = 83% RQD = 0%	
	20					RC-2	Rec = 100% RQD = 37%	Horizontal fractures from 23.5 to 27.4 ft
1300			23.5 ft / El. 1297.1 ft					
			SANDY DOLOSTONE, gray, strong to very strong, slightly weathered, moderately to slightly fractured, hard to very hard. Highly fractured from 24.0 to 24.2'					Elv. 1295.0 ft UC = 11840 psi
	25					RC-3	Rec = 100% RQD = 68%	Vertical fracture at 27.8 ft Elv. 1291.3 ft UC = 8500 psi
1295			27.4 ft / El. 1293.2 ft					
			SHALE INTERBEDDED WITH LIMESTONE, fine grained, dark gray with gray, strong to very strong, slightly weathered, moderately to slightly fractured, hard to very hard.					
	30		30.5 ft / El. 1290.1 ft					



Refusal at 17.5 ft.
Bottom of borehole at 30.5 ft.

FHWA LOG - FHWA_DATATEMPLATE.GDT - 6/28/24 09:35 - C:\USERS\YOUMOUSSI\ONEDRIVE - STANTEC\ATTACHMENTS\DESKTOP\CHEROKEE NATIONAL FOREST\20262523 29\TN ERFO SITE 1.GPJ

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY DIVISION

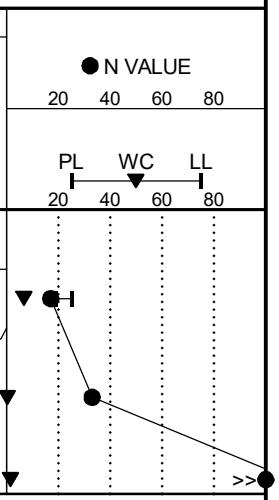
BORING LOG 590-B

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Project Location: Cherokee National Forest, TN
Groundwater Depth:
While Drilling: No Groundwater Encountered
At Completion: ---
After Drilling: ---
Notes:
Boring backfilled with soil cuttings.

Surface Elevation: 1323.1 ft
Latitude: 35.9472179° Longitude: -82.8969801°
State Plane Coors: N 602022.561 ft E 2886822.397 ft
Date Started: 4/8/24 Date Completed: 4/8/24
Driller/Company: A. Clements/Stantec Drill CME-45
Hammer Type: 140 lbs Automatic Hammer Efficiency: 87.1 %
Logger/Company: Y. Oumoussi/Stantec
Weather: Partly cloudy

Sheet: 1 of 1
Datum: NAVD88
Datum: NAD83

Elevation (ft)	Depth (ft)	Graphic Log	MATERIAL DESCRIPTION	Drilling Method	Type	No.	Field Blow Count (Recovery)	Test Results
			GRAVEL - 3 INCHES 0.3 ft / El. 1322.8 ft					
			SILTY, CLAYEY GRAVEL WITH SAND (GC-GM), brown with light gray, medium dense, dry. 4 ft / El. 1319.1 ft	3-1/4" HSA		SS-1	6-7-10 (16" = 89%)	Mostly sandstone fragments
1320	5		POORLY GRADED GRAVEL (GP), little sand, trace silt, light gray with brown, dense, dry. 6.5 ft / El. 1316.6 ft			SS-2	19-15-18 (5" = 28%)	Boulder material
			SILTY GRAVEL WITH SAND (GM), light gray with brown, very dense, dry. 7.2 ft / El. 1315.9 ft			SS-3	13-50/2" (5" = 63%)	



Auger bent due to sandstone boulder at 7.2'. Boring offset 15' @ 205 degrees SW, see Boring Log 590-B2.
Bottom of borehole at 7.2 ft.

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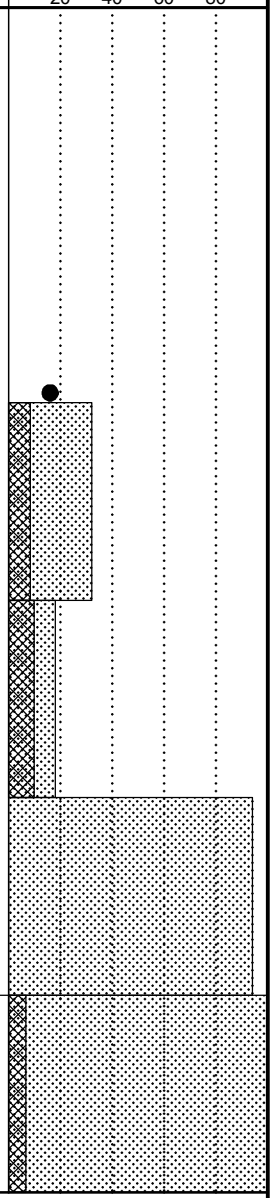
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY DIVISION

BORING LOG 590-B2

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Sheet: 1 of 1
Project Location: Cherokee National Forest, TN
Surface Elevation: 1322.1 ft
Datum: NAVD88
Groundwater Depth:
Latitude: 35.947184° Longitude: -82.8970079°
Datum: NAD83
While Drilling: No Groundwater Encountered
State Plane Coors: N 602009.95 ft E 2886814.587 ft
At Completion: ---
Date Started: 4/8/24 Date Completed: 4/8/24
After Drilling: ---
Driller/Company: A. Clements/Stantec
Drill CME-45
Notes:
Hammer Type: 140 lbs Automatic
Hammer Efficiency: 87.1 %
Boring backfilled with soil cuttings.
Logger/Company: Y. Oumoussi/Stantec
Weather: Partly cloudy

Elevation (ft)	Depth (ft)	Graphic Log	MATERIAL DESCRIPTION	Drilling Method	SAMPLE Type	No.	Field Blow Count (Recovery) Core Rec., RQD, and Frac. Freq.	Test Results
			GRAVEL - 3 INCHES 0.3 ft / El. 1321.8 ft					
1320			SANDSTONE BOULDERS/COBBLES INTERBEDDED WITH SOIL LAYERS.	3-1/4" HSA				Drilled without sampling from 0 to 9.0 ft
1315	5							
			10 ft / El. 1312.1 ft			SS-4	6-8-8 (0" = 0%)	
1310	10		SANDSTONE BOULDERS, light gray. 6-12" soil layers inbetween.	NQ CORE		RC-1	Rec = 32% RQD = 8%	
			15 ft / El. 1307.1 ft					
1305	15		SANDSTONE BOULDERS, light gray and brown. Few soil layers inbetween.			RC-2	Rec = 18% RQD = 10%	
			20 ft / El. 1302.1 ft					
1300	20		SILTSTONE INTERBEDDED WITH SANDSTONE, brown with gray, very weak to weak, highly weathered, highly fractured to fractured, soft to medium hard, contains many iron oxide stains.			RC-3	Rec = 94% RQD = 0%	
1295	25					RC-4	Rec = 100% RQD = 7%	Horizontal and diagonal fractures from 20.0 to 30.0 ft
			28 ft / El. 1294.1 ft					
	30		SILTSTONE, gray with brown, sightly strong, weathered, fractured to moderately fractured, medium hard to hard, contains few iron oxide stains.					
			30 ft / El. 1292.1 ft					



Refusal at 10 ft.
Bottom of borehole at 30 ft.

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U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY DIVISION

BORING LOG 599-A

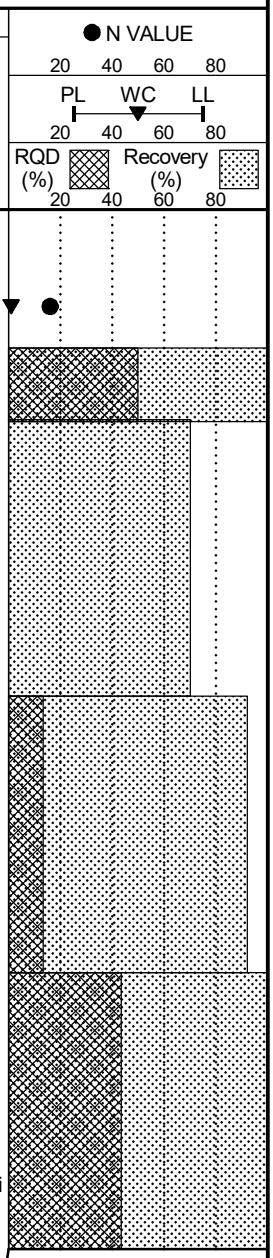
Project Name: TN ERFO FS CHRKE804 2020-2(1)
Project Location: Cherokee National Forest, TN
Groundwater Depth:
While Drilling: No Groundwater Encountered
At Completion: ---
After Drilling: ---
Notes:
Boring backfilled with soil cuttings.

Surface Elevation: 2077.5 ft
Latitude: 36.2237035° Longitude: -82.402078°
State Plane Coors: N 707617.098 ft E 3029525.322 ft
Date Started: 4/5/24 Date Completed: 4/5/24
Driller/Company: A. Clements/Stantec Drill CME-45
Hammer Type: 140 lbs Automatic Hammer Efficiency: 87.1 %
Logger/Company: Y. Oumoussi/Stantec
Weather: Cloudy

Sheet: 1 of 1
Datum: NAVD88
Datum: NAD83

Elevation (ft)	Depth (ft)	Graphic Log	MATERIAL DESCRIPTION	Drilling Method	Type	No.	Field Blow Count (Recovery) / Core Rec., RQD, and Frac. Freq.	Test Results
			LOOSE GRAVEL - 1 INCH 0.1 ft / El. 2077.4 ft	3-1/4" HSA				Mostly shale fragments
			POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM), gray with brown, medium dense, dry, contains few iron ozide stains. 2.5 ft / El. 2075 ft			SS-1	7-8-8 (12" = 67%)	Nearly horizontal fractures from 2.5 to 3.8 ft
2075			SHALE (90%) INTERBEDDED WITH SANDSTONE (10%), gray, moderately strong to strong, moderately weathered, highly fractured to fractured, hard. 3.8 ft / El. 2073.7 ft	NQ CORE		RC-1	Rec = 100% RQD = 50%	
	5		DOLOSTONE (90%) INTERBEDDED WITH SANDSTONE (10%), gray and brown, strong, highly weathered, highly fractured, medium hard to hard.			RC-2	Rec = 70% RQD = 0%	
2070								
	10		11.9 ft / El. 2065.6 ft			RC-3	Rec = 92% RQD = 13%	Diagonal fractures from 11.9 to 16.3 ft
2065			DOLOSTONE, gray, strong, moderately weathered, fractured to moderately fractured, hard. Highly fractured from 16.3 to 17.3'					
	15					RC-4	Rec = 100% RQD = 43%	
2060			18.8 ft / El. 2058.7 ft					Elv. 2060.2 ft UC = 10890 psi Nearly horizontal fractures at 17.5 ft

Refusal at 2.5 ft.
Bottom of borehole at 18.8 ft.



FHWA LOG - FHWA_DATATEMPLATE.GDT - 6/28/24 09:35 - C:\USERS\YOUMOUSSI\ONEDRIVE - STANTEC\ATTACHMENTS\DESKTOP\CHEROKEE NATIONAL FOREST\202625232 9\TN ERFO SITE 1.GPJ

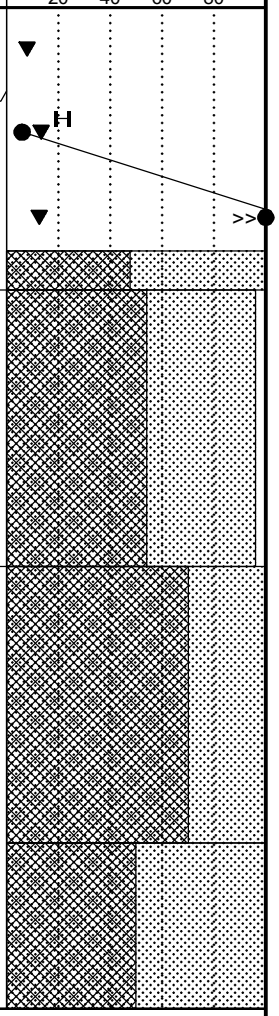
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY DIVISION

BORING LOG 599-B

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Sheet: 1 of 1
Project Location: Cherokee National Forest, TN
Surface Elevation: 2083.3 ft
Datum: NAVD88
Groundwater Depth:
Latitude: 36.2236205° Longitude: -82.401888°
Datum: NAD83
While Drilling: No Groundwater Encountered
State Plane Coors: N 707588.96 ft E 3029582.449 ft
At Completion: ---
Date Started: 4/6/24 Date Completed: 4/6/24
After Drilling: ---
Driller/Company: A.Clements/Stantec
Drill CME-45
Notes:
Hammer Type: 140 lbs Automatic
Hammer Efficiency: 87.1 %
Boring backfilled with soil cuttings.
Logger/Company: Y. Oumoussi/Stantec
Weather: Partly cloudy

Elevation (ft)	Depth (ft)	Graphic Log	MATERIAL DESCRIPTION	Drilling Method	Type	No.	Field Blow Count (Recovery) / Core Rec., RQD, and Frac. Freq.	Test Results
			LOOSE GRAVEL - 2 INCHES 0.2 ft / El. 2083.1 ft	3-1/4" HSA		GB-1		Difficult drilling from 0.2 to 1.0 ft and 3.5 to 4.4 ft
			SILTY, CLAYEY SAND WITH GRAVEL (SC-SM), brown, loose, moist, contains iron oxide stains. Possible cobbles from 0.2 to 1.0' Contains wood fragments from 3.5 to 4.0' Moderately organic from 3.5 to 4.0' 4 ft / El. 2079.3 ft			SS-1	3-3-3 (10" = 56%)	
2080						SS-2	15-50/1" (6" = 86%)	
			SANDY SHALE, gray with brown, slightly strong, highly weathered, highly fractured, medium hard, contains many iron oxide stains. 4.7 ft / El. 2078.6 ft	NQ CORE		RC-1	Rec = 100% RQD = 48%	
	5		DOLOSTONE, gray, strong to very strong, slightly weathered to unweathered, moderately to slightly fractured, had to very hard. Fractured from 15.6 to 16.8' Calcareous stains from 8.6 to 16.0' Calcarreous and carbonaceous stains from 16.0 to 18.1'			RC-2	Rec = 96% RQD = 54%	Elv. 2076.6 ft UC = 13430 psi Horizontal, vertical and diagonal fractures from 5.1 to 17.8 ft
2075								
	10					RC-3	Rec = 100% RQD = 70%	Elv. 2069.1 ft UC = 11820 psi
2070								
	15					RC-4	Rec = 100% RQD = 50%	
			18.1 ft / El. 2065.2 ft					

Refusal at 4.4 ft.
Bottom of borehole at 18.1 ft.



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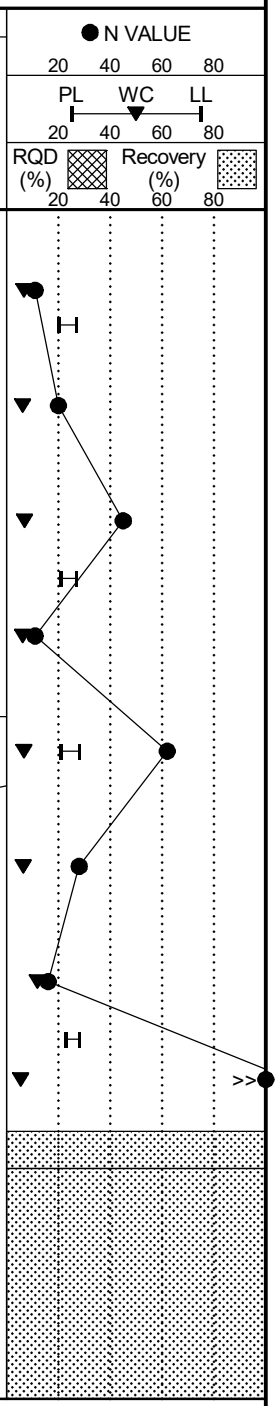
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY DIVISION

BORING LOG 633-A

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Sheet: 1 of 1
Project Location: Cherokee National Forest, TN
Surface Elevation: 2423.1 ft
Datum: NAVD88
Groundwater Depth:
Latitude: 36.229491° Longitude: -82.3784495°
Datum: NAD83
While Drilling: No Groundwater Encountered
State Plane Coors: N 709979.566 ft E 3036412.238 ft
At Completion: ---
Date Started: 4/6/24 Date Completed: 4/6/24
After Drilling: ---
Driller/Company: A. Clements/Stantec
Drill CME-45
Notes:
Hammer Type: 140 lbs Automatic
Hammer Efficiency: 87.1 %
Boring backfilled with soil cuttings.
Logger/Company: Y. Oumoussi/Stantec
Weather: Partly cloudy

Elevation (ft)	Depth (ft)	Graphic Log	MATERIAL DESCRIPTION	Drilling Method	Type	No.	Field Blow Count (Recovery) Core Rec., RQD, and Frac. Freq.	Test Results
			WELL GRADED GRAVEL WITH CLAY AND SAND (GW-GC), brown with gray, medium dense, dry to damp, contains some to many iron oxide stains.	3-1/4" HSA				
						SS-1	6-5-6 (13" = 72%)	Mostly sandstone and shale fragments
2420								
						SS-2	10-10-10 (18" = 100%)	
	5		5.5 ft / El. 2417.6 ft					
			SILTY, CLAYEY SAND WITH GRAVEL (SC-SM), brown with gray, medium dense to dense, damp, contains many iron oxide stains.					
						SS-3	20-22-23 (18" = 100%)	
2415								
						SS-4	7-5-6 (14" = 80%)	
	10		10.5 ft / El. 2412.6 ft					
			SILTY SAND WITH GRAVEL (SM), brown, medium dense to very dense, damp, contains few to many iron oxide stains. Very dense at 11.0' Medium dense at 13.5' Similar to weathered sandstone from 18.0 to 19.0'					
						SS-5	25-35-27 (18" = 100%)	Mostly sandy shale fragments
2410								
						SS-6	15-16-12 (18" = 100%)	
	15							
						SS-7	2-6-10 (14" = 80%)	
2405								
			19 ft / El. 2404.1 ft					
						SS-8	23-50/3" (9" = 100%)	
			SANDSTONE, fine to medium grained, brown becoming gray, strong, weathered to moderately weathered, highly fractured to fractured, hard.					
	20		21 ft / El. 2402.1 ft	NQ CORE		RC-1	Rec = 100% RQD = 0%	Horizontal and vertical fractures from 21.0 to 25.8 ft
			SANDY SHALE, fine grained, gray with brown, strong, weathered, highly fractured to fractured, hard.					
2400						RC-2	Rec = 100% RQD = 0%	
	25		25.8 ft / El. 2397.3 ft					



Bottom of borehole at 25.8 ft.

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U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY DIVISION

BORING LOG 633-B

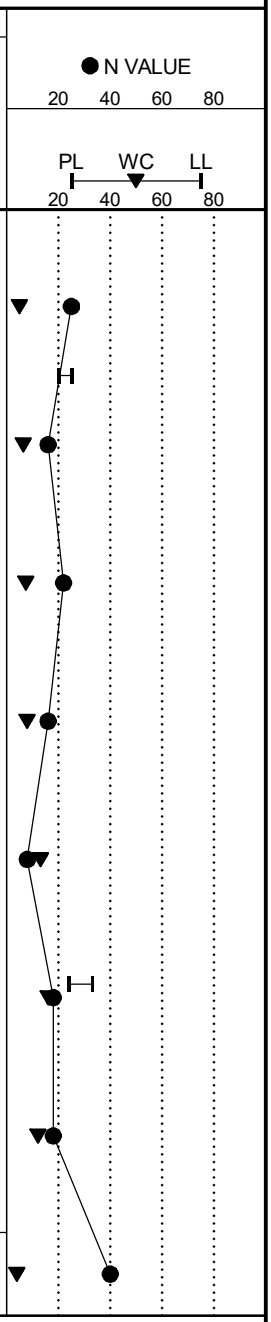
Project Name: TN ERFO FS CHRKE804 2020-2(1)
Project Location: Cherokee National Forest, TN
Groundwater Depth:
While Drilling: No Groundwater Encountered
At Completion: ---
After Drilling: No Groundwater Encountered
Notes:
Boring backfilled with soil cuttings.

Surface Elevation: 2419.7 ft
Latitude: 36.2295384° Longitude: -82.3781653°
State Plane Coors: N 709999.892 ft E 3036495.364 ft
Date Started: 4/6/24 Date Completed: 4/6/24
Driller/Company: A. Clements/Stantec Drill CME-45
Hammer Type: 140 lbs Automatic Hammer Efficiency: 87.1 %
Logger/Company: Y. Oumoussi/Stantec
Weather: Partly cloudy

Sheet: 1 of 1
Datum: NAVD88
Datum: NAD83

Elevation (ft)	Depth (ft)	Graphic Log	MATERIAL DESCRIPTION	Drilling Method	Type	No.	Field Blow Count (Recovery)	Test Results
			WELL GRADED GRAVEL WITH CLAY AND SAND (GW-GC), brown and gray, medium dense, dry to damp, contains few iron oxide stains.	3-1/4" HSA				
						SS-1	8-10-15 (18" = 100%)	Mostly sandstone and shale fragments
						SS-2	7-7-9 (18" = 100%)	
2415	5		5.5 ft / El. 2414.2 ft					
			SILTY SAND WITH GRAVEL(SM), brown with gray, medium dense, moist to very moist, contains many iron oxide stains.			SS-3	7-11-11 (16" = 89%)	
						SS-4	8-8-8 (18" = 100%)	
2410	10		10.5 ft / El. 2409.2 ft					
			POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM), brown with gray, loose to medium dense, moist to very moist, contains many iron oxide stains.			SS-5	3-3-5 (13" = 72%)	
						SS-6	17-8-10 (18" = 100%)	Mostly shale and sandstone fragments
2405	15					SS-7	6-8-10 (18" = 100%)	
			18 ft / El. 2401.7 ft					
			POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM), gray with brown, dense, dry, contains few iron oxide stains.			SS-8	17-20-20 (18" = 100%)	Mostly sandy shale fragments
2400	20		20 ft / El. 2399.7 ft					

Bottom of borehole at 20 ft.



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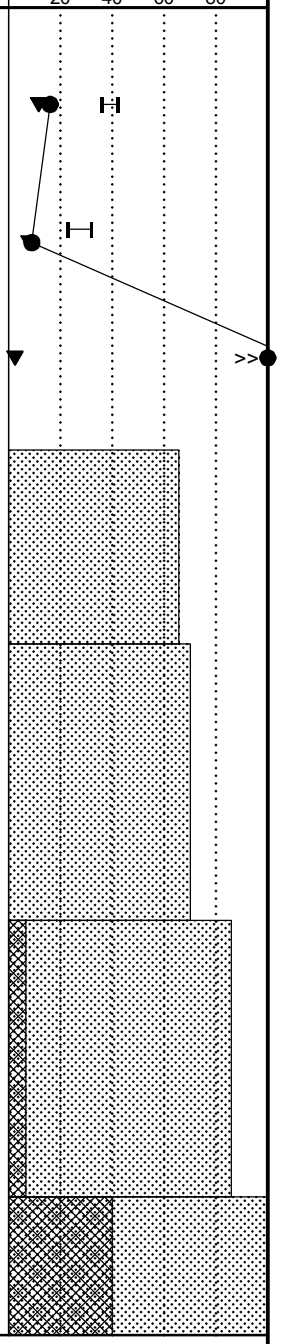
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY DIVISION

BORING LOG 659-A

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Sheet: 1 of 1
Project Location: Cherokee National Forest, TN
Surface Elevation: 1776.5 ft
Datum: NAVD88
Groundwater Depth:
Latitude: 36.514508° Longitude: -82.0391154° Datum: NAD83
While Drilling: No Groundwater Encountered
State Plane Coors: N 817533.492 ft E 3132223.48 ft
At Completion: ---
Date Started: 4/2/24 Date Completed: 4/2/24
After Drilling: No Groundwater Encountered
Driller/Company: A. Clements/Stantec Drill CME-45
Notes:
Hammer Type: 140 lbs Automatic Hammer Efficiency: 87.1 %
Boring backfilled with soil cuttings then an equal thicknes of asphalt cold patch.
Logger/Company: Y. Oumoussi/Stantec
Weather: Partly cloudy to cloudy

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Drilling Method	Sample Type	Sample No.	Field Blow Count (Recovery) / Core Rec., RQD, and Frac. Freq.	Test Results
		ASPHALT - 3 INCHES 0.3 ft / El. 1776.2 ft					
		AGGREGATE BASE - 4 INCHES 0.6 ft / El. 1775.9 ft					
1775		CLAYEY SAND WITH GRAVEL (SC), brown, medium dense, damp, contains iron oxide stains. 3 ft / El. 1773.5 ft		SS	SS-1	7-8-8 (2" = 8%)	
		POORLY GRADED GRAVEL WITH CLAY AND SAND (GP-GC), brown, loose, moist, contains iron oxide stains. 5.5 ft / El. 1771 ft	3-1/4" HSA	SS	SS-2	4-4-5 (2" = 8%)	
1770	5	SILTSTONE INTERBEDDED WITH SHALE, gray to greenish gray, slightly strong, highly to moderately weathered, highly fractured to fractured, medium hard, contains few iron oxide stains. 10 ft / El. 1766.5 ft		SS	SS-3	16-50/2" (1" = 9%)	
1765	10	SILTSTONE, greenish gray, very weak, extremly to highly weathered, highly fractured, very soft to soft, contains iron oxide stains. Possible void from 19.0 to 19.8'	NQ CORE	RC	RC-1	Rec = 66% RQD = 0%	Vertical fracture from 8.9 to 9.1 ft
1760	15			RC	RC-2	Rec = 70% RQD = 0%	
	20	20.5 ft / El. 1756 ft		RC	RC-3	Rec = 86% RQD = 7%	Diagonal and vertical fractures from 19.0 to 24.0 ft Elv. 1756.0 ft UC = 2368 psi
1755		SHALE INTERBEDDED WITH SILTSTONE, gray, moderately strong to strong, slightly weathered, moderately fractured, hard, contains iron oxide stains. 24 ft / El. 1752.5 ft		RC	RC-4	Rec = 100% RQD = 40%	

Graphic Log



Bottom of borehole at 24 ft.

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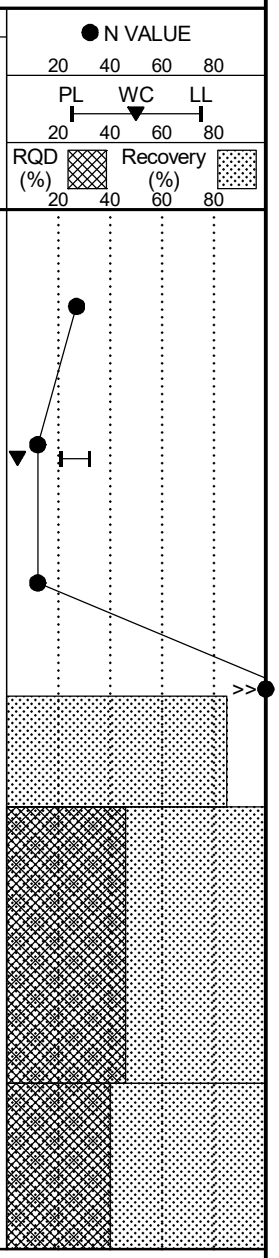
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY DIVISION

BORING LOG 659-B

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Sheet: 1 of 1
Project Location: Cherokee National Forest, TN
Surface Elevation: 1775.5 ft
Datum: NAVD88
Groundwater Depth:
Latitude: 36.5145938° Longitude: -82.038985°
Datum: NAD83
While Drilling: No Groundwater Encountered
State Plane Coors: N 817566.272 ft E 3132260.498 ft
At Completion: ---
Date Started: 4/2/24 Date Completed: 4/2/24
After Drilling: ---
Driller/Company: A. Clements/Stantec
Drill CME-45
Notes:
Hammer Type: 140 lbs Automatic
Hammer Efficiency: 87.1 %
Boring backfilled with soil cuttings then an equal thickness of asphalt cold patch.
Logger/Company: Y. Oumoussi/Stantec
Weather: Partly cloudy to cloudy

Elevation (ft)	Depth (ft)	Graphic Log	MATERIAL DESCRIPTION	Drilling Method	SAMPLE Type	No.	Field Blow Count (Recovery) / Core Rec., RQD, and Frac. Freq.	Test Results
1775			ASPHALT - 3.5 INCHES 0.3 ft / El. 1775.2 ft					
			AGGREGATE BASE - 4 INCHES 0.6 ft / El. 1774.9 ft					
			WELL GRADED GRAVEL WITH CLAY AND SAND (GW-GC), gray with brown, medium dense, dry to damp, contains iron oxide stains.	3-1/4" HSA	SS	SS-1	14-15-12 (5" = 28%)	Mostly sandstone and shale fragments
	5				SS	SS-2	12-7-5 (14" = 78%)	
1770					SS	SS-3	4-8-4 (10" = 56%)	
			8 ft / El. 1767.5 ft					
			SILTSTONE, gray with brown, slightly strong, highly to moderately weathered, highly fractured to fractured, medium hard to hard, contains some iron oxide stains. Highly fractured from 10.8 to 11.0' Clay seam from 11.6 to 11.7'		SS	SS-4	50/4" (4" = 100%)	
	10			NQ CORE	RC	RC-1	Rec = 85% RQD = 0%	Diagonal fractures from 9.5 to 16.6 ft
1765			12.5 ft / El. 1763 ft					
			SHALE, gray, slightly to moderately strong, slightly weathered, fractured to moderately fractured, hard, contains few iron oxide stains.		RC	RC-2	Rec = 100% RQD = 46%	Elv. 1762.1 ft UC = 2094 psi
	15							
1760					RC	RC-3	Rec = 100% RQD = 40%	Elv. 1758.8 ft UC = 853 psi
			17.9 ft / El. 1757.6 ft					
			SILTSTONE, greenish gray, moderately strong, moderately weathered, fractured, hard. Calcareous from 17.9 to 18.0'					
			18.8 ft / El. 1756.7 ft					

Bottom of borehole at 18.8 ft.



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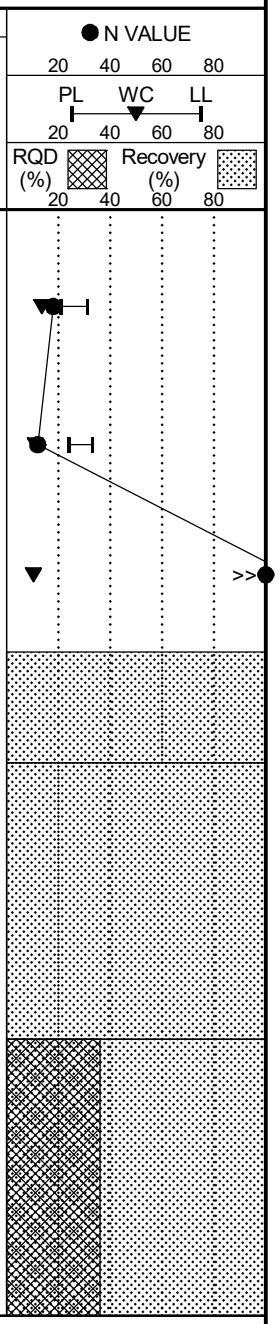
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY DIVISION

BORING LOG 660-A

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Sheet: 1 of 1
Project Location: Cherokee National Forest, TN
Surface Elevation: 1773.3 ft
Datum: NAVD88
Groundwater Depth:
Latitude: 36.5148247° Longitude: -82.0383457°
Datum: NAD83
While Drilling: No Groundwater Encountered
State Plane Coors: N 817657.846 ft E 3132444.818 ft
At Completion: ---
Date Started: 4/3/24 Date Completed: 4/3/24
After Drilling: ---
Driller/Company: A. Clements/Stantec
Drill CME-45
Notes:
Hammer Type: 140 lbs Automatic
Hammer Efficiency: 87.1 %
Boring backfilled with soil cuttings then an equal thickness of asphalt cold patch.
Logger/Company: Y. Oumoussi/Stantec
Weather: Cloudy with light rain

Elevation (ft)	Depth (ft)	Graphic Log	MATERIAL DESCRIPTION	Drilling Method	Sample Type	Sample No.	Field Blow Count (Recovery) / Core Rec., RQD, and Frac. Freq.	Test Results
			ASPHALT - 2 INCHES 0.2 ft / El. 1773.1 ft					
			AGGREGATE BASE - 4 INCHES 0.5 ft / El. 1772.8 ft					
			CLAYEY GRAVEL WITH SAND (CL), brown with gray, medium dense, damp. (Possible fill) 3 ft / El. 1770.3 ft		SS	SS-1	12-10-8 (18" = 100%)	
1770			SANDSTONE FRAGMENTS WITH SAND (GM), similar to silty gravel with sand, fine to medium grained, brown with gray, medium dense, dry, contains iron oxide stains.	3-1/4" HSA	SS	SS-2	7-8-4 (18" = 100%)	
	5				SS	SS-3	12-18-50/2" (14" = 100%)	Many horizontal fractures from 7.0 to 11.0 ft
			7 ft / El. 1766.3 ft SILTSTONE (70%) INTERBEDDED WITH SANDSTONE (30%), brown with gray, slightly strong, highly weathered, highly fractured to fractured, medium hard, contains many iron oxide stains.					
1765				NQ CORE	RC	RC-1	Rec = 100% RQD = 0%	
	10				RC	RC-2	Rec = 100% RQD = 0%	
1760			13.9 ft / El. 1759.4 ft LIMESTONE INTERBEDDED WITH SHALE, gray, moderately strong to strong, slightly weathered, fractured to moderately fractured, hard.					
	15				RC	RC-3	Rec = 100% RQD = 36%	Elv. 1757.8 ft UC = 2856 psi Horizontal and diagonal fractures from 15.0 to 20.0 ft
1755			20 ft / El. 1753.3 ft					
	20							

Bottom of borehole at 20 ft.



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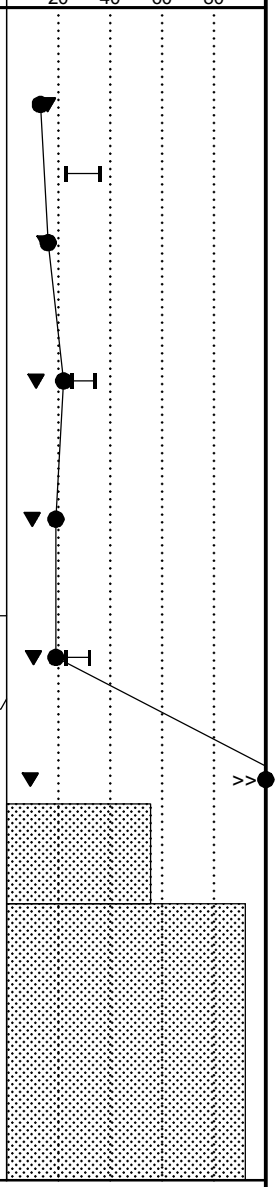
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY DIVISION

BORING LOG 660-B

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Sheet: 1 of 1
Project Location: Cherokee National Forest, TN
Surface Elevation: 1773.6 ft
Datum: NAVD88
Groundwater Depth:
Latitude: 36.5148014° Longitude: -82.0385896°
Datum: NAD83
While Drilling: No Groundwater Encountered
State Plane Coors: N 817646.479 ft E 3132373.542 ft
At Completion: ---
Date Started: 4/3/02 Date Completed: 4/3/04
After Drilling: ---
Driller/Company: A. Clements/Stantec
Drill CME-45
Notes:
Hammer Type: 140 lbs Automatic
Hammer Efficiency: 87.1 %
Boring backfilled with mixture of soil cuttings and bentonite chips then an equal thickness of asphalt cold patch.
Logger/Company: Y. Oumoussi/Stantec
Weather: Cloudy with light rain

Elevation (ft)	Depth (ft)	Graphic Log	MATERIAL DESCRIPTION	Drilling Method	Type	No.	Field Blow Count (Recovery) / Core Rec., RQD, and Frac. Freq.	Test Results
			ASPHALT - 3 INCHES 0.3 ft / El. 1773.3 ft					
			AGGREGATE BASE - 4 INCHES 0.6 ft / El. 1773 ft					
			CLAYEY GRAVEL WITH SAND (GC), brown, medium dense, dry to damp, contains few iron oxide stains.		SS	SS-1	6-6-7 (16" = 87%)	Mostly sandstone fragments
1770					SS	SS-2	7-8-8 (12" = 67%)	
	5		5.5 ft / El. 1768.1 ft					
			SILTY SAND (SM), trace rock fragments, brown, medium dense, damp, contains few iron oxide stains.	3-1/4" HSA	SS	SS-3	6-10-12 (18" = 100%)	
			8 ft / El. 1765.6 ft					
1765			CLAYEY GRAVEL WITH SAND (GM), fine grained, brown, medium dense, dry, contains few iron oxide stains.		SS	SS-4	7-9-10 (18" = 100%)	
	10				SS	SS-5	10-10-9 (14" = 80%)	Mostly sandstone and limestone fragments
1760					SS	SS-6	33-50/5" (11" = 100%)	Horizontal, vertical and diagonal fractures from 14.9 to 21.2 ft
			14.9 ft / El. 1758.7 ft					
	15		LIMESTONE INTERBEDDED WITH SHALE, gray, slightly strong, highly to moderately weathered, highly fractured to fractured, medium hard to hard, contains few iron oxide stains. Extremely fractured from 19.2 to 19.7'	NQ CORE	RC	RC-1	Rec = 56% RQD = 0%	
1755					RC	RC-2	Rec = 92% RQD = 0%	
	20		21.2 ft / El. 1752.4 ft					



Bottom of borehole at 21.2 ft.

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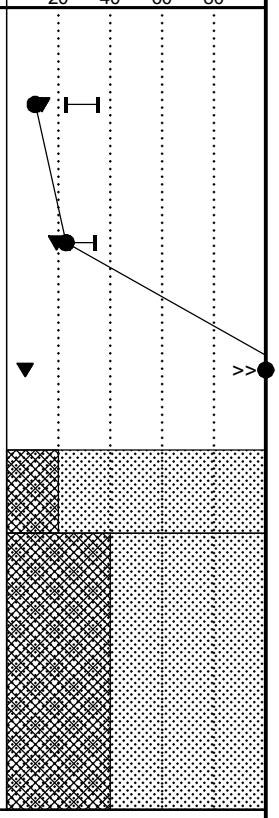
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY DIVISION

BORING LOG 660-C

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Sheet: 1 of 1
Project Location: Cherokee National Forest, TN
Surface Elevation: 1774.8 ft
Datum: NAVD88
Groundwater Depth:
Latitude: 36.5146842° Longitude: -82.0388809°
Datum: NAD83
While Drilling: No Groundwater Encountered
State Plane Coors: N 817600.378 ft E 3132289.735 ft
At Completion: ---
Date Started: 4/4/24 Date Completed: 4/4/24
After Drilling: ---
Driller/Company: A. Clements/Stantec
Drill CME-45
Notes:
Hammer Type: 140 lbs Automatic
Hammer Efficiency: 87.1 %
Boring backfilled with mixture of soil cuttings and bentonite chips then an equal thickness of asphalt cold patch.
Logger/Company: Y. Oumoussi/Stantec
Weather: Cloudy with heavy rain

Elevation (ft)	Depth (ft)	Graphic Log	MATERIAL DESCRIPTION	Drilling Method	Sample Type	Sample No.	Field Blow Count (Recovery) / Core Rec., RQD, and Frac. Freq.	Test Results
			ASPHALT - 2.5 INCHES 0.2 ft / El. 1774.6 ft	3-1/4" HSA				
			AGGREGATE BASE - 4.5 INCHES 0.6 ft / El. 1774.2 ft		SS	SS-1	6-6-5 (18" = 100%)	
			CLAYEY SAND WITIH GRAVEL (SC), brown with gray, medium dense, dry to damp, contains few iron oxide stains. (Possible fill) 3 ft / El. 1771.8 ft					
1770	5		SILTY SAND WITH GRAVEL (SC), trace clay, brown, medium dense, damp, ntains some iron oxide stains. 5.5 ft / El. 1769.3 ft		SS	SS-2	11-11-12 (18" = 100%)	Mostly sandstone and limestone fragments
			SILTY, CLAYEY GRAVEL WITH SAND (GC-GM), fine grained, brown with gray, dense to very dense, dry, contains iron oxide stains. 7 ft / El. 1767.8 ft		SS	SS-3	28-33-50/1" (14" = 106%)	
			SILTSTONE, gray, slightly strong, highly to moderately weathered, highly fractured to fractured, medium hard to hard, contains iron oxide stains. 8.5 ft / El. 1766.3 ft	NQ CORE	RC	RC-1	Rec = 100% RQD = 20%	Diagonal fractures from 8.5 to 14.5 ft
1765	10		SHALE INTERBEDDED WITH LIMESTONE, gray, strong, slightly weathered, fractured to moderately fractured, hard to very hard, contains few iron oxide stains. 14.5 ft / El. 1760.3 ft		RC	RC-2	Rec = 100% RQD = 40%	Elv. 1764.3 ft UC = 1278 psi

Bottom of borehole at 14.5 ft.



FHWA LOG - FHWA_DATATEMPLATE.GDT - 6/28/24 09:35 - C:\USERS\YOUMOUSSI\ONEDRIVE - STANTEC\ATTACHMENTS\DESKTOP\CHEROKEE NATIONAL FOREST\20262523291TN ERFO SITE 1.GPJ

APPENDIX C
Laboratory Test Results

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	659-A, 1.0'-2.5'	Lab ID	1
Sample Type	SS-1	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: AASHTO T 265

Moisture Content (%): 11.6

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	84.9
3/8"	9.5	80.0
No. 4	4.75	80.0
No. 10	2	62.3
No. 40	0.425	38.3
No. 200	0.075	31.0
	0.02	20.1
	0.005	13.1
	0.002	9.2
Estimated	0.001	6.3

Plus 3 in. Material, Not Included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	20.0	37.7
Coarse Sand	17.7	24.0
Medium Sand	24.0	---
Fine Sand	7.3	7.3
Silt	17.9	21.8
Clay	13.1	9.2

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	36
Plastic Limit:	24
Plasticity Index:	12
Activity Index:	1.3

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	SC
Group Name:	Clayey Sand with Gravel
AASHTO Classification:	A-2-6 (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Source: 659-A, 1.0'-2.5'

Project Number: 2026252329
Lab ID: 1

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: JP
Test Date: 05-10-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	84.9
3/8"	80.0
No. 4	80.0
No. 10	62.3

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

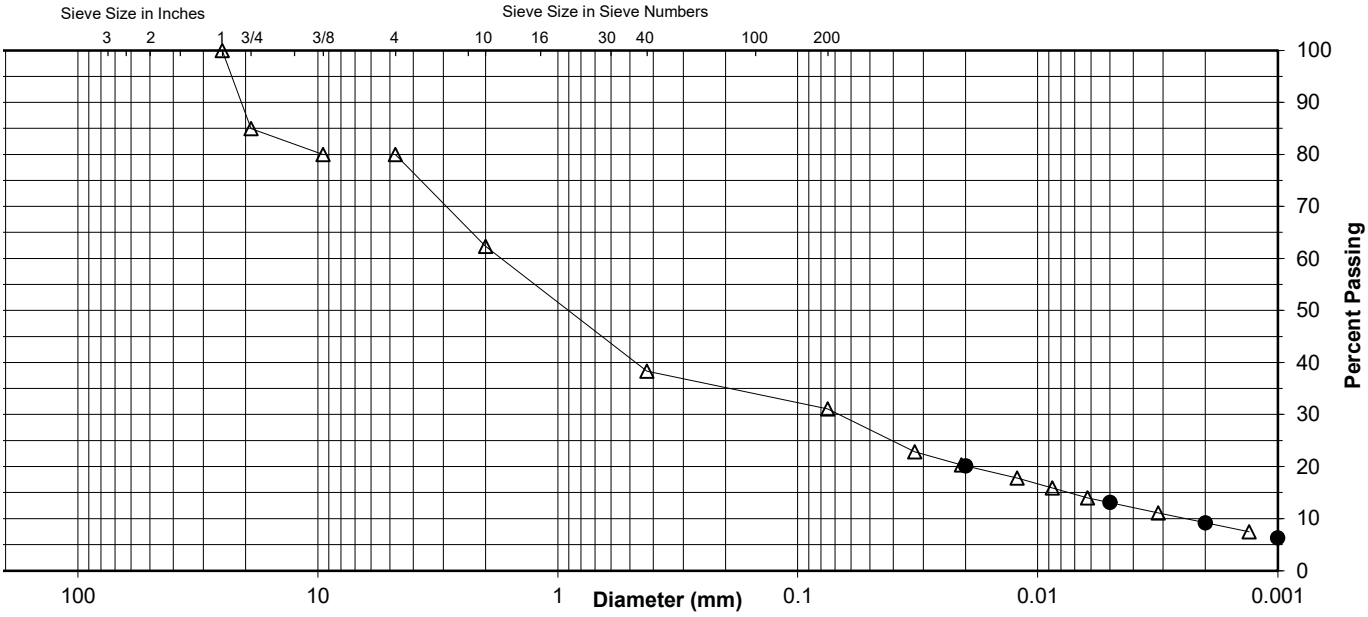
Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	38.3
No. 200	31.0
0.02 mm	20.1
0.005 mm	13.1
0.002 mm	9.2
0.001 mm	6.3

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	15.1	4.9	17.7	24.0	7.3	17.9	13.1
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt	Clay
	37.7			24.0	7.3	21.8	9.2



Comments

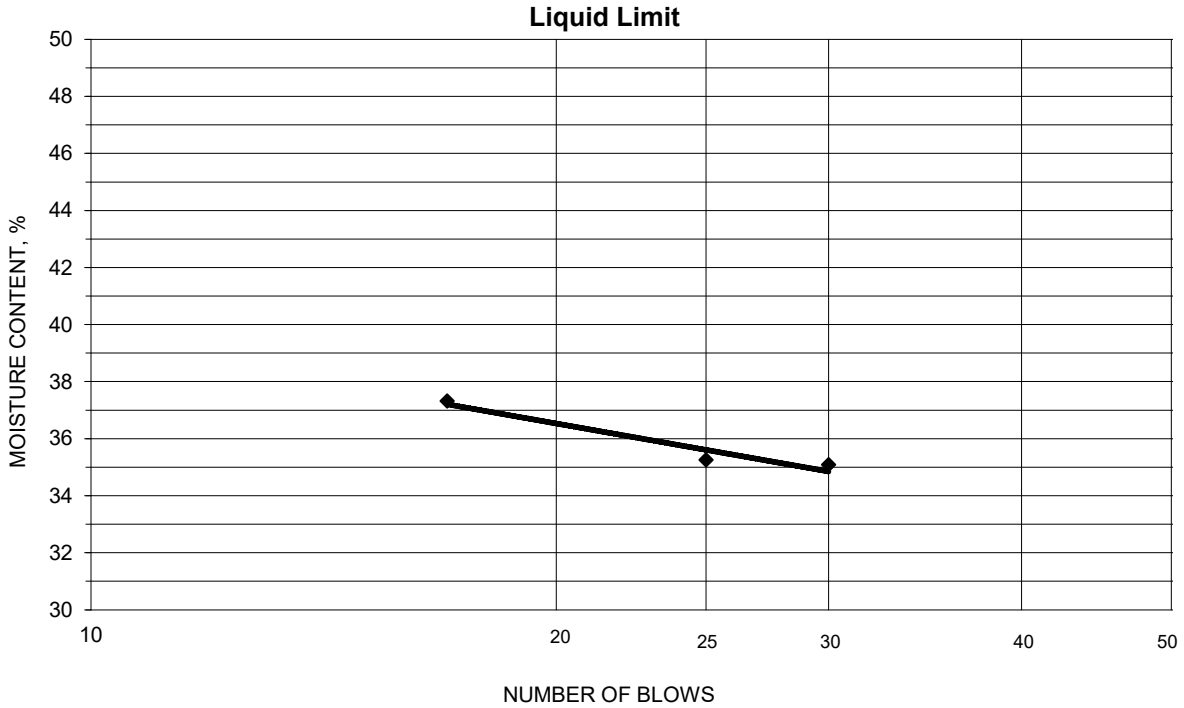
Reviewed By: REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	659-A, 1.0'-2.5'	Lab ID	1
		% + No. 40	62
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-14-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.57	17.26	11.07	17	37.3	
19.05	16.85	10.61	25	35.3	
18.76	16.76	11.06	30	35.1	36



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
24.08	21.44	10.59	24.3	24	12
24.66	21.98	11.01	24.4		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	659-A, 3.5'-5.0', 6.0'-6.7'	Lab ID	2
Sample Type	SS-2 Composite	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 5.1

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	87.9
3/8"	9.5	64.3
No. 4	4.75	51.7
No. 10	2	33.6
No. 40	0.425	16.0
No. 200	0.075	11.3
	0.02	6.7
	0.005	3.8
	0.002	2.6
Estimated	0.001	1.6

Plus 3 in. Material, Not Included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	48.3	66.4
Coarse Sand	18.1	17.6
Medium Sand	17.6	---
Fine Sand	4.7	4.7
Silt	7.5	8.7
Clay	3.8	2.6

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	32
Plastic Limit:	23
Plasticity Index:	9
Activity Index:	3.5

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	GP-GC
Group Name:	Poorly Graded Gravel with Clay and Sand (or Silty Clay and Sand)
AASHTO Classification:	A-2-4 (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Source: 659-A, 3.5'-5.0', 6.0'-6.7'

Project Number: 2026252329
Lab ID: 2

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: JP
Test Date: NU
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	87.9
3/8"	64.3
No. 4	51.7
No. 10	33.6

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

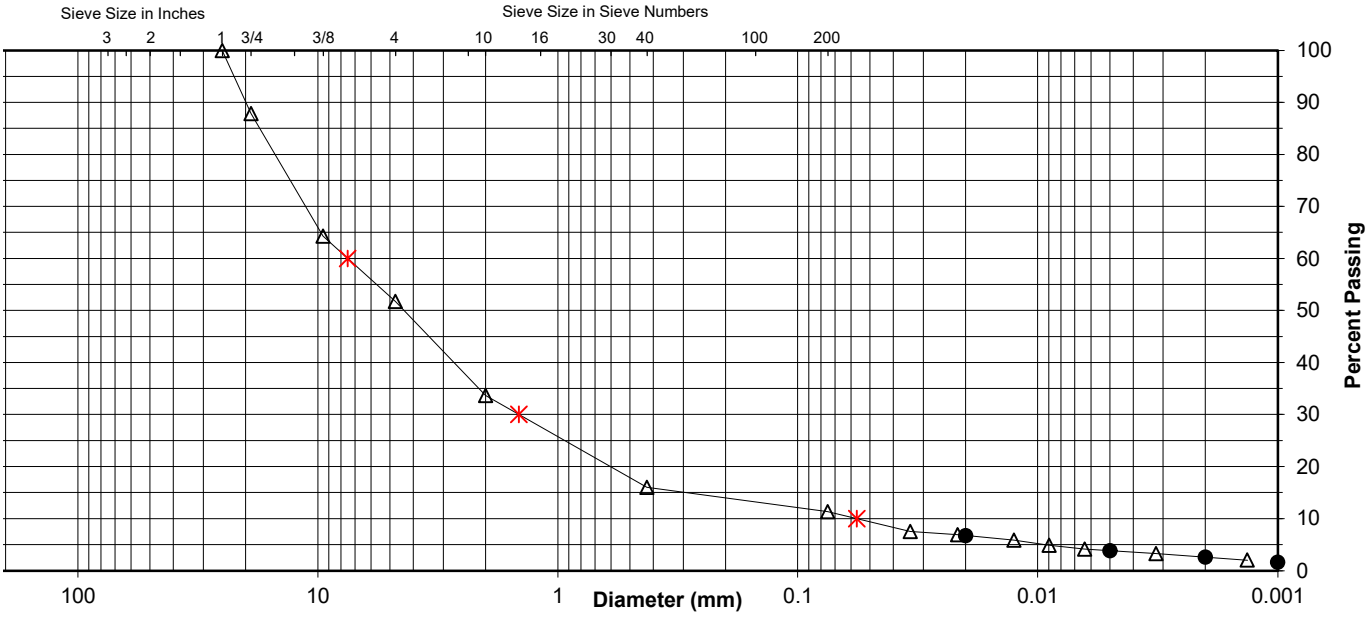
Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	16.0
No. 200	11.3
0.02 mm	6.7
0.005 mm	3.8
0.002 mm	2.6
0.001 mm	1.6

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	12.1	36.2	18.1	17.6	4.7	7.5	3.8
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt	Clay
	66.4			17.6	4.7	8.7	2.6



Comments

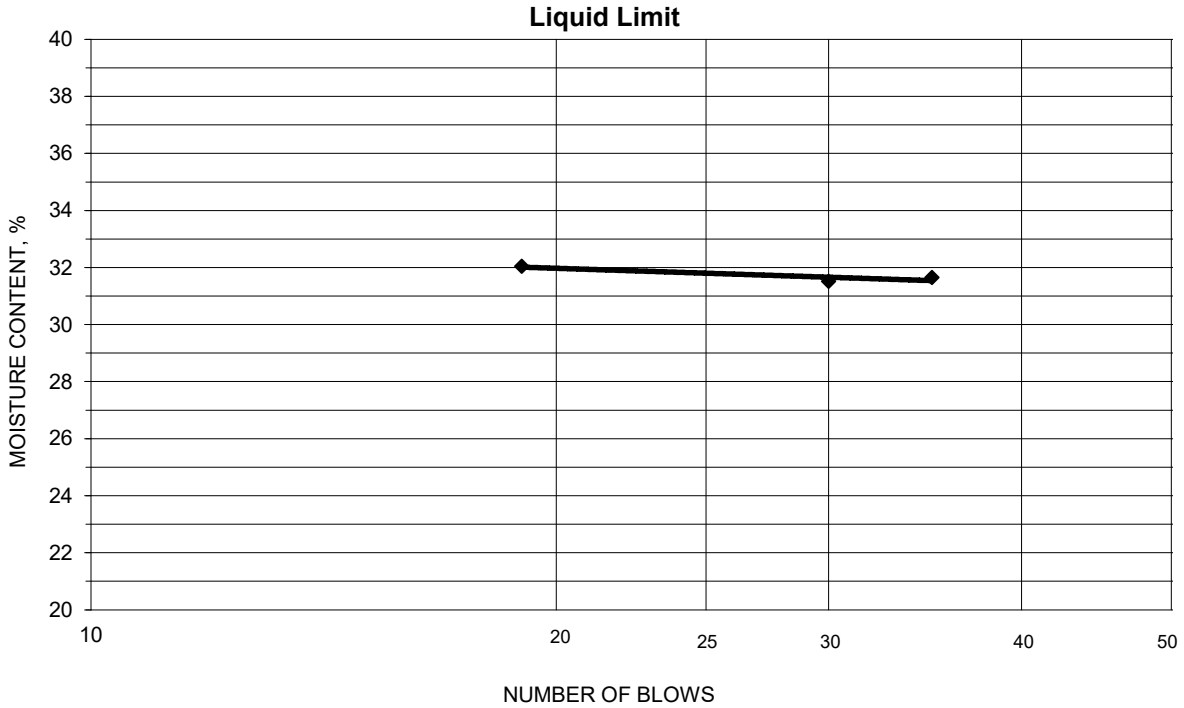
Reviewed By REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	659-A, 3.5'-5.0', 6.0'-6.7'	Lab ID	2
		% + No. 40	84
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-14-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.28	17.20	10.71	19	32.0	32
20.18	17.98	11.00	30	31.5	
20.13	17.94	11.02	35	31.6	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
23.48	21.13	11.06	23.3	23	9
21.36	19.46	11.04	22.6		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	659-B, 1.0'-2.5', 3.5'-5.0', 6.0'-7.5'	Lab ID	5
Sample Type	SS-1 Composite	Date Received	4-25-24
		Date Reported	5-24-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 11.7

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	54.2
3/8"	9.5	40.5
No. 4	4.75	29.8
No. 10	2	21.7
No. 40	0.425	9.9
No. 200	0.075	7.5
	0.02	4.0
	0.005	2.3
	0.002	1.2
Estimated	0.001	0.3

Plus 3 in. Material, Not Included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	70.2	78.3
Coarse Sand	8.1	11.8
Medium Sand	11.8	---
Fine Sand	2.4	2.4
Silt	5.2	6.3
Clay	2.3	1.2

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	32
Plastic Limit:	21
Plasticity Index:	11
Activity Index:	9.2

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	GW-GC
Group Name:	Well-Graded Gravel with Clay and Sand (or Silty Clay and Sand)
AASHTO Classification:	A-2-6 (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Source: 659-B, 1.0'-2.5', 3.5'-5.0', 6.0'-7.5'

Project Number: 2026252329
Lab ID: 5

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: GK
Test Date: 05-21-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	54.2
3/8"	40.5
No. 4	29.8
No. 10	21.7

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

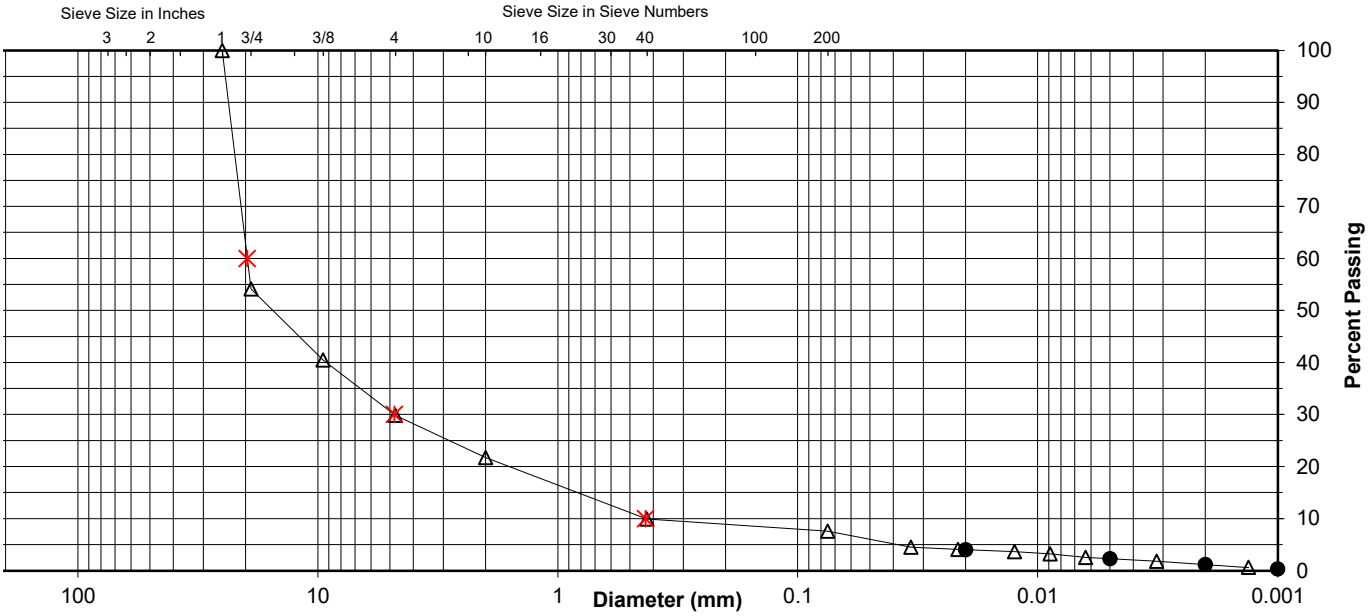
Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	9.9
No. 200	7.5
0.02 mm	4.0
0.005 mm	2.3
0.002 mm	1.2
0.001 mm	0.3

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	45.8	24.4	8.1	11.8	2.4	5.2	2.3
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt	Clay
	78.3			11.8	2.4	6.3	1.2



Comments

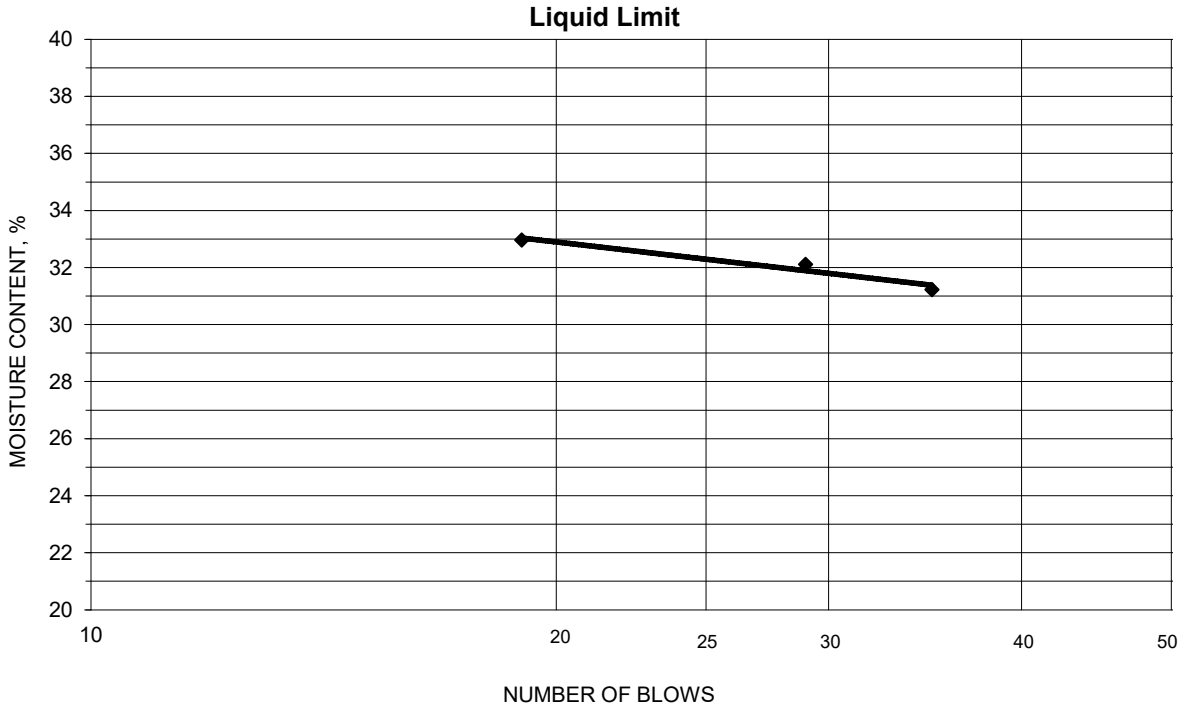
Reviewed By: REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	659-B, 1.0'-2.5', 3.5'-5.0', 6.0'-7.5'	Lab ID	5
		% + No. 40	90
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-22-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.01	16.92	10.58	19	33.0	32
19.62	17.51	10.94	29	32.1	
19.72	17.55	10.60	35	31.2	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
21.42	19.51	10.68	21.6	21	11
24.29	21.97	11.02	21.2		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	660-A, 1.0'-2.5'	Lab ID	10
Sample Type	SS-1	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: AASHTO T 265

Moisture Content (%): 13.5

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	82.7
3/8"	9.5	63.5
No. 4	4.75	50.8
No. 10	2	36.1
No. 40	0.425	22.4
No. 200	0.075	17.1
	0.02	11.6
	0.005	7.5
	0.002	4.9
Estimated	0.001	2.9

Plus 3 in. Material, Not Included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	49.2	63.9
Coarse Sand	14.7	13.7
Medium Sand	13.7	---
Fine Sand	5.3	5.3
Silt	9.6	12.2
Clay	7.5	4.9

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	31
Plastic Limit:	21
Plasticity Index:	10
Activity Index:	2.0

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	GC
Group Name:	Clayey Gravel with Sand
AASHTO Classification:	A-2-4 (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	660-A, 1.0'-2.5'	Lab ID	10

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: NU
Test Date: 05-06-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	82.7
3/8"	63.5
No. 4	50.8
No. 10	36.1

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

Specific Gravity: 2.7

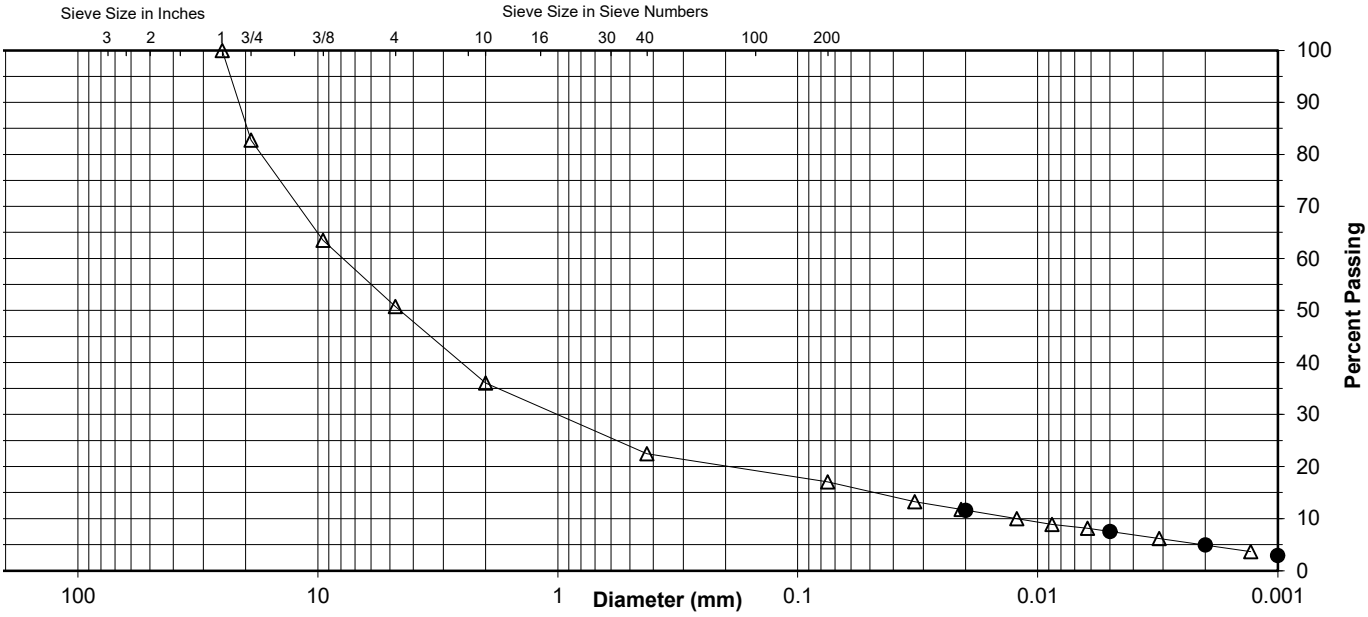
Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	22.4
No. 200	17.1
0.02 mm	11.6
0.005 mm	7.5
0.002 mm	4.9
0.001 mm	2.9

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	17.3	31.9	14.7	13.7	5.3	9.6	7.5

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	63.9	13.7	5.3	12.2	4.9



Comments

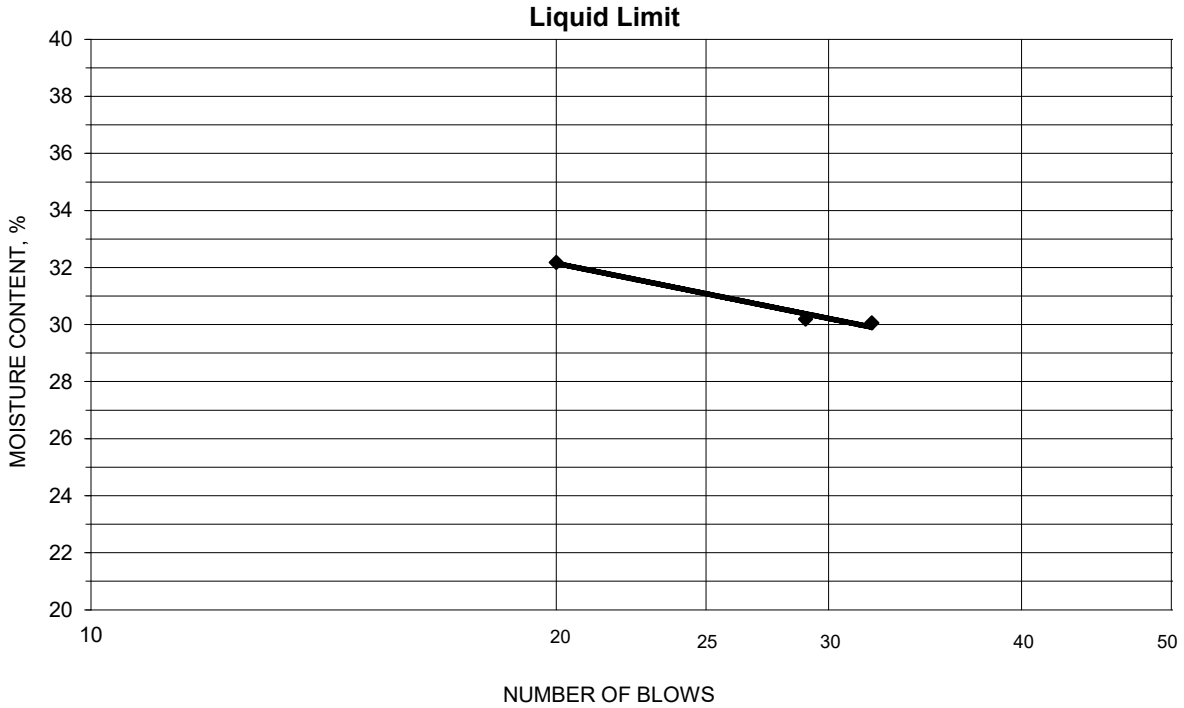
Reviewed By REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	660-A, 1.0'-2.5'	Lab ID	10
		% + No. 40	78
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-09-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
20.24	18.00	11.04	20	32.2	31
19.22	17.33	11.07	29	30.2	
20.29	18.15	11.03	32	30.1	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
20.87	19.10	10.57	20.8	21	10
22.16	20.24	10.99	20.8		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	660-A, 3.5'-5.0', 6.0'-7.5'	Lab ID	11
Sample Type	SS-2 Composite	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Not Performed

Moisture Content (%): N/A

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	79.3
3/8"	9.5	67.2
No. 4	4.75	54.7
No. 10	2	38.8
No. 40	0.425	19.1
No. 200	0.075	14.7
	0.02	11.0
	0.005	7.4
	0.002	5.3
Estimated	0.001	3.8

Plus 3 in. Material, Not Included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	45.3	61.2
Coarse Sand	15.9	19.7
Medium Sand	19.7	---
Fine Sand	4.4	4.4
Silt	7.3	9.4
Clay	7.4	5.3

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	33
Plastic Limit:	24
Plasticity Index:	9
Activity Index:	1.7

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	GM
Group Name:	Silty Gravel with Sand
AASHTO Classification:	A-2-4 (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Source: 660-A, 3.5'-5.0', 6.0'-7.5'

Project Number: 2026252329
Lab ID: 11

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: NU
Test Date: 05-06-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	79.3
3/8"	67.2
No. 4	54.7
No. 10	38.8

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	19.1
No. 200	14.7
0.02 mm	11.0
0.005 mm	7.4
0.002 mm	5.3
0.001 mm	3.8

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	20.7	24.6	15.9	19.7	4.4	7.3	7.4
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt	Clay
	61.2			19.7	4.4	9.4	5.3

Comments

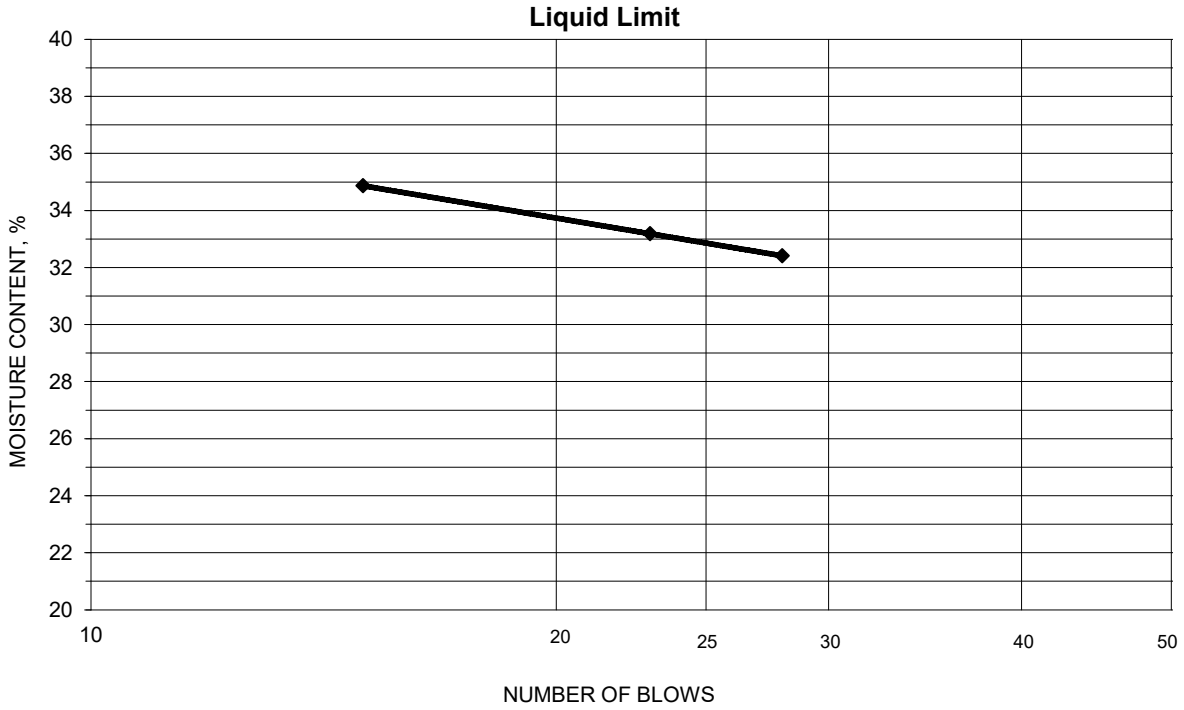
Reviewed By REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	660-A, 3.5'-5.0', 6.0'-7.5'	Lab ID	11
		% + No. 40	81
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	04-09-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
20.11	17.76	11.02	15	34.9	33
19.89	17.68	11.02	23	33.2	
20.51	18.16	10.91	28	32.4	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
21.10	19.06	10.61	24.1	24	9
21.05	19.05	10.58	23.6		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	660-B, 1.0'-2.5', 3.5'-5.0'	Lab ID	14
Sample Type	SS-1 Composite	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 15.3

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	78.3
3/8"	9.5	67.0
No. 4	4.75	52.3
No. 10	2	42.9
No. 40	0.425	32.6
No. 200	0.075	25.9
	0.02	20.1
	0.005	13.3
	0.002	9.6
Estimated	0.001	6.8

Plus 3 in. Material, Not Included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	47.7	57.1
Coarse Sand	9.4	10.3
Medium Sand	10.3	---
Fine Sand	6.7	6.7
Silt	12.6	16.3
Clay	13.3	9.6

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	36
Plastic Limit:	23
Plasticity Index:	13
Activity Index:	1.4

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	GC
Group Name:	Clayey Gravel with Sand
AASHTO Classification:	A-2-6 (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Source: 660-B, 1.0'-2.5', 3.5'-5.0'

Project Number: 2026252329
Lab ID: 14

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: NU
Test Date: 05-06-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	78.3
3/8"	67.0
No. 4	52.3
No. 10	42.9

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

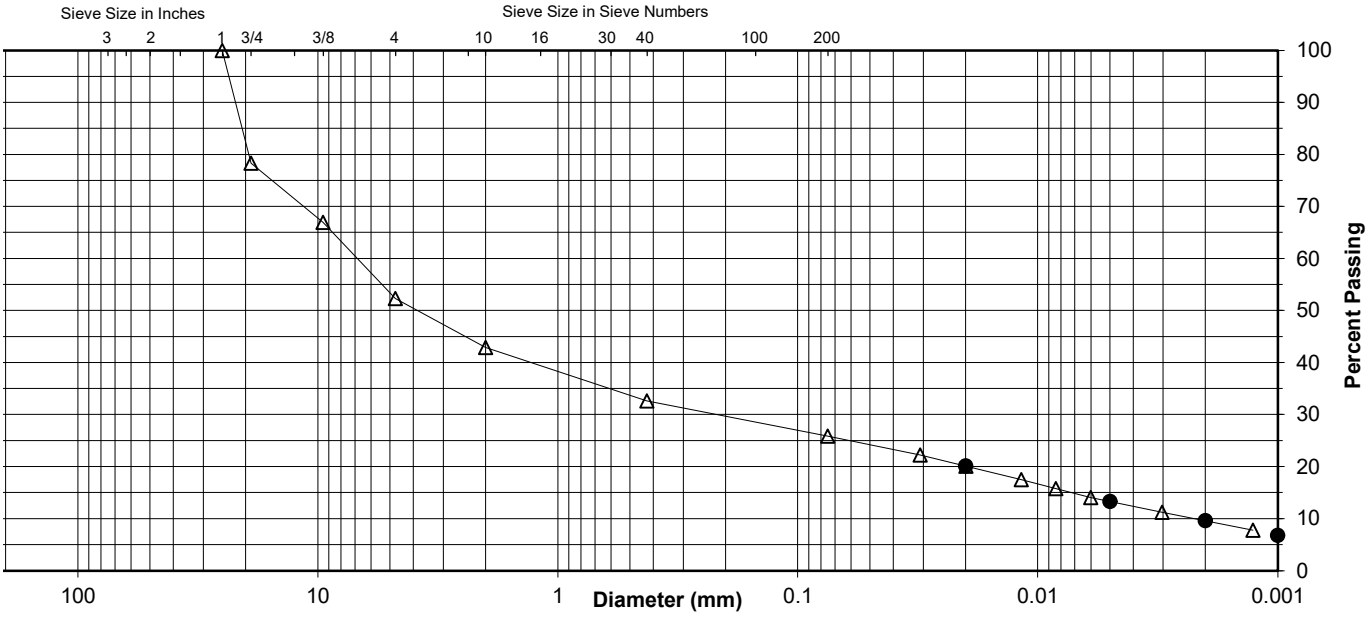
Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	32.6
No. 200	25.9
0.02 mm	20.1
0.005 mm	13.3
0.002 mm	9.6
0.001 mm	6.8

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	21.7	26.0	9.4	10.3	6.7	12.6	13.3
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt	Clay
	57.1			10.3	6.7	16.3	9.6



Comments

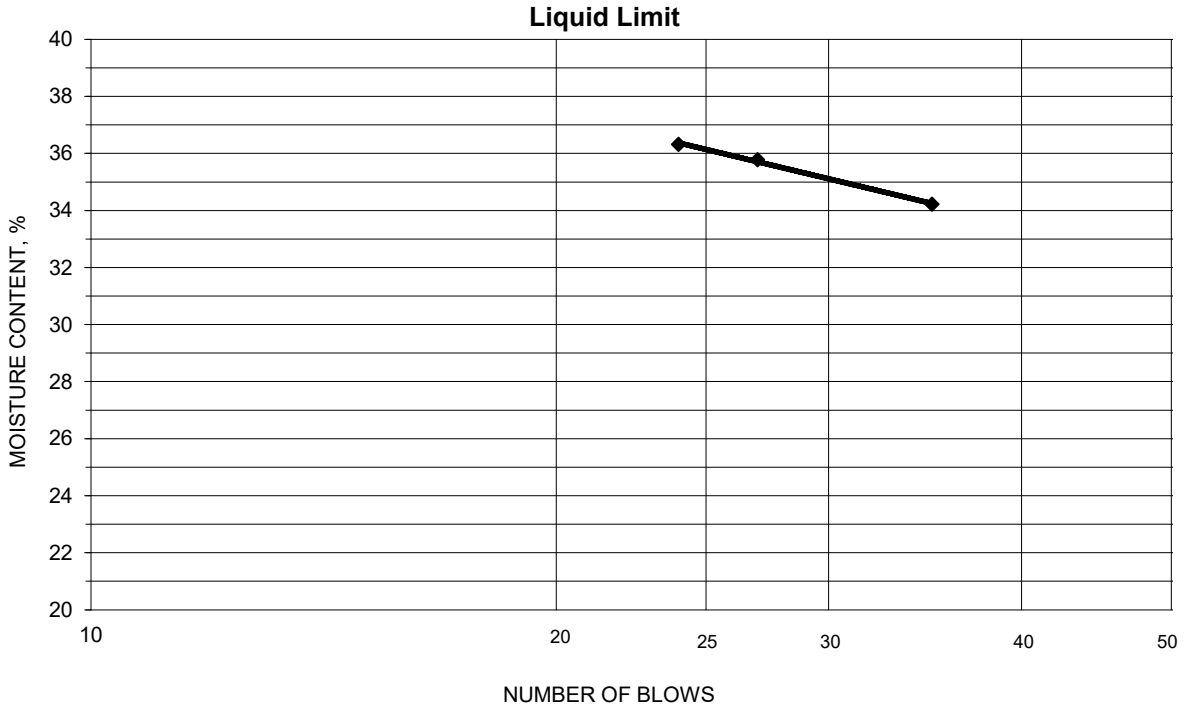
Reviewed By REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	660-B, 1.0'-2.5', 3.5'-5.0'	Lab ID	14
		% + No. 40	67
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-08-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
20.04	17.65	11.07	24	36.3	36
21.56	18.78	11.01	27	35.8	
19.56	17.38	11.01	35	34.2	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
23.10	20.73	10.59	23.4	23	13
23.63	21.24	11.06	23.5		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	660-B, 6.0'-7.5'	Lab ID	17
Sample Type	SS-3	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: AASHTO T 265

Moisture Content (%): 11.3

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	95.8
3/8"	9.5	95.8
No. 4	4.75	95.8
No. 10	2	73.5
No. 40	0.425	43.2
No. 200	0.075	33.8
	0.02	26.1
	0.005	16.9
	0.002	11.9
Estimated	0.001	8.4

Plus 3 in. Material, Not Included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	4.2	26.5
Coarse Sand	22.3	30.3
Medium Sand	30.3	---
Fine Sand	9.4	9.4
Silt	16.9	21.9
Clay	16.9	11.9

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	34
Plastic Limit:	25
Plasticity Index:	9
Activity Index:	0.8

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	SM
Group Name:	Silty Sand
AASHTO Classification:	A-2-4 (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Source: 660-B, 6.0'-7.5'

Project Number: 2026252329
Lab ID: 17

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: NU
Test Date: 05-06-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	95.8
3/8"	95.8
No. 4	95.8
No. 10	73.5

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	43.2
No. 200	33.8
0.02 mm	26.1
0.005 mm	16.9
0.002 mm	11.9
0.001 mm	8.4

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	4.2	0.0	22.3	30.3	9.4	16.9	16.9

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	26.5	30.3	9.4	21.9	11.9

Comments

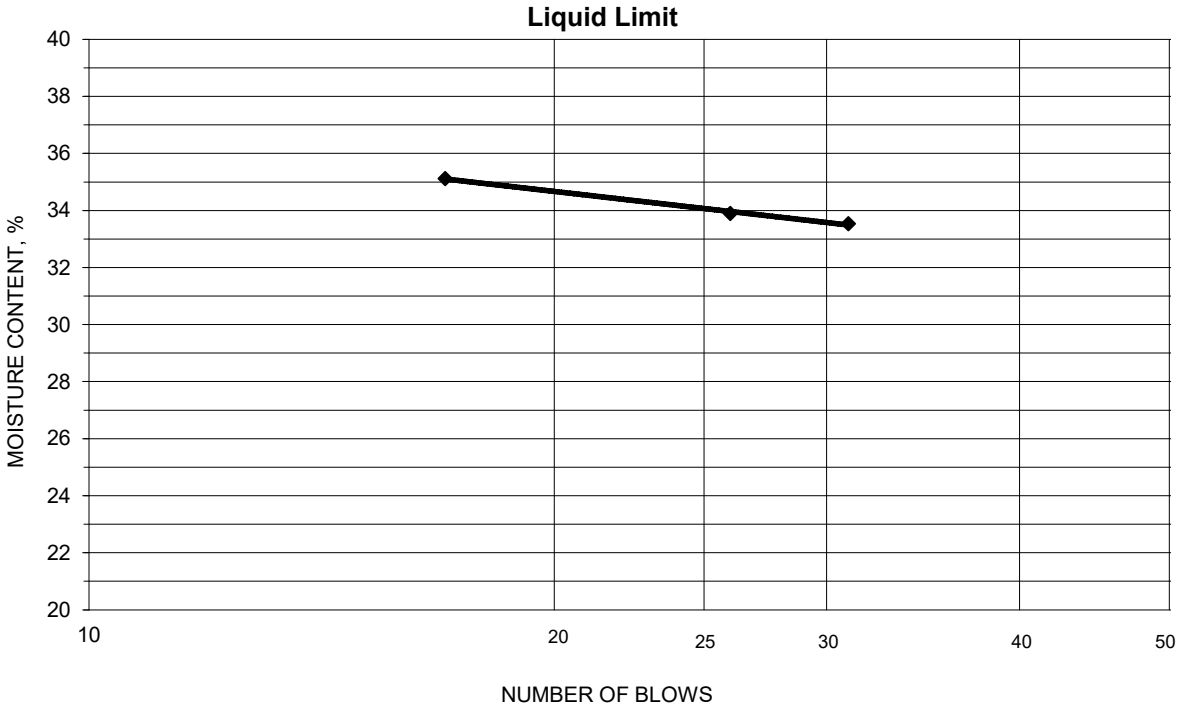
Reviewed By: REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	660-B, 6.0'-7.5'	Lab ID	17
		% + No. 40	57
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-08-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
20.34	17.92	11.03	17	35.1	34
20.45	18.06	11.01	26	33.9	
19.82	17.62	11.06	31	33.5	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
23.38	20.89	11.04	25.3	25	9
23.46	20.91	10.66	24.9		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	660-B, 8.5'-10.0', 11.0'-12.5', 13.5'-15.0'	Lab ID	18
Sample Type	SS-4 Composite	Date Received	4-25-24
		Date Reported	5-24-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 9.7

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	81.1
3/8"	9.5	61.9
No. 4	4.75	51.2
No. 10	2	43.2
No. 40	0.425	31.8
No. 200	0.075	23.6
	0.02	14.5
	0.005	8.8
	0.002	5.8
Estimated	0.001	2.9

Plus 3 in. Material, Not Included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	48.8	56.8
Coarse Sand	8.0	11.4
Medium Sand	11.4	---
Fine Sand	8.2	8.2
Silt	14.8	17.8
Clay	8.8	5.8

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	32
Plastic Limit:	23
Plasticity Index:	9
Activity Index:	1.6

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	GC
Group Name:	Clayey Gravel with Sand
AASHTO Classification:	A-2-4 (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	660-B, 8.5'-10.0', 11.0'-12.5', 13.5'-15.0'	Lab ID	18

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: GK
Test Date: 05-21-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	81.1
3/8"	61.9
No. 4	51.2
No. 10	43.2

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	31.8
No. 200	23.6
0.02 mm	14.5
0.005 mm	8.8
0.002 mm	5.8
0.001 mm	2.9

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	18.9	29.9	8.0	11.4	8.2	14.8	8.8

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	56.8	11.4	8.2	17.8	5.8

Comments _____

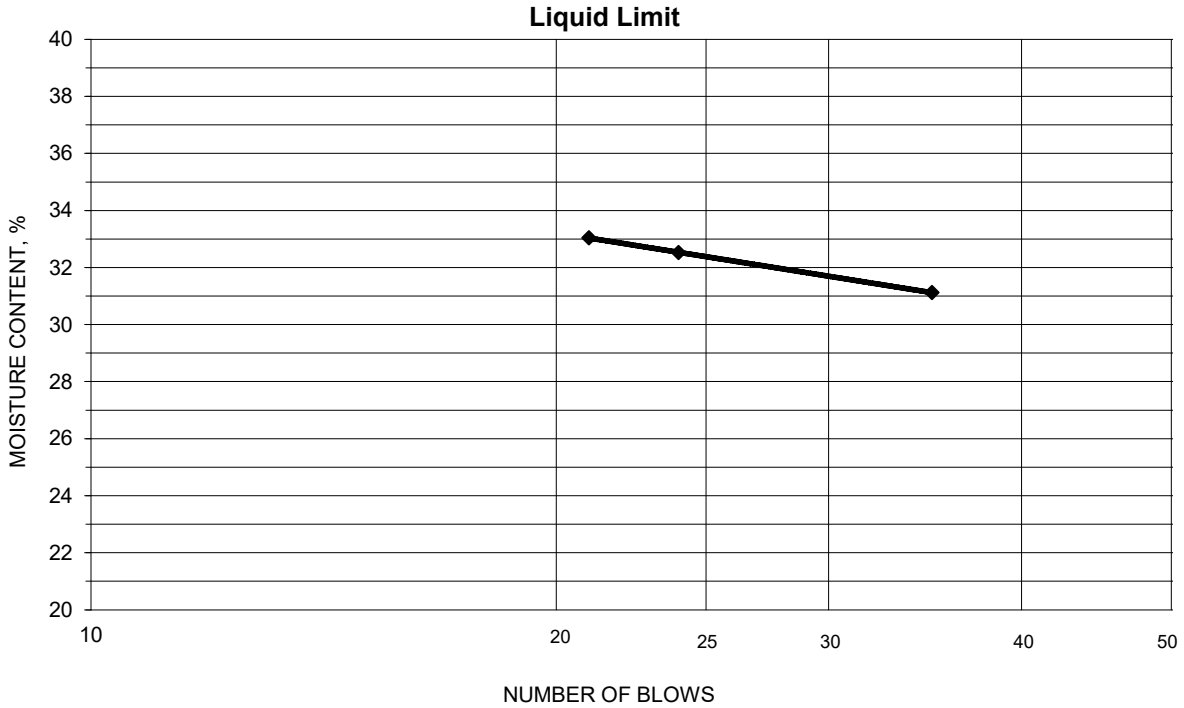
Reviewed By REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	660-B, 8.5'-10.0', 11.0'-12.5', 13.5'-15.0'	Lab ID	18
		% + No. 40	68
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-22-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
20.09	17.85	11.07	21	33.0	32
20.41	17.98	10.51	24	32.5	
20.34	18.09	10.86	35	31.1	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
23.72	21.25	10.66	23.3	23	9
24.16	21.68	11.00	23.2		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	660-C, 1.0'-2.5'	Lab ID	22
Sample Type	SS-1	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: AASHTO T 265

Moisture Content (%): 13.6

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	96.2
3/8"	9.5	80.3
No. 4	4.75	69.6
No. 10	2	52.1
No. 40	0.425	37.7
No. 200	0.075	29.1
	0.02	17.9
	0.005	10.9
	0.002	7.1
Estimated	0.001	4.2

Plus 3 in. Material, Not Included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	30.4	47.9
Coarse Sand	17.5	14.4
Medium Sand	14.4	---
Fine Sand	8.6	8.6
Silt	18.2	22.0
Clay	10.9	7.1

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	35
Plastic Limit:	23
Plasticity Index:	12
Activity Index:	1.7

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	SC
Group Name:	Clayey Sand with Gravel
AASHTO Classification:	A-2-6 (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Source: 660-C, 1.0'-2.5'

Project Number: 2026252329
Lab ID: 22

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: JP
Test Date: 05-07-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	96.2
3/8"	80.3
No. 4	69.6
No. 10	52.1

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

Specific Gravity: 2.7

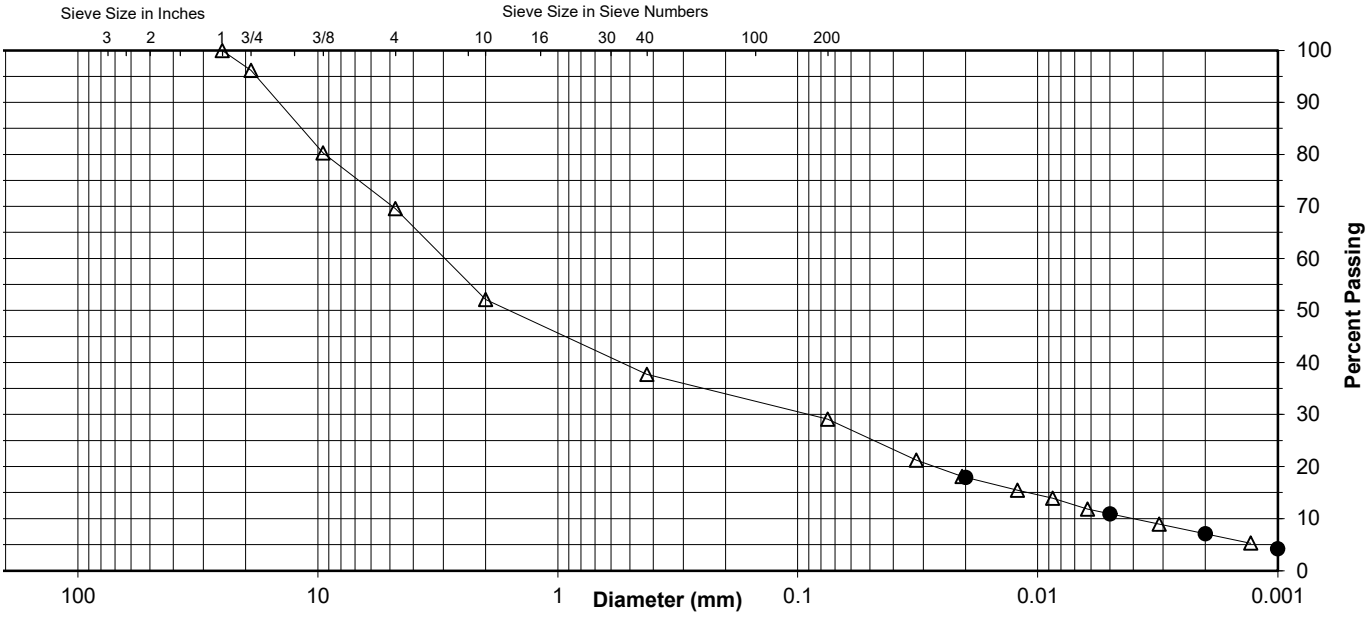
Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	37.7
No. 200	29.1
0.02 mm	17.9
0.005 mm	10.9
0.002 mm	7.1
0.001 mm	4.2

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	3.8	26.6	17.5	14.4	8.6	18.2	10.9

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	47.9	14.4	8.6	22.0	7.1



Comments

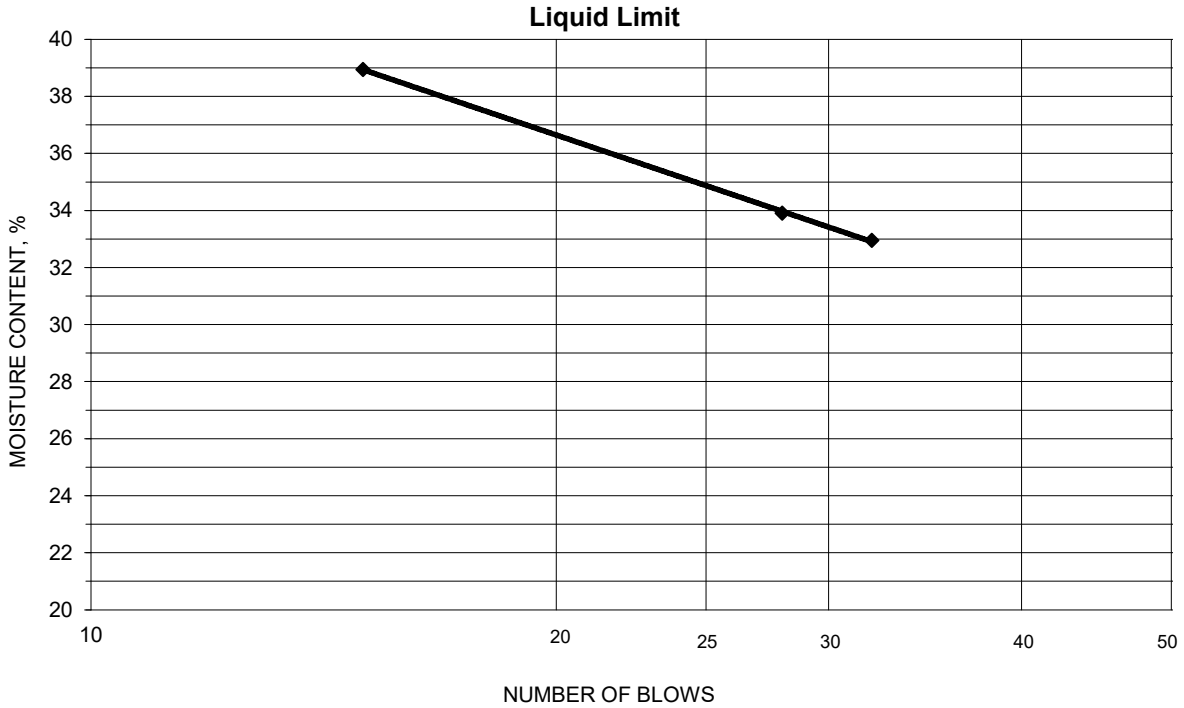
Reviewed By: REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	660-C, 1.0'-2.5'	Lab ID	22
		% + No. 40	62
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-09-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
18.98	16.76	11.06	15	38.9	
19.56	17.41	11.07	28	33.9	
19.98	17.65	10.58	32	33.0	35



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
22.91	20.63	10.62	22.8	23	12
22.67	20.43	10.51	22.6		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	660-C, 3.5'-5.0'	Lab ID	23
Sample Type	SS-2	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: AASHTO T 265

Moisture Content (%): 19.3

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	82.5
3/8"	9.5	75.4
No. 4	4.75	71.9
No. 10	2	56.1
No. 40	0.425	38.3
No. 200	0.075	29.8
	0.02	20.4
	0.005	13.9
	0.002	9.7
Estimated	0.001	6.7

Plus 3 in. Material, Not Included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	28.1	43.9
Coarse Sand	15.8	17.8
Medium Sand	17.8	---
Fine Sand	8.5	8.5
Silt	15.9	20.1
Clay	13.9	9.7

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	34
Plastic Limit:	24
Plasticity Index:	10
Activity Index:	1.0

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	SM
Group Name:	Silty Sand with Gravel
AASHTO Classification:	A-2-4 (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Source: 660-C, 3.5'-5.0'

Project Number: 2026252329
Lab ID: 23

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: JP
Test Date: 05-10-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	82.5
3/8"	75.4
No. 4	71.9
No. 10	56.1

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

Specific Gravity: 2.7

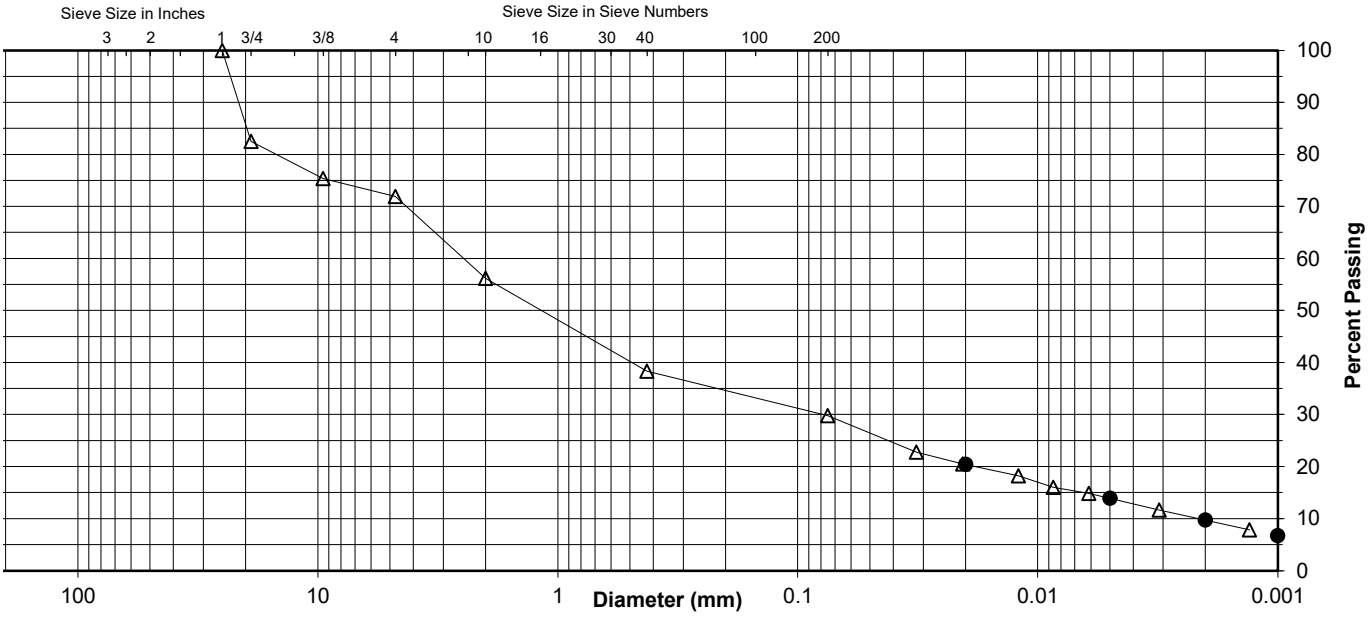
Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	38.3
No. 200	29.8
0.02 mm	20.4
0.005 mm	13.9
0.002 mm	9.7
0.001 mm	6.7

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	17.5	10.6	15.8	17.8	8.5	15.9	13.9

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	43.9	17.8	8.5	20.1	9.7



Comments

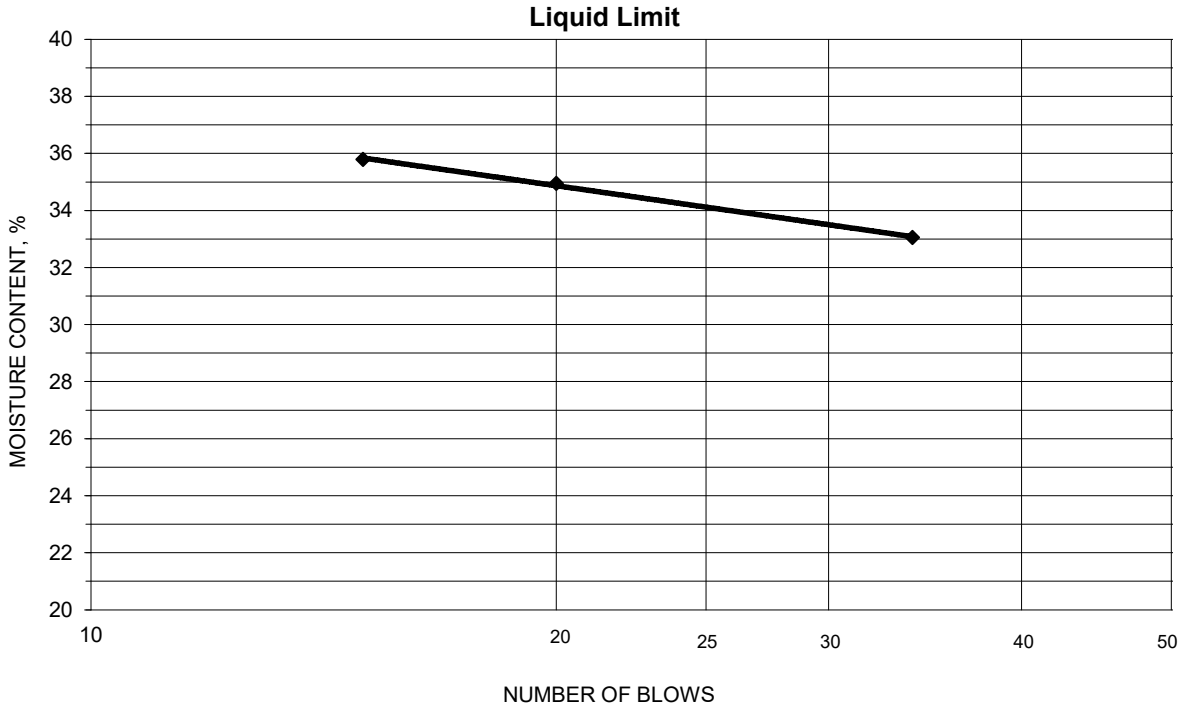
Reviewed By: REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	660-C, 3.5'-5.0'	Lab ID	23
		% + No. 40	62
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-15-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.91	17.43	10.50	15	35.8	34
20.52	17.93	10.52	20	35.0	
20.45	18.10	10.99	34	33.1	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
24.04	21.52	11.02	24.0	24	10
23.63	21.14	10.54	23.5		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	599-B, 0.0'-1.5', 1.5'-3.0', 3.5'-4.4'	Lab ID	26
Sample Type	GR-1 Composite	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 11.2

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	93.6
3/8"	9.5	78.2
No. 4	4.75	63.5
No. 10	2	49.3
No. 40	0.425	34.6
No. 200	0.075	23.4
	0.02	15.9
	0.005	10.1
	0.002	7.0
Estimated	0.001	5.5

Plus 3 in. Material, Not Included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	36.5	50.7
Coarse Sand	14.2	14.7
Medium Sand	14.7	---
Fine Sand	11.2	11.2
Silt	13.3	16.4
Clay	10.1	7.0

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	24
Plastic Limit:	19
Plasticity Index:	5
Activity Index:	0.7

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	SC-SM
Group Name:	Silty, Clayey Sand with Gravel
AASHTO Classification:	A-1-b (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	599-B, 0.0'-1.5', 1.5'-3.0', 3.5'-4.4'	Lab ID	26

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: JP
Test Date: 04-29-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	93.6
3/8"	78.2
No. 4	63.5
No. 10	49.3

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

Specific Gravity: 2.7

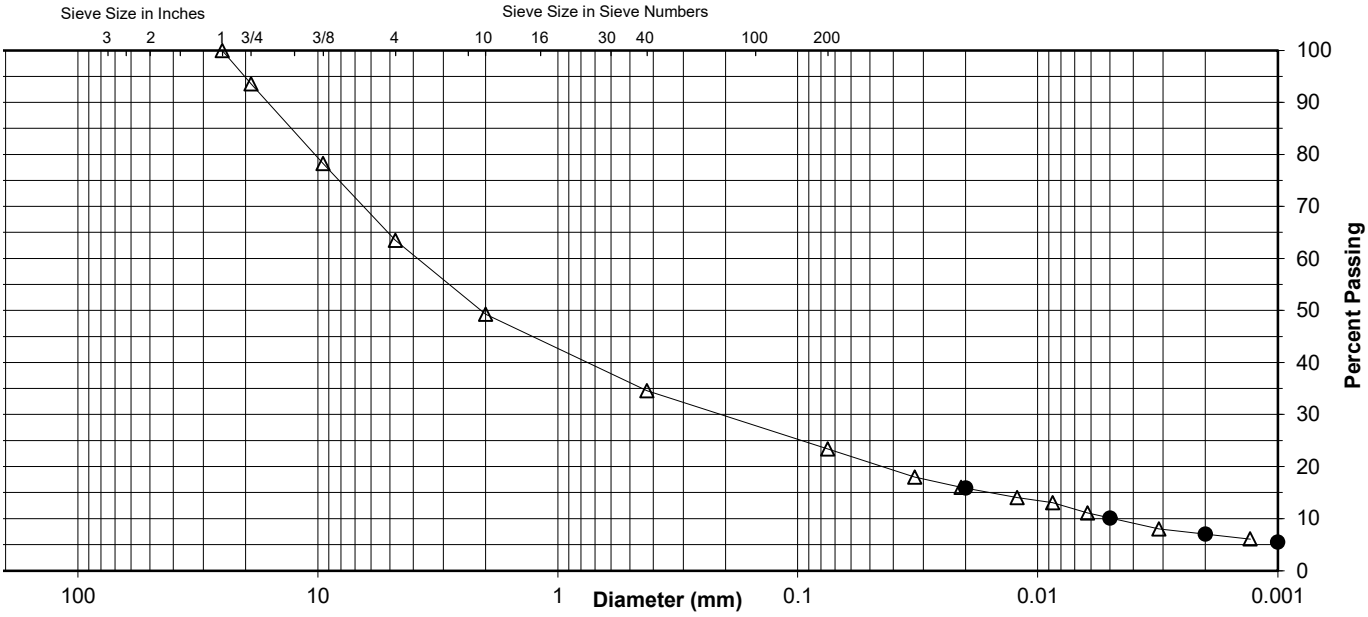
Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	34.6
No. 200	23.4
0.02 mm	15.9
0.005 mm	10.1
0.002 mm	7.0
0.001 mm	5.5

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	6.4	30.1	14.2	14.7	11.2	13.3	10.1

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	50.7	14.7	11.2	16.4	7.0



Comments

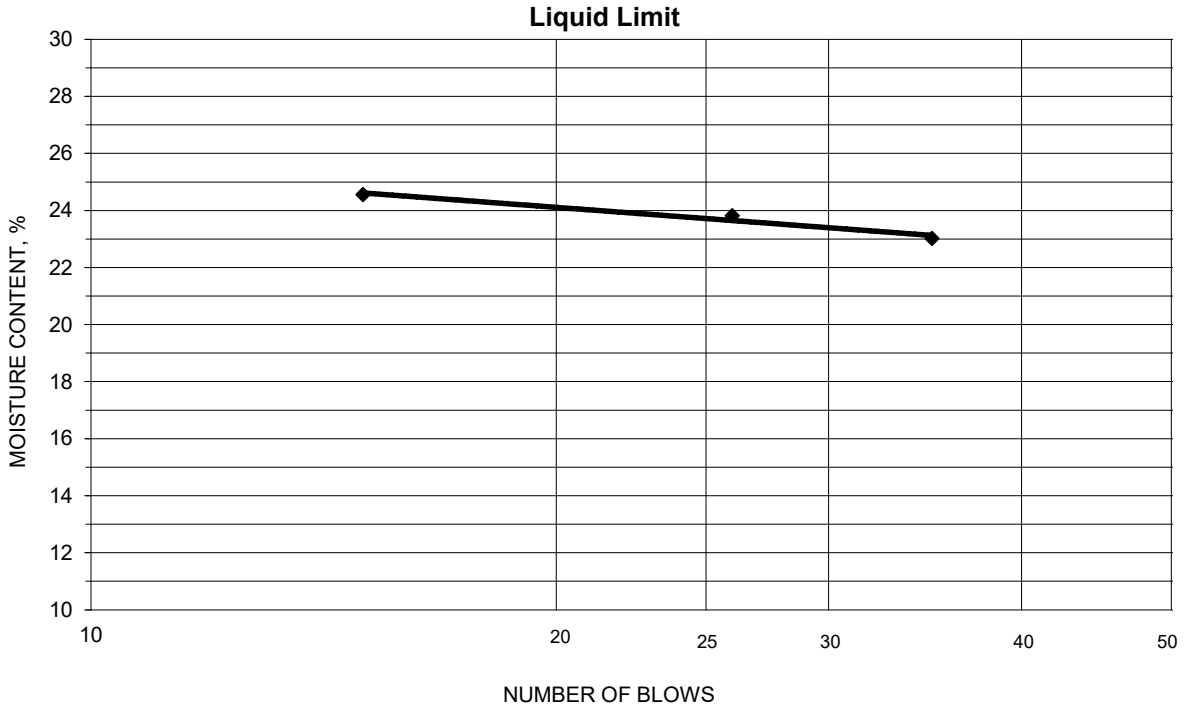
Reviewed By REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	599-B, 0.0'-1.5', 1.5'-3.0', 3.5'-4.4'	Lab ID	26
		% + No. 40	65
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-01-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
20.49	18.55	10.65	15	24.6	24
19.45	17.84	11.08	26	23.8	
20.01	18.24	10.55	35	23.0	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
23.42	21.46	11.10	18.9	19	5
23.00	21.06	10.66	18.7		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	633-A, 1.0'-2.5', 3.5'-5.0'	Lab ID	30
Sample Type	SS-1 Composite	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 6.4

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	82.4
3/8"	9.5	62.1
No. 4	4.75	49.7
No. 10	2	35.1
No. 40	0.425	16.6
No. 200	0.075	8.7
	0.02	4.3
	0.005	3.1
	0.002	2.2
Estimated	0.001	1.4

Plus 3 in. Material, Not Included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	50.3	64.9
Coarse Sand	14.6	18.5
Medium Sand	18.5	---
Fine Sand	7.9	7.9
Silt	5.6	6.5
Clay	3.1	2.2

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	27
Plastic Limit:	20
Plasticity Index:	7
Activity Index:	3.2

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	GW-GC
Group Name:	Well-Graded Gravel with Clay and Sand (or Silty Clay and Sand)
AASHTO Classification:	A-2-4 (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Source: 633-A, 1.0'-2.5', 3.5'-5.0'

Project Number: 2026252329
Lab ID: 30

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: NU
Test Date: 05-10-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	82.4
3/8"	62.1
No. 4	49.7
No. 10	35.1

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

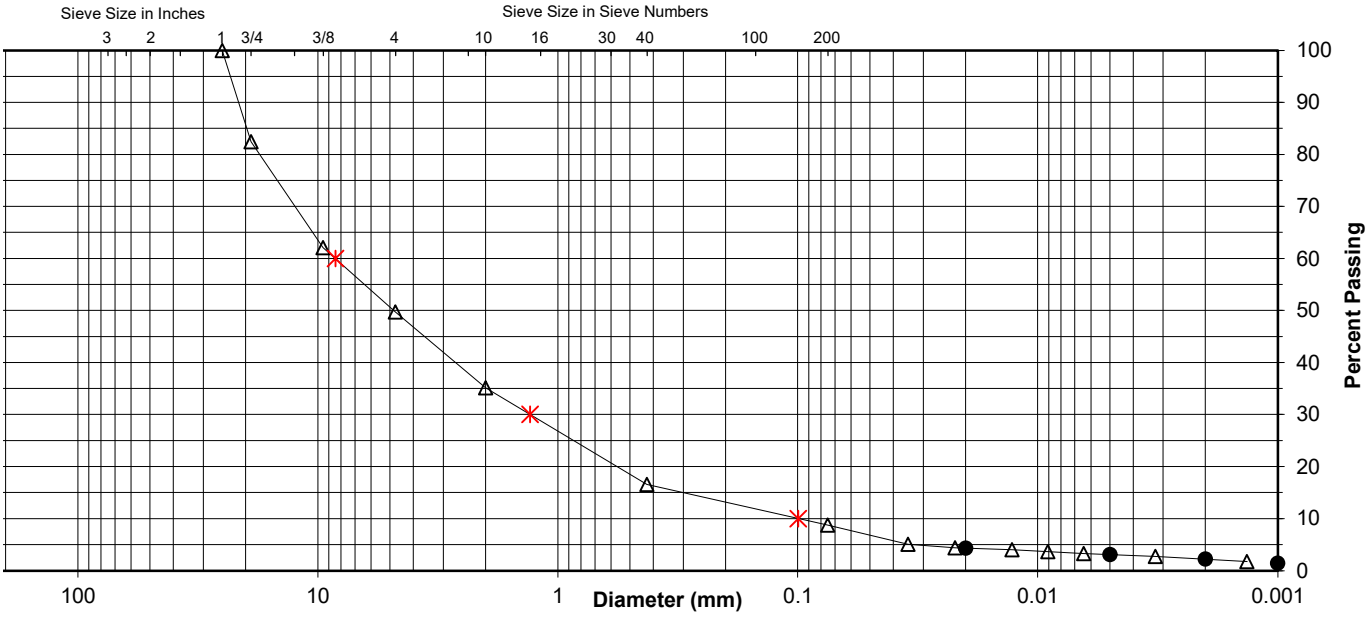
Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	16.6
No. 200	8.7
0.02 mm	4.3
0.005 mm	3.1
0.002 mm	2.2
0.001 mm	1.4

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	17.6	32.7	14.6	18.5	7.9	5.6	3.1
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt	Clay
	64.9			18.5	7.9	6.5	2.2



Comments

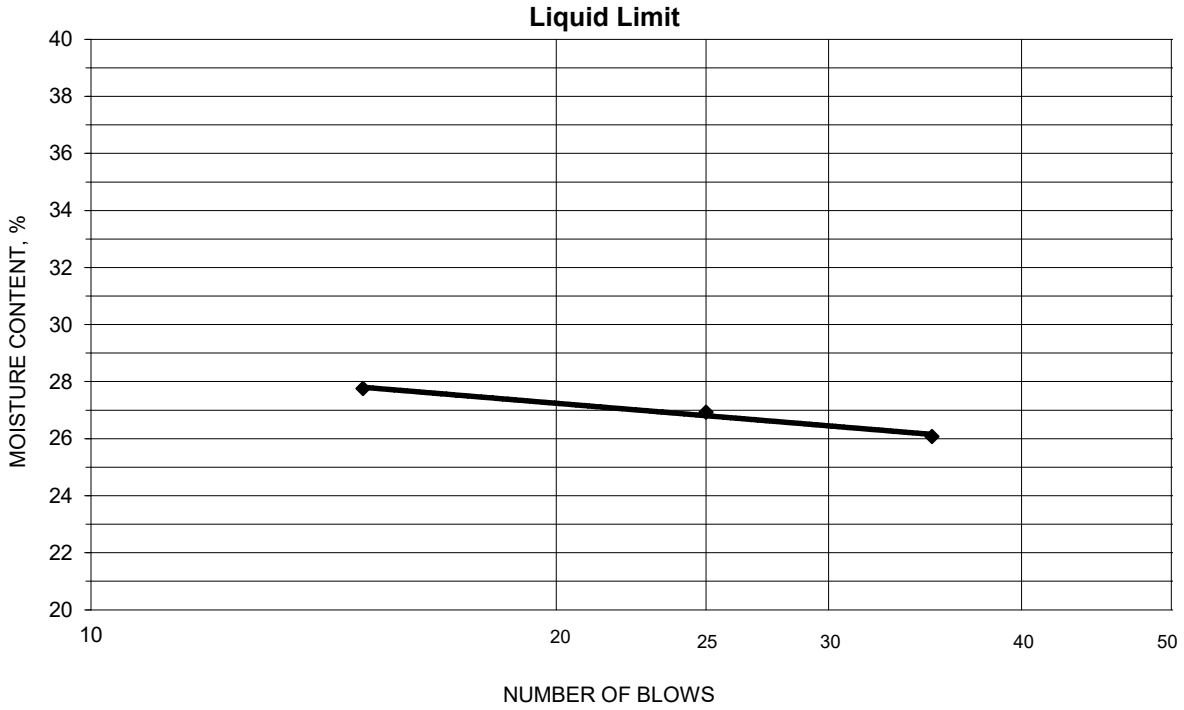
Reviewed By REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	633-A, 1.0'-2.5', 3.5'-5.0'	Lab ID	30
		% + No. 40	83
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-14-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.05	17.21	10.58	15	27.8	27
19.12	17.41	11.06	25	26.9	
19.32	17.50	10.52	35	26.1	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
24.19	21.96	11.04	20.4	20	7
24.39	22.15	11.08	20.2		

Remarks: _____

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	633-A, 6.0'-7.5', 8.5'-10.0'	Lab ID	33
Sample Type	SS-3 Composite	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 6.5

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	80.9
3/8"	9.5	70.1
No. 4	4.75	60.4
No. 10	2	45.6
No. 40	0.425	26.3
No. 200	0.075	14.1
	0.02	6.4
	0.005	3.4
	0.002	2.2
Estimated	0.001	1.5

Plus 3 in. Material, Not Included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	39.6	54.4
Coarse Sand	14.8	19.3
Medium Sand	19.3	---
Fine Sand	12.2	12.2
Silt	10.7	11.9
Clay	3.4	2.2

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	27
Plastic Limit:	21
Plasticity Index:	6
Activity Index:	2.7

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	SC-SM
Group Name:	Silty, Clayey Sand with Gravel
AASHTO Classification:	A-1-a (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	633-A, 6.0'-7.5', 8.5'-10.0'	Lab ID	33

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: NU
Test Date: 05-10-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	80.9
3/8"	70.1
No. 4	60.4
No. 10	45.6

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

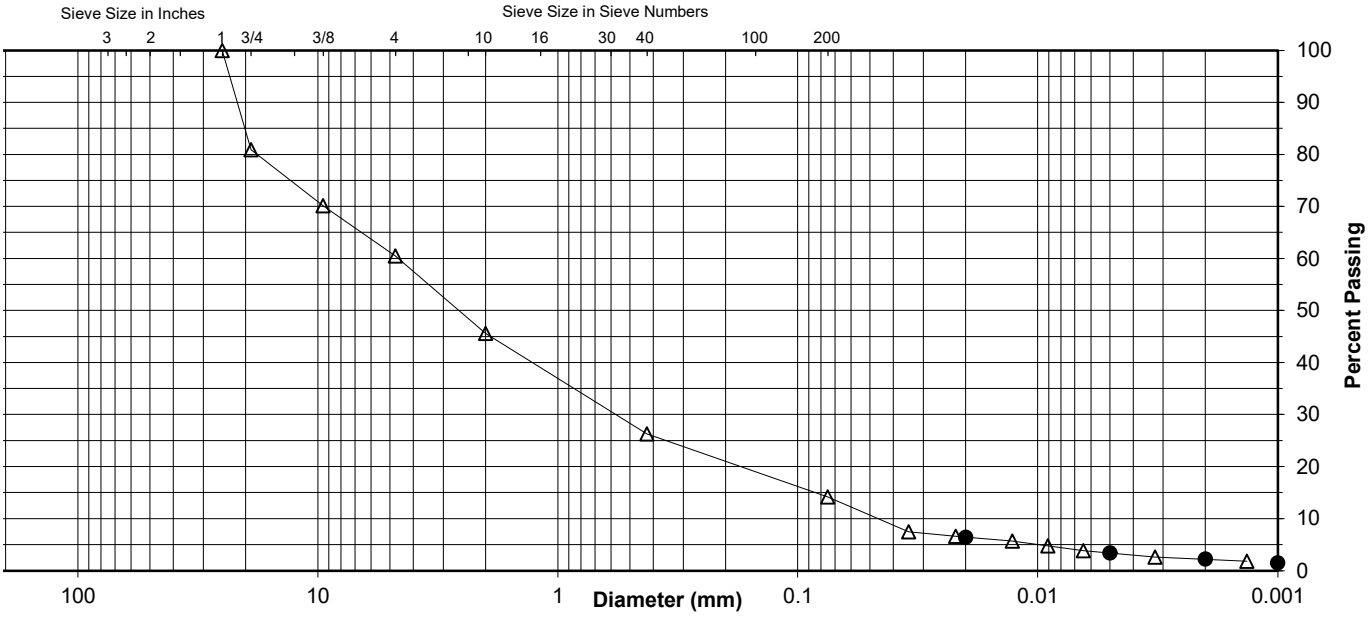
Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	26.3
No. 200	14.1
0.02 mm	6.4
0.005 mm	3.4
0.002 mm	2.2
0.001 mm	1.5

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	19.1	20.5	14.8	19.3	12.2	10.7	3.4
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt	Clay
	54.4			19.3	12.2	11.9	2.2



Comments _____

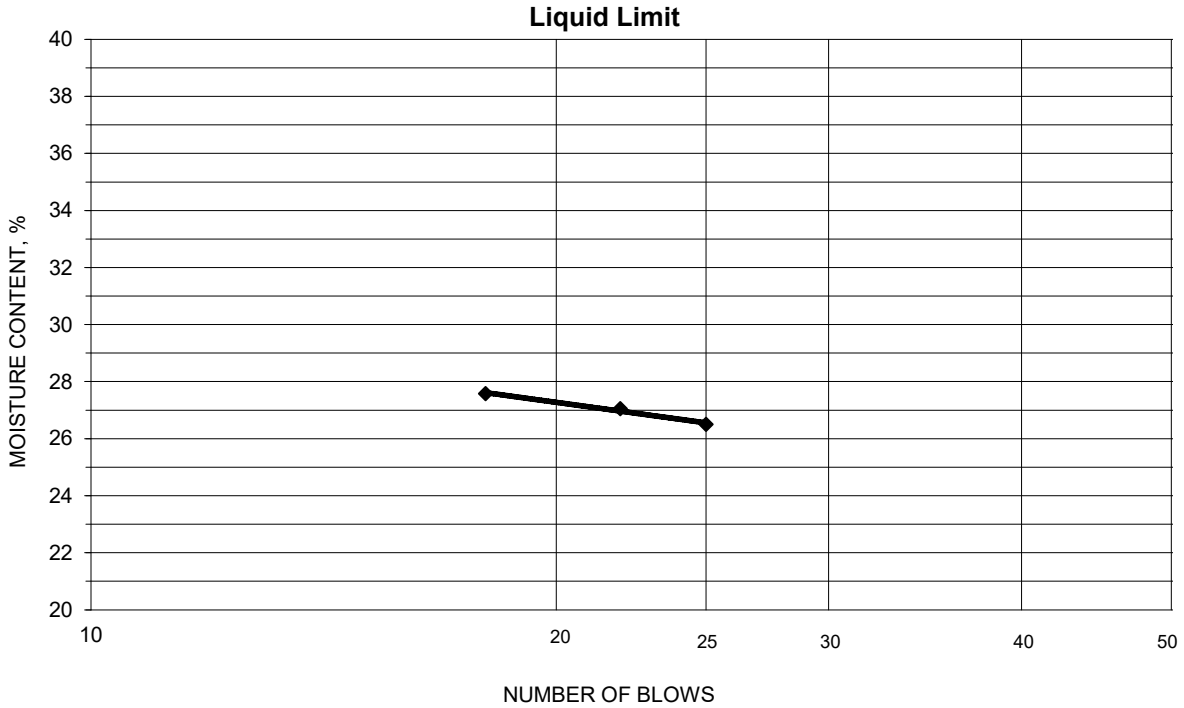
Reviewed By REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	633-A, 6.0'-7.5', 8.5'-10.0'	Lab ID	33
		% + No. 40	74
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-14-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.71	17.84	11.06	18	27.6	27
19.02	17.24	10.66	22	27.1	
20.74	18.71	11.05	25	26.5	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
24.01	21.68	10.61	21.0	21	6
24.43	22.11	11.01	20.9		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	633-A, 11.0'-12.5', 13.5'-15.0'	Lab ID	36
Sample Type	SS-5 Composite	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 6.5

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	92.4
3/8"	9.5	79.2
No. 4	4.75	71.2
No. 10	2	57.6
No. 40	0.425	32.7
No. 200	0.075	18.3
	0.02	12.4
	0.005	8.6
	0.002	7.2
Estimated	0.001	6.3

Plus 3 in. Material, Not Included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	28.8	42.4
Coarse Sand	13.6	24.9
Medium Sand	24.9	---
Fine Sand	14.4	14.4
Silt	9.7	11.1
Clay	8.6	7.2

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	28
Plastic Limit:	21
Plasticity Index:	7
Activity Index:	1.0

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	SC-SM
Group Name:	Silty, Clayey Sand with Gravel
AASHTO Classification:	A-2-4 (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	633-A, 11.0'-12.5', 13.5'-15.0'	Lab ID	36

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: NU
Test Date: 05-16-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	92.4
3/8"	79.2
No. 4	71.2
No. 10	57.6

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

Specific Gravity: 2.7

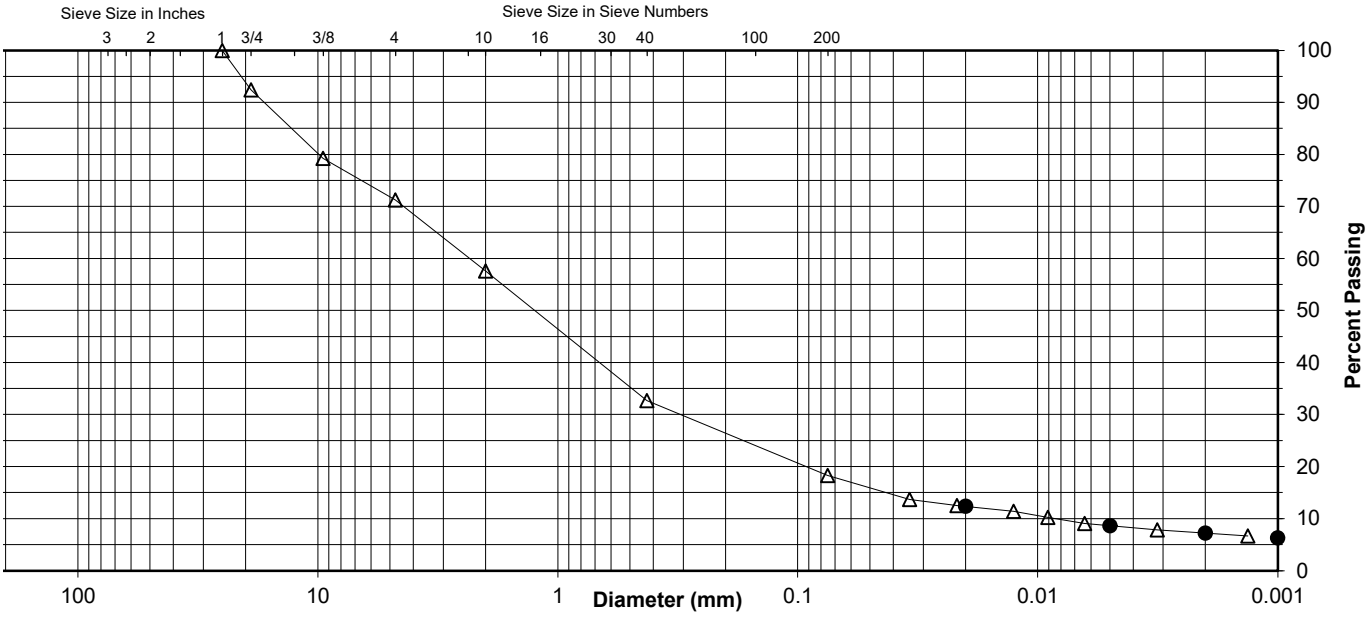
Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	32.7
No. 200	18.3
0.02 mm	12.4
0.005 mm	8.6
0.002 mm	7.2
0.001 mm	6.3

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	7.6	21.2	13.6	24.9	14.4	9.7	8.6

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	42.4	24.9	14.4	11.1	7.2



Comments

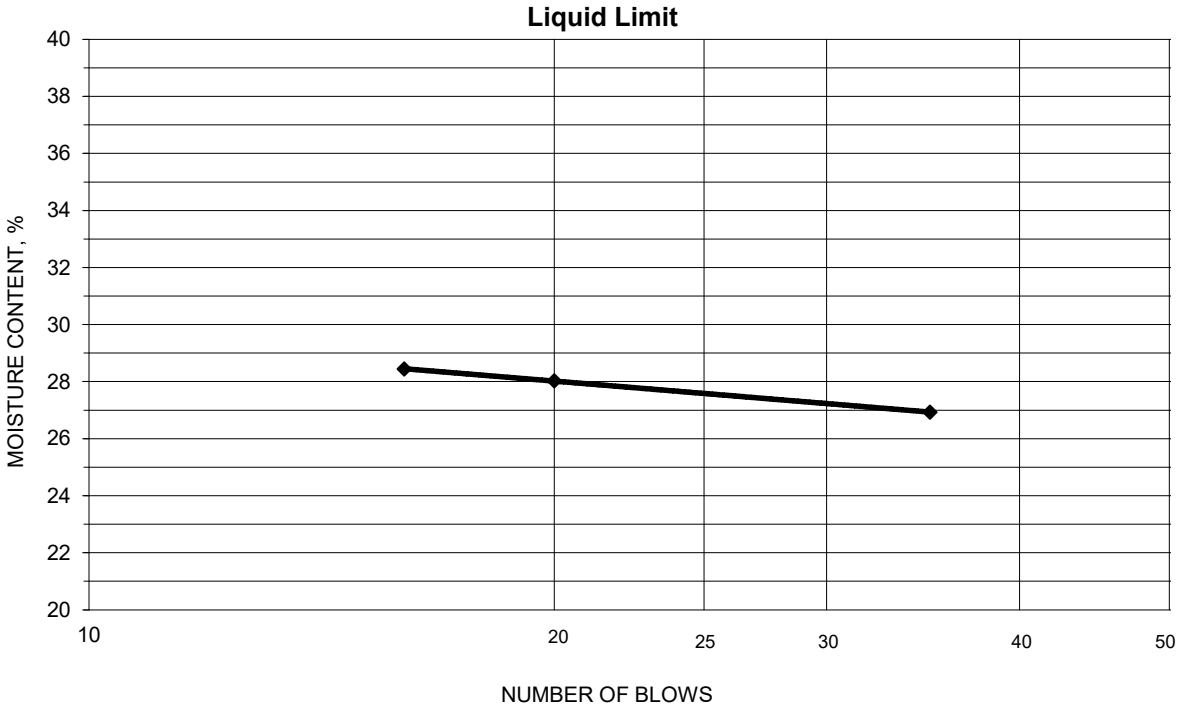
Reviewed By REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	633-A, 11.0'-12.5', 13.5'-15.0'	Lab ID	36
		% + No. 40	67
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-17-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.89	17.93	11.04	16	28.4	28
19.45	17.62	11.09	20	28.0	
18.12	16.62	11.05	35	26.9	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
24.76	22.42	11.10	20.7	21	7
24.28	21.95	10.63	20.6		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	633-A, 16.0'-17.5', 18.5'-20.0'	Lab ID	39
Sample Type	SS-7 Composite	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 8.7

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	91.5
3/8"	9.5	79.6
No. 4	4.75	64.1
No. 10	2	50.9
No. 40	0.425	26.0
No. 200	0.075	13.8
	0.02	8.9
	0.005	6.2
	0.002	5.3
Estimated	0.001	4.5

Plus 3 in. Material, Not Included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	35.9	49.1
Coarse Sand	13.2	24.9
Medium Sand	24.9	---
Fine Sand	12.2	12.2
Silt	7.6	8.5
Clay	6.2	5.3

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit: 28
Plastic Limit: 23
Plasticity Index: 5
Activity Index: 0.9

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: SM
Group Name: Silty Sand with Gravel

AASHTO Classification: A-1-b (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	633-A, 16.0'-17.5', 18.5'-20.0'	Lab ID	39

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: NU
Test Date: 05-16-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	91.5
3/8"	79.6
No. 4	64.1
No. 10	50.9

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

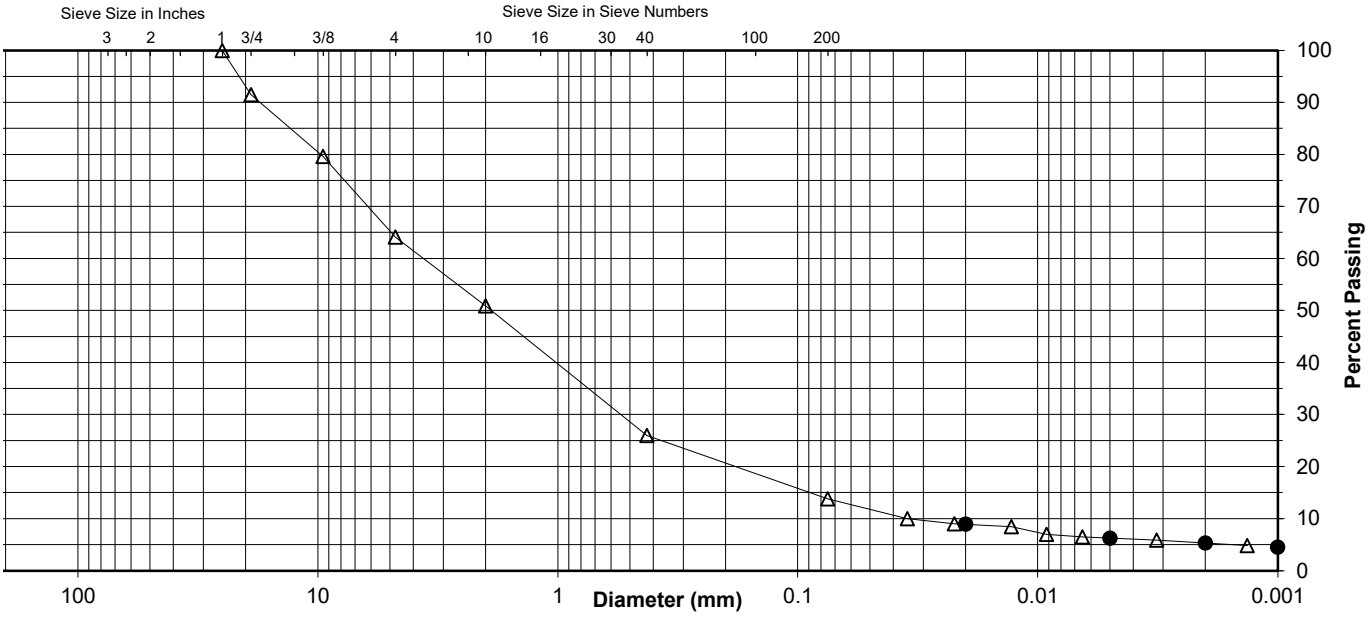
Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	26.0
No. 200	13.8
0.02 mm	8.9
0.005 mm	6.2
0.002 mm	5.3
0.001 mm	4.5

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	8.5	27.4	13.2	24.9	12.2	7.6	6.2
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt	Clay
	49.1			24.9	12.2	8.5	5.3



Comments

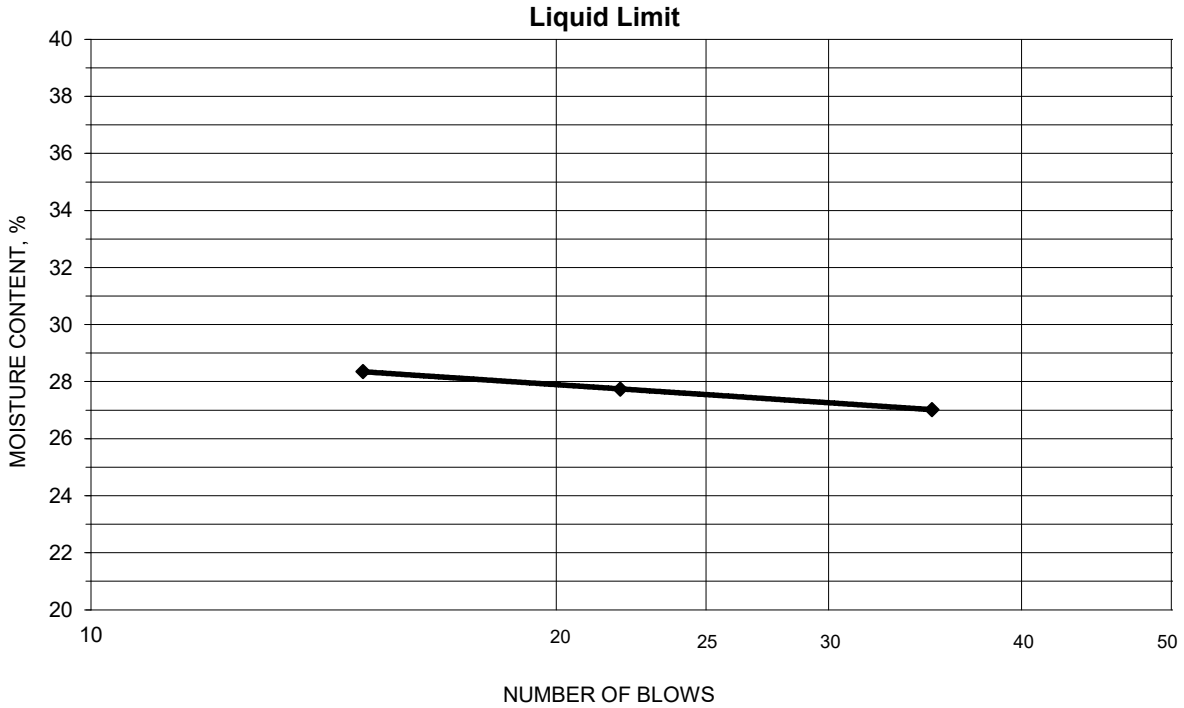
Reviewed By REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	633-A, 16.0'-17.5', 18.5'-20.0'	Lab ID	39
		% + No. 40	74
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-17-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.34	17.50	11.01	15	28.4	28
18.85	17.05	10.56	22	27.7	
18.50	16.83	10.65	35	27.0	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
25.25	22.51	10.69	23.2	23	5
25.28	22.55	10.58	22.8		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	633-B, 1.0'-2.5', 3.5'-5.0'	Lab ID	42
Sample Type	SS-1 Composite	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 5.6

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	84.2
3/8"	9.5	59.4
No. 4	4.75	47.2
No. 10	2	35.1
No. 40	0.425	22.2
No. 200	0.075	10.3
	0.02	4.9
	0.005	3.1
	0.002	2.0
Estimated	0.001	0.9

Plus 3 in. Material, Not Included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	52.8	64.9
Coarse Sand	12.1	12.9
Medium Sand	12.9	---
Fine Sand	11.9	11.9
Silt	7.2	8.3
Clay	3.1	2.0

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit: 25
Plastic Limit: 20
Plasticity Index: 5
Activity Index: 2.5

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: GW-GC
Group Name: Well-Graded Gravel with Clay and Sand (or Silty Clay and Sand)

AASHTO Classification: A-1-a (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Source: 633-B, 1.0'-2.5', 3.5'-5.0'

Project Number: 2026252329
Lab ID: 42

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: NU
Test Date: 05-06-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	84.2
3/8"	59.4
No. 4	47.2
No. 10	35.1

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

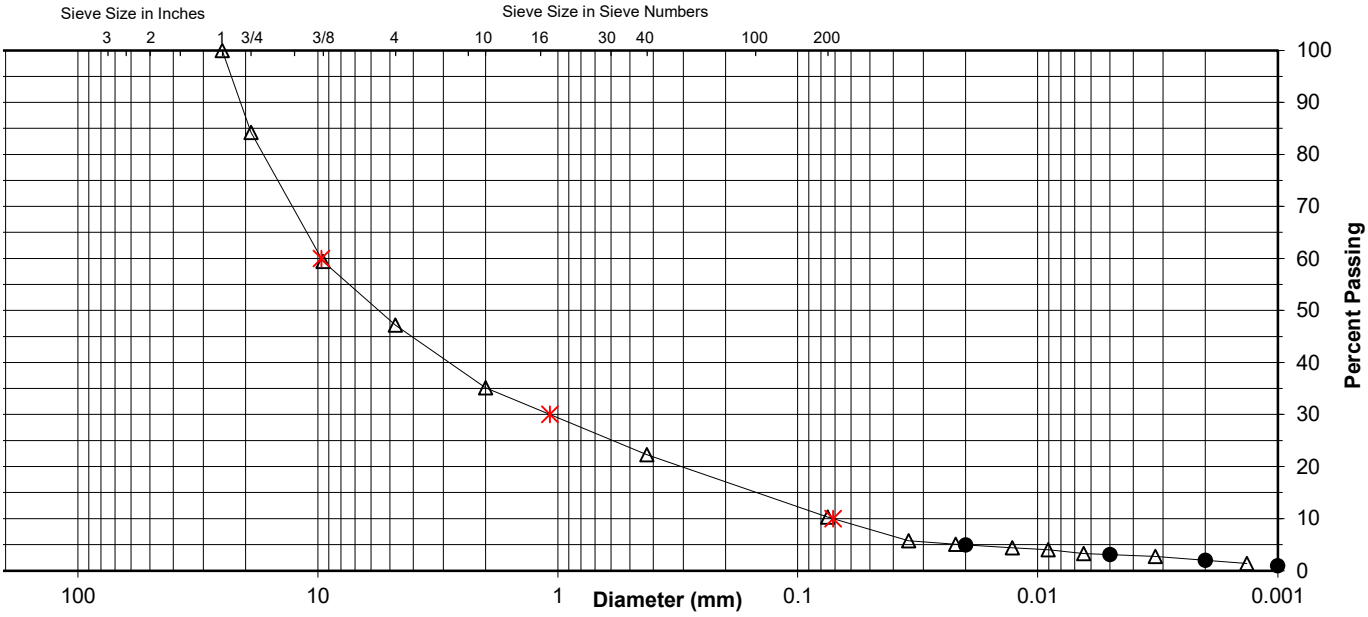
Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	22.2
No. 200	10.3
0.02 mm	4.9
0.005 mm	3.1
0.002 mm	2.0
0.001 mm	0.9

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	15.8	37.0	12.1	12.9	11.9	7.2	3.1
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt	Clay
	64.9			12.9	11.9	8.3	2.0



Comments

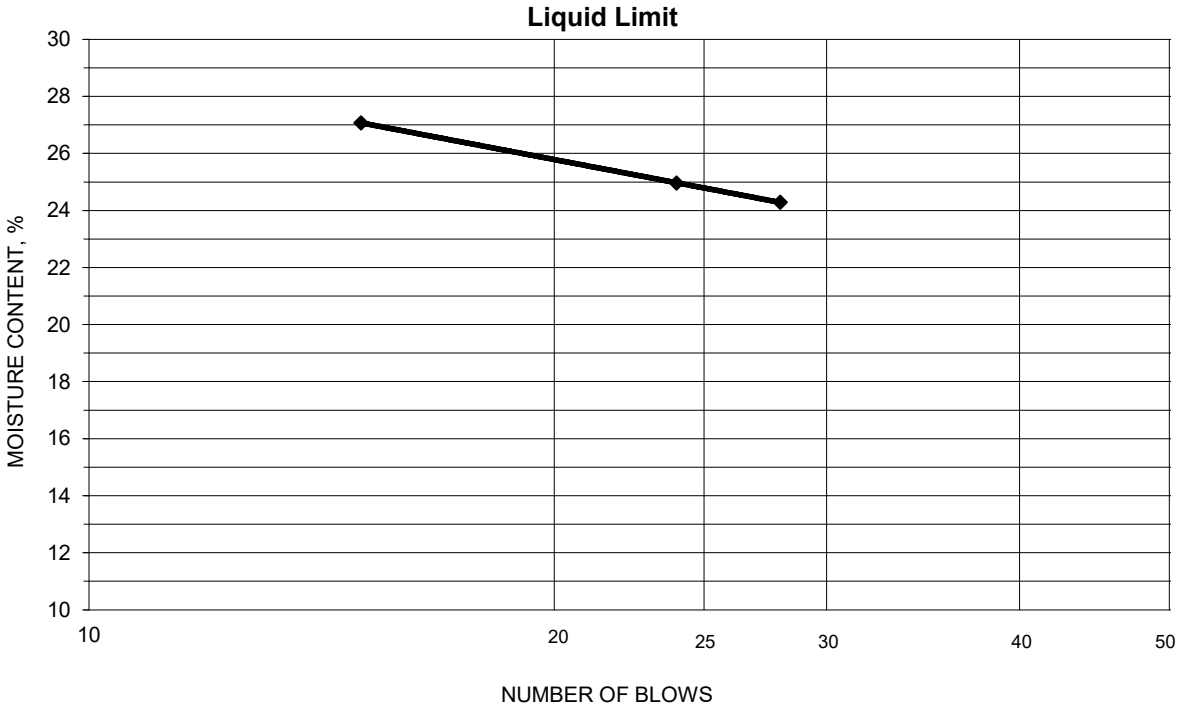
Reviewed By: REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	633-B, 1.0'-2.5', 3.5'-5.0'	Lab ID	42
		% + No. 40	78
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-14-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.21	17.48	11.09	15	27.1	25
20.27	18.43	11.06	24	25.0	
19.35	17.73	11.06	28	24.3	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
23.34	21.34	11.09	19.5	20	5
23.45	21.33	10.64	19.8		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	633-B, 6.0'-7.5', 8.5'-10.0'	Lab ID	45
Sample Type	SS-3 Composite	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 7.7

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	81.0
3/8"	9.5	65.1
No. 4	4.75	49.6
No. 10	2	37.5
No. 40	0.425	23.5
No. 200	0.075	11.5
	0.02	7.6
	0.005	5.4
	0.002	3.7
Estimated	0.001	2.6

Plus 3 in. Material, Not Included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	50.4	62.5
Coarse Sand	12.1	14.0
Medium Sand	14.0	---
Fine Sand	12.0	12.0
Silt	6.1	7.8
Clay	5.4	3.7

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit: 26
Plastic Limit: 21
Plasticity Index: 5
Activity Index: 1.4

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: GW-GC
Group Name: Well-Graded Gravel with Clay and Sand (or Silty Clay and Sand)

AASHTO Classification: A-1-a (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	633-B, 6.0'-7.5', 8.5'-10.0'	Lab ID	45

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: NU
Test Date: 05-06-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	81.0
3/8"	65.1
No. 4	49.6
No. 10	37.5

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

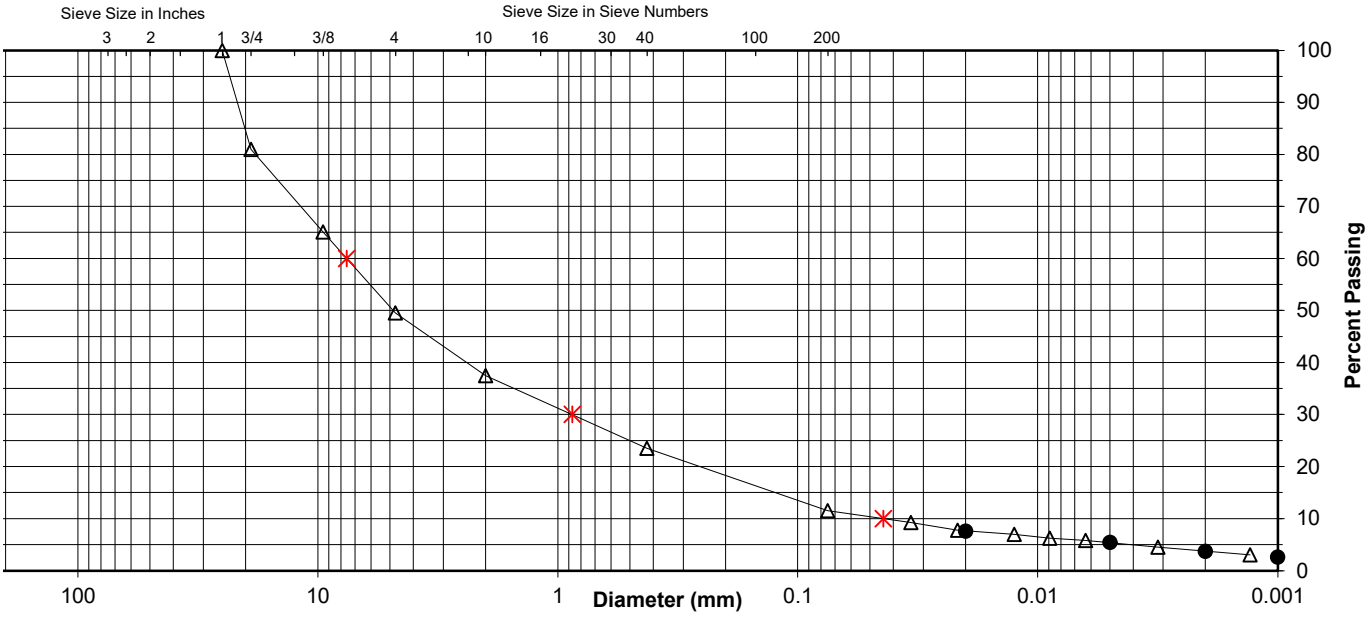
Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	23.5
No. 200	11.5
0.02 mm	7.6
0.005 mm	5.4
0.002 mm	3.7
0.001 mm	2.6

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	19.0	31.4	12.1	14.0	12.0	6.1	5.4
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt	Clay
	62.5			14.0	12.0	7.8	3.7



Comments

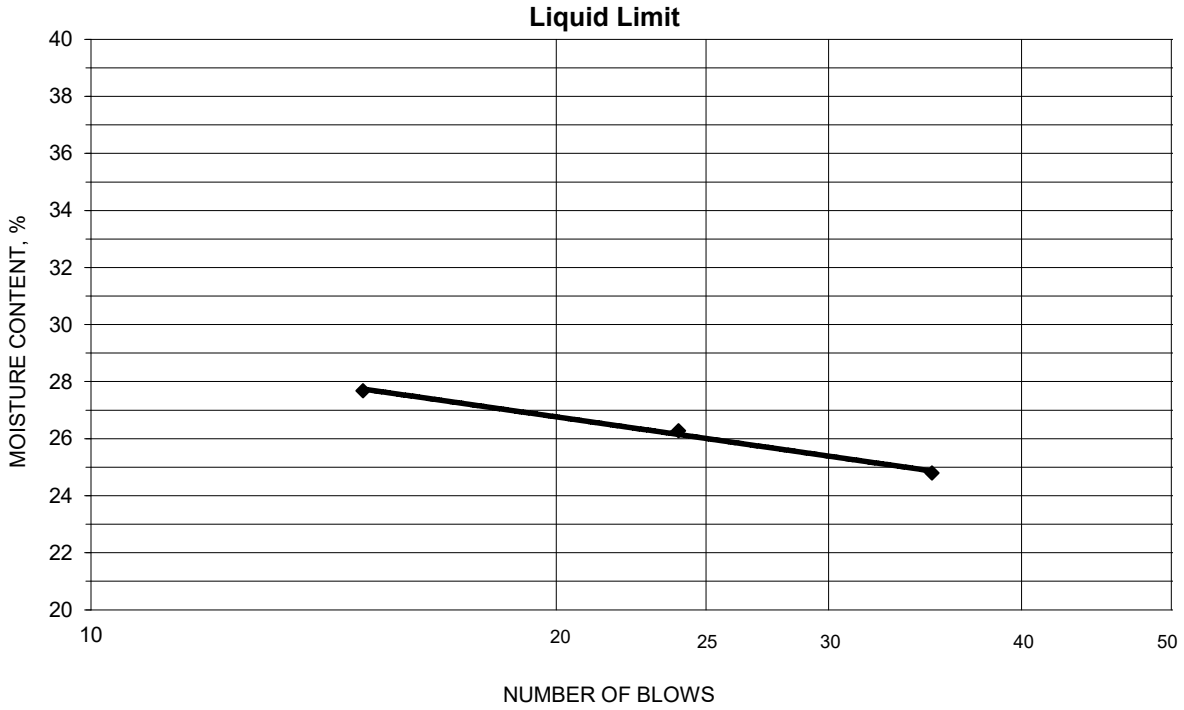
Reviewed By REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	633-B, 6.0'-7.5', 8.5'-10.0'	Lab ID	45
		% + No. 40	76
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-13-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
19.82	17.91	11.01	15	27.7	26
19.90	18.05	11.01	24	26.3	
18.53	17.03	10.98	35	24.8	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
22.94	20.80	10.58	20.9	21	5
24.55	22.26	11.14	20.6		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	633-B, 11.0'-12.5', 13.5'-15.0', 16.0'-17.5'	Lab ID	48
Sample Type	SS-5 Composite	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 13.7

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	86.1
3/8"	9.5	65.8
No. 4	4.75	49.5
No. 10	2	34.5
No. 40	0.425	18.0
No. 200	0.075	11.1
	0.02	9.5
	0.005	7.4
	0.002	5.4
Estimated	0.001	4.1

Plus 3 in. Material, Not Included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	50.5	65.5
Coarse Sand	15.0	16.5
Medium Sand	16.5	---
Fine Sand	6.9	6.9
Silt	3.7	5.7
Clay	7.4	5.4

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	33
Plastic Limit:	24
Plasticity Index:	9
Activity Index:	1.7

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	GP-GM
Group Name:	Poorly Graded Gravel with Silt and Sand
AASHTO Classification:	A-2-4 (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	633-B, 11.0'-12.5', 13.5'-15.0', 16.0'-17.5'	Lab ID	48

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: NU
Test Date: 05-06-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	86.1
3/8"	65.8
No. 4	49.5
No. 10	34.5

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

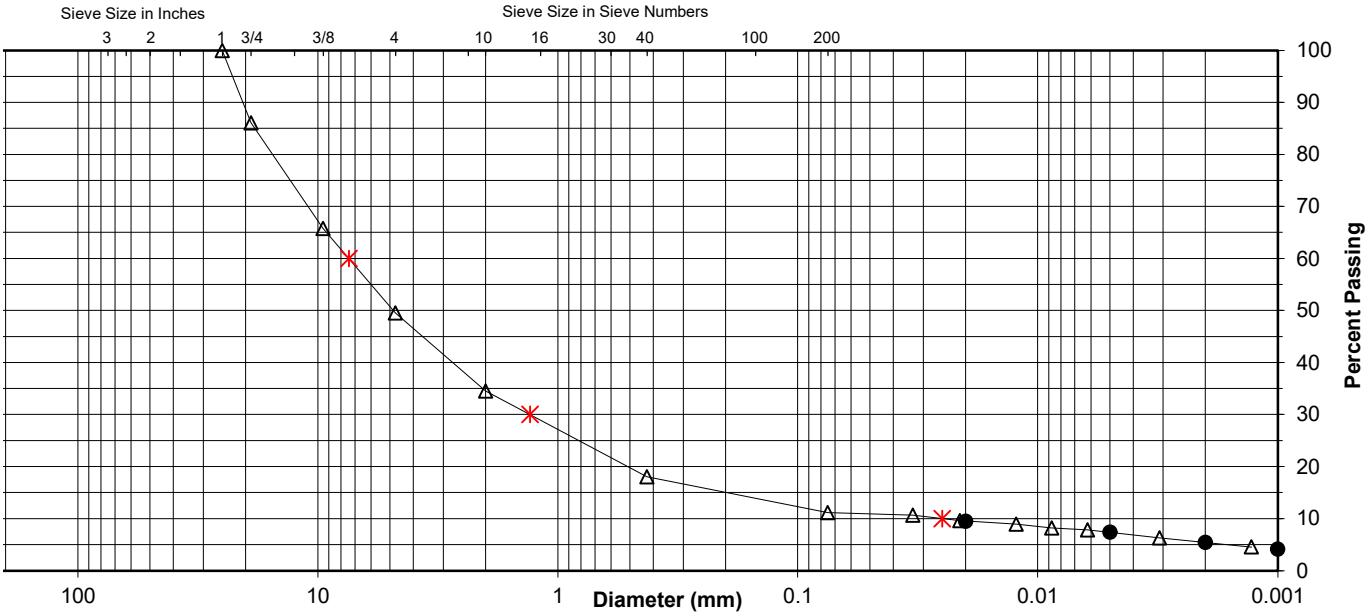
Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	18.0
No. 200	11.1
0.02 mm	9.5
0.005 mm	7.4
0.002 mm	5.4
0.001 mm	4.1

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	13.9	36.6	15.0	16.5	6.9	3.7	7.4
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt	Clay
	65.5			16.5	6.9	5.7	5.4



Comments

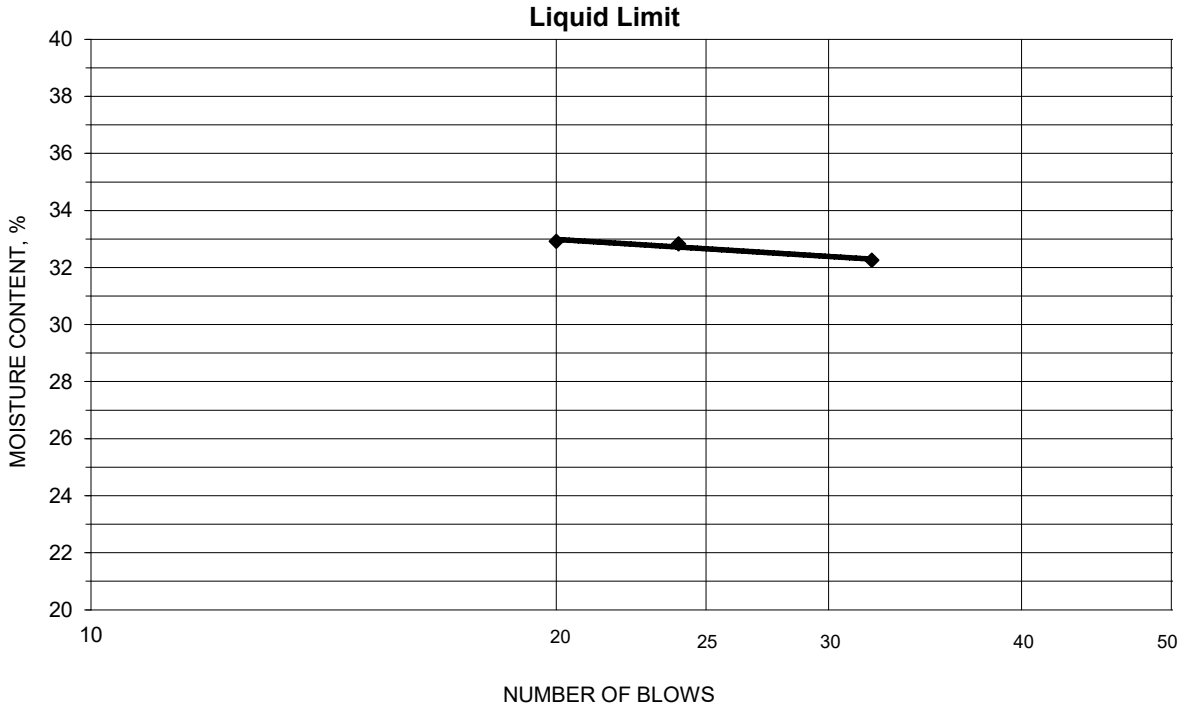
Reviewed By REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	633-B, 11.0'-12.5', 13.5'-15.0', 16.0'-17.5'	Lab ID	48
		% + No. 40	82
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-14-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
21.82	19.16	11.08	20	32.9	33
19.71	17.56	11.01	24	32.8	
19.88	17.69	10.90	32	32.3	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
23.30	20.88	10.67	23.7	24	9
24.30	21.78	11.07	23.5		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	590-A, 1.5'-3.0', 4.0'-5.5'	Lab ID	53
Sample Type	SS-1 Composite	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 2.2

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	70.6
3/8"	9.5	56.7
No. 4	4.75	44.9
No. 10	2	36.0
No. 40	0.425	27.5
No. 200	0.075	15.1
	0.02	10.0
	0.005	6.9
	0.002	5.6
Estimated	0.001	4.6

Plus 3 in. Material, Not Included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	55.1	64.0
Coarse Sand	8.9	8.5
Medium Sand	8.5	---
Fine Sand	12.4	12.4
Silt	8.2	9.5
Clay	6.9	5.6

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	22
Plastic Limit:	17
Plasticity Index:	5
Activity Index:	0.9

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	GC-GM
Group Name:	Silty, Clayey Gravel with Sand
AASHTO Classification:	A-1-a (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	590-A, 1.5'-3.0', 4.0'-5.5'	Lab ID	53

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: JP
Test Date: 05-10-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	70.6
3/8"	56.7
No. 4	44.9
No. 10	36.0

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

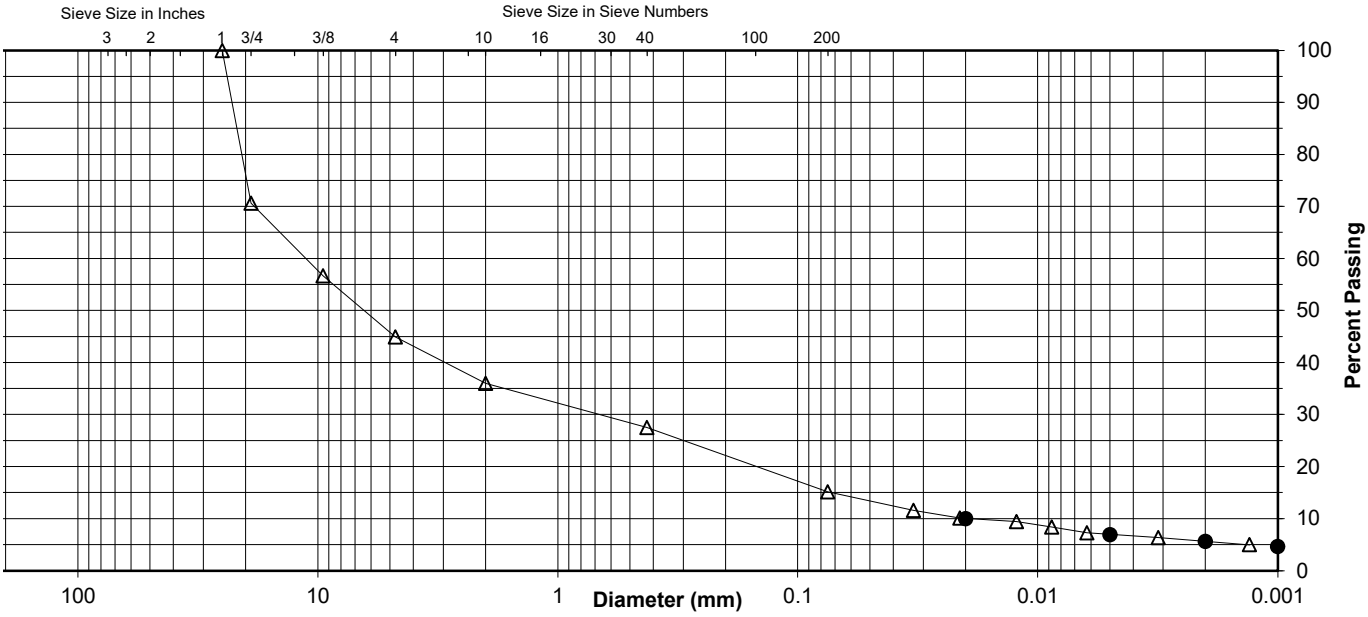
Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	27.5
No. 200	15.1
0.02 mm	10.0
0.005 mm	6.9
0.002 mm	5.6
0.001 mm	4.6

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	29.4	25.7	8.9	8.5	12.4	8.2	6.9
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt	Clay
	64.0			8.5	12.4	9.5	5.6



Comments

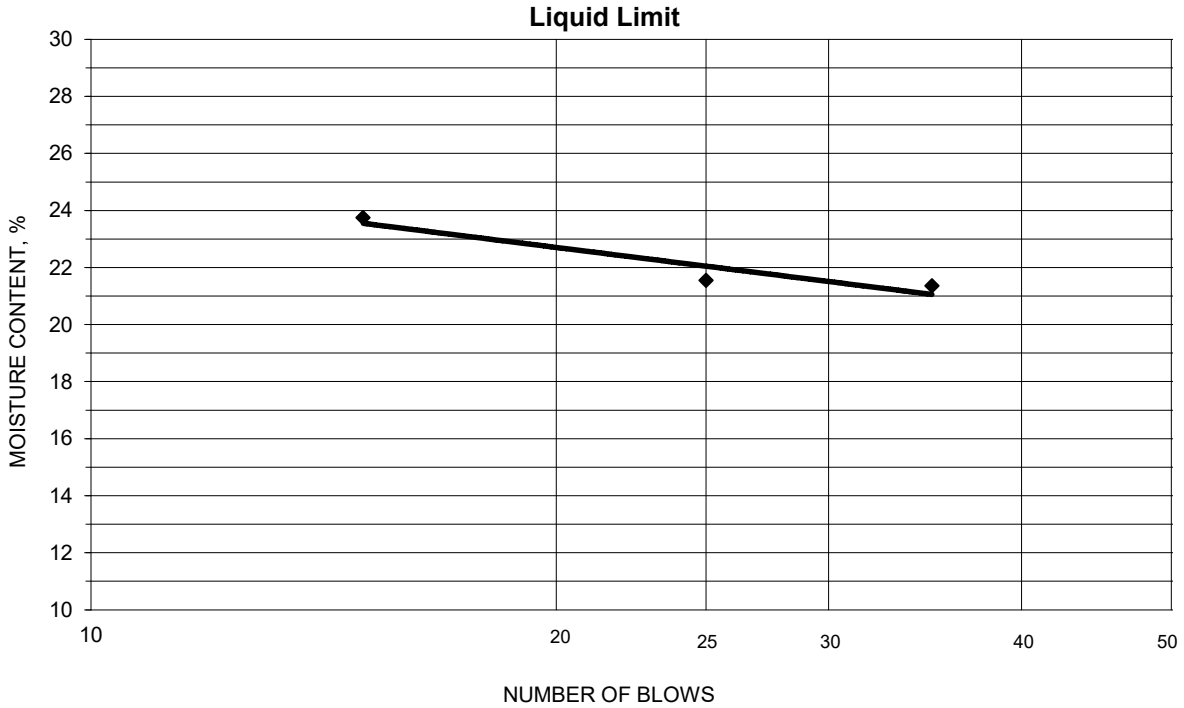
Reviewed By REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	590-A, 1.5'-3.0', 4.0'-5.5'	Lab ID	53
		% + No. 40	73
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-15-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
20.57	18.72	10.93	15	23.7	22
20.77	19.02	10.90	25	21.6	
19.06	17.58	10.65	35	21.4	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
24.07	22.15	10.58	16.6	17	5
24.75	22.79	11.03	16.7		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	590-A, 9.0'-10.5', 11.5'-13.0', 14.0'-15.5'	Lab ID	57
Sample Type	SS-4 Composite	Date Received	4-25-24
		Date Reported	5-24-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 2.8

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	70.6
3/8"	9.5	43.8
No. 4	4.75	34.6
No. 10	2	29.3
No. 40	0.425	24.8
No. 200	0.075	13.7
	0.02	8.1
	0.005	4.0
	0.002	2.7
Estimated	0.001	1.7

Plus 3 in. Material, Not Included: 0 (%)

Range	ASTM (%)	AASHTO (%)
Gravel	65.4	70.7
Coarse Sand	5.3	4.5
Medium Sand	4.5	---
Fine Sand	11.1	11.1
Silt	9.7	11.0
Clay	4.0	2.7

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit: 22
Plastic Limit: 17
Plasticity Index: 5
Activity Index: 1.9

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3): N/A
Maximum Dry Density (kg/m^3): N/A
Optimum Moisture Content (%): N/A
Over Size Correction %: N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%): N/A
Compacted Dry Density (lb/ft^3): N/A
Compacted Moisture Content (%): N/A

Specific Gravity

Estimated

Particle Size: No. 10
Specific Gravity at 20° Celsius: 2.70

Classification

Unified Group Symbol: GC-GM
Group Name: Silty, Clayey Gravel with Sand

AASHTO Classification: A-1-a (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	590-A, 9.0'-10.5', 11.5'-13.0', 14.0'-15.5'	Lab ID	57

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: GK
Test Date: 05-21-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	70.6
3/8"	43.8
No. 4	34.6
No. 10	29.3

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

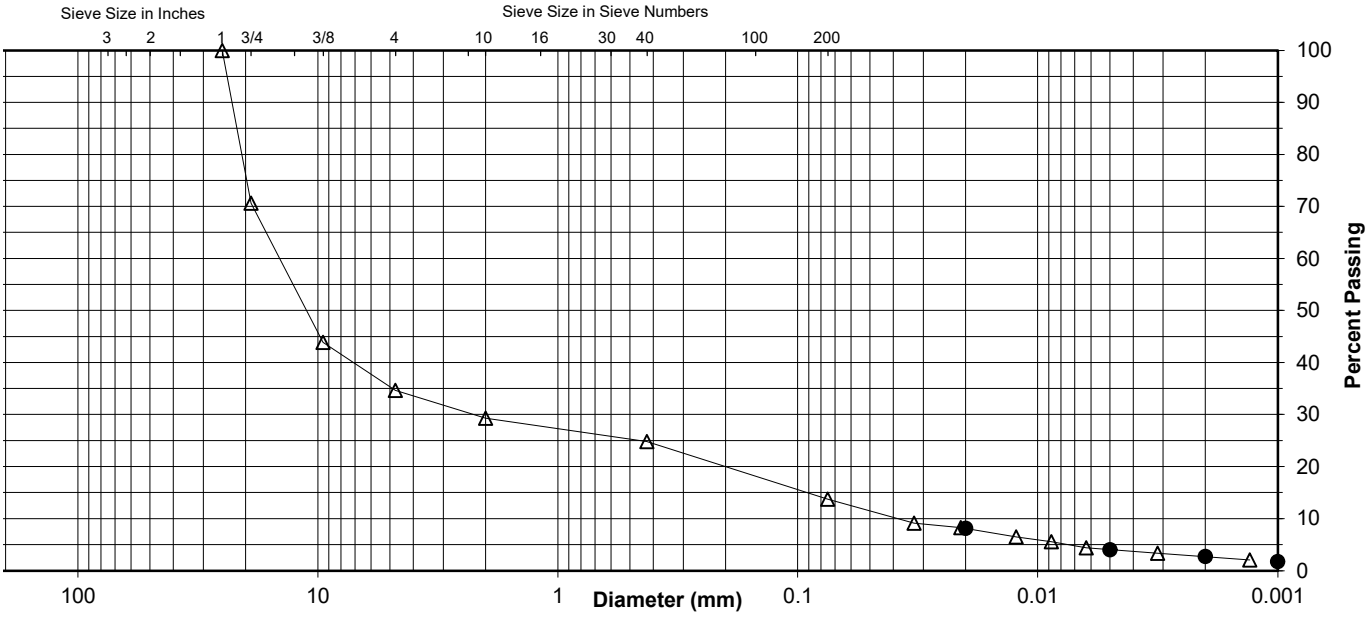
Specific Gravity: 2.7

Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	24.8
No. 200	13.7
0.02 mm	8.1
0.005 mm	4.0
0.002 mm	2.7
0.001 mm	1.7

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	29.4	36.0	5.3	4.5	11.1	9.7	4.0
AASHTO	Gravel			Coarse Sand	Fine Sand	Silt	Clay
	70.7			4.5	11.1	11.0	2.7



Comments

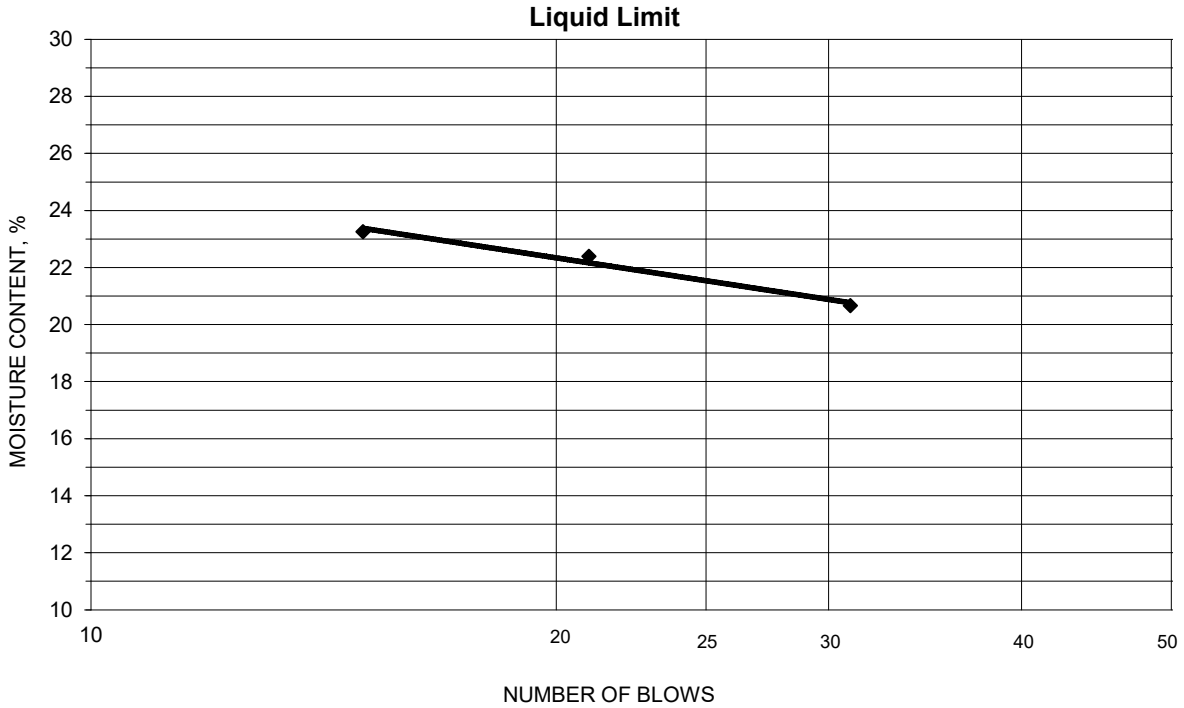
Reviewed By REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	590-A, 9.0'-10.5', 11.5'-13.0', 14.0'-15.5'	Lab ID	57
		% + No. 40	75
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-22-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
18.49	17.06	10.91	15	23.3	22
18.63	17.17	10.65	21	22.4	
20.59	18.96	11.07	31	20.7	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
21.79	20.24	11.02	16.8	17	5
22.48	20.79	10.58	16.6		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	590-A, 14.0'-15.5', 16.5'-18.0'	Lab ID	61
Sample Type	SS-6B Composite	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: ASTM D 2216

Moisture Content (%): 14.6

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	86.6
3/8"	9.5	75.2
No. 4	4.75	68.2
No. 10	2	57.4
No. 40	0.425	49.8
No. 200	0.075	29.1
	0.02	18.3
	0.005	10.9
	0.002	7.6
Estimated	0.001	4.9

Plus 3 in. Material, Not Included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	31.8	42.6
Coarse Sand	10.8	7.6
Medium Sand	7.6	---
Fine Sand	20.7	20.7
Silt	18.2	21.5
Clay	10.9	7.6

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	21
Plastic Limit:	17
Plasticity Index:	4
Activity Index:	0.5

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	SC-SM
Group Name:	Silty, Clayey Sand with Gravel
AASHTO Classification:	A-2-4 (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Source: 590-A, 14.0'-15.5', 16.5'-18.0'

Project Number: 2026252329
Lab ID: 61

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: NU
Test Date: 04-29-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	86.6
3/8"	75.2
No. 4	68.2
No. 10	57.4

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

Specific Gravity: 2.7

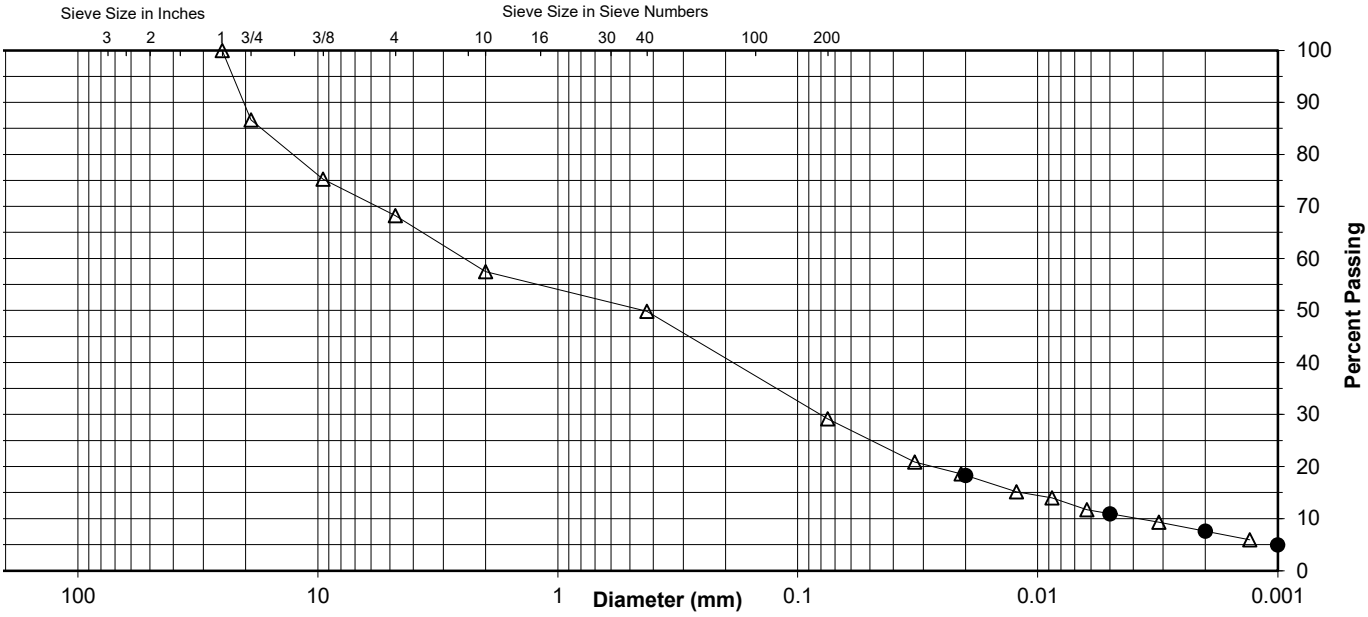
Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	49.8
No. 200	29.1
0.02 mm	18.3
0.005 mm	10.9
0.002 mm	7.6
0.001 mm	4.9

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	13.4	18.4	10.8	7.6	20.7	18.2	10.9

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	42.6	7.6	20.7	21.5	7.6



Comments

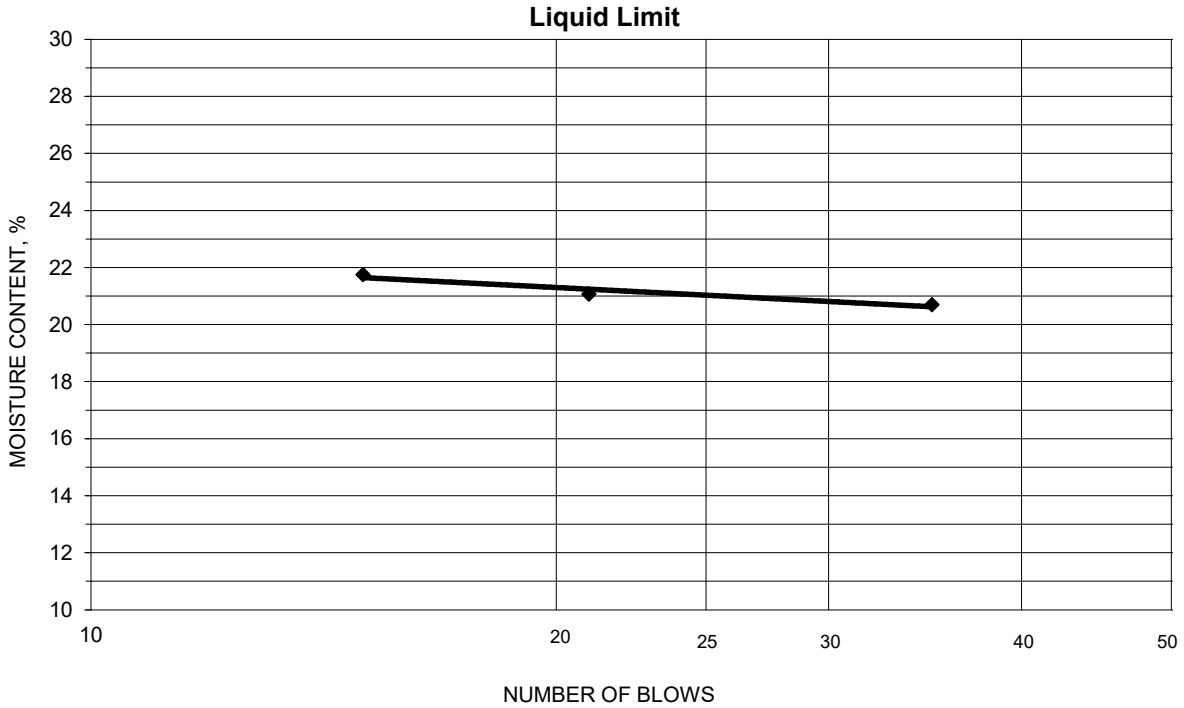
Reviewed By: REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	590-A, 14.0'-15.5', 16.5'-18.0'	Lab ID	61
		% + No. 40	50
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-03-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
21.67	19.71	10.70	15	21.8	21
22.25	20.23	10.64	21	21.1	
19.35	17.92	11.01	35	20.7	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
23.33	21.49	10.63	16.9	17	4
23.77	21.97	11.05	16.5		

Remarks:

Reviewed By REL

Stantec

Summary of Soil Tests

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	590-B, 1.5'-3.0'	Lab ID	64
Sample Type	SS-1	Date Received	4-25-24
		Date Reported	5-17-24

Test Results

Natural Moisture Content

Test Method: AASHTO T 265

Moisture Content (%): 6.6

Particle Size Analysis

Preparation Method: AASHTO T 87
Gradation Method: AASHTO T 88
Hydrometer Method: AASHTO T 88

Particle Size		%
Sieve Size	(mm)	Passing
	N/A	
	N/A	
	N/A	
1"	25	100.0
3/4"	19	80.9
3/8"	9.5	71.6
No. 4	4.75	59.5
No. 10	2	48.2
No. 40	0.425	35.6
No. 200	0.075	22.0
	0.02	14.4
	0.005	9.2
	0.002	6.8
Estimated	0.001	5.4

Plus 3 in. Material, Not Included: 0 (%)

	ASTM	AASHTO
Range	(%)	(%)
Gravel	40.5	51.8
Coarse Sand	11.3	12.6
Medium Sand	12.6	---
Fine Sand	13.6	13.6
Silt	12.8	15.2
Clay	9.2	6.8

Atterberg Limits

Test Method: AASHTO T 89 & T 90
Prepared: Dry

Liquid Limit:	25
Plastic Limit:	19
Plasticity Index:	6
Activity Index:	0.9

Moisture-Density Relationship

Test Not Performed

Maximum Dry Density (lb/ft^3):	N/A
Maximum Dry Density (kg/m^3):	N/A
Optimum Moisture Content (%):	N/A
Over Size Correction %:	N/A

California Bearing Ratio

Test Not Performed

Bearing Ratio (%):	N/A
Compacted Dry Density (lb/ft^3):	N/A
Compacted Moisture Content (%):	N/A

Specific Gravity

Estimated

Particle Size:	No. 10
Specific Gravity at 20° Celsius:	2.70

Classification

Unified Group Symbol:	GC-GM
Group Name:	Silty, Clayey Gravel with Sand
AASHTO Classification:	A-1-b (0)

Comments:

Reviewed By REL

Stantec

Particle-Size Analysis of Soils
AASHTO T 88

Project Name: TN ERFO FS CHRKE804 2020-2(1)
Source: 590-B, 1.5'-3.0'

Project Number: 2026252329
Lab ID: 64

Sieve Analysis for the Portion Coarser than the No. 10 Sieve

Test Method: AASHTO T 88
Prepared Using: AASHTO T 87

Particle Shape: Angular
Particle Hardness: Hard and Durable

Tested By: JP
Test Date: 04-29-2024
Date Received: 04-25-2024

Maximum Particle Size: 1" Sieve

Sieve Size	% Passing
1"	100.0
3/4"	80.9
3/8"	71.6
No. 4	59.5
No. 10	48.2

Analysis for the Portion Finer than the No. 10 Sieve

Analysis Based on -3 inch Fraction Only

Specific Gravity: 2.7

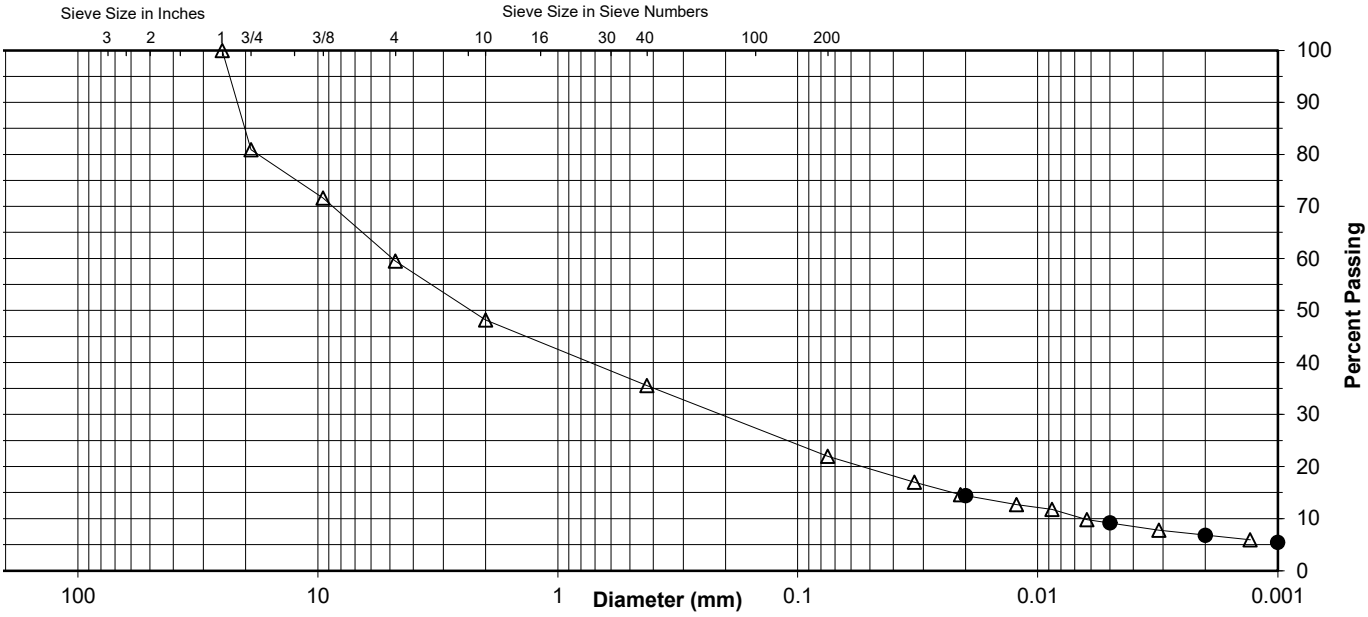
Dispersed Using: Apparatus A - Mechanical, for 1 Minute

No. 40	35.6
No. 200	22.0
0.02 mm	14.4
0.005 mm	9.2
0.002 mm	6.8
0.001 mm	5.4

Particle Size Distribution

ASTM	Coarse Gravel	Fine Gravel	C. Sand	Medium Sand	Fine Sand	Silt	Clay
	19.1	21.4	11.3	12.6	13.6	12.8	9.2

AASHTO	Gravel	Coarse Sand	Fine Sand	Silt	Clay
	51.8	12.6	13.6	15.2	6.8



Comments

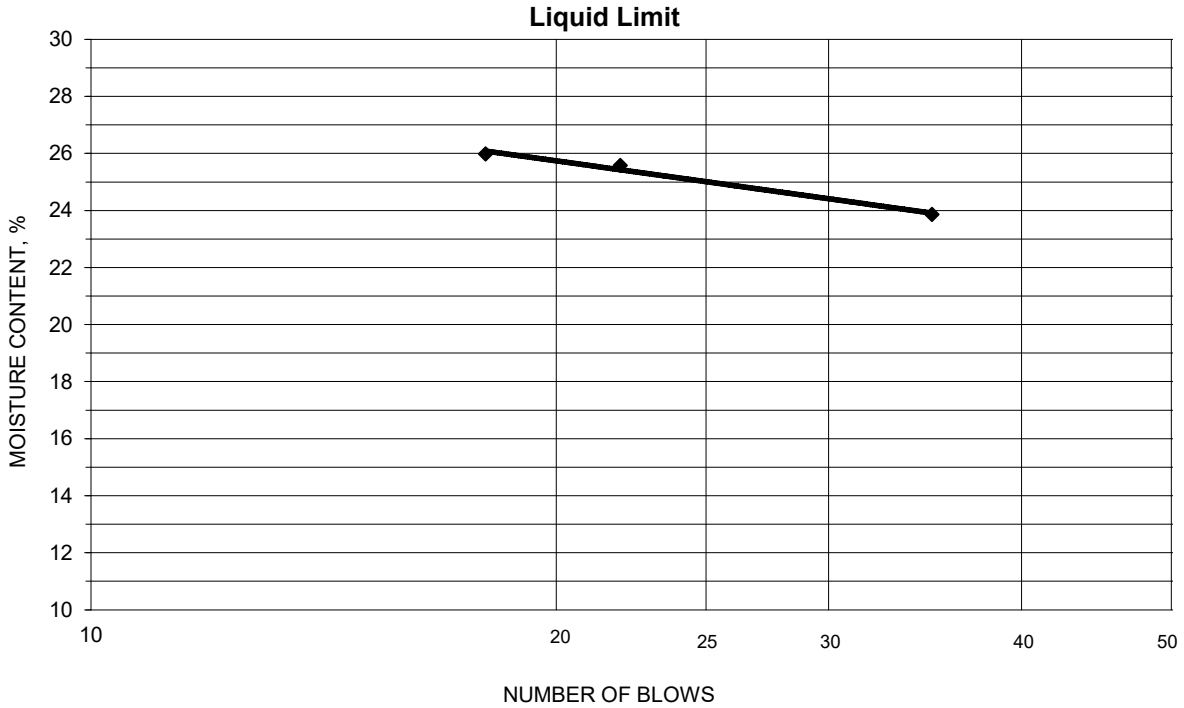
Reviewed By: REL

Stantec

ATTERBERG LIMITS

Project	TN ERFO FS CHRKE804 2020-2(1)	Project No.	2026252329
Source	590-B, 1.5'-3.0'	Lab ID	64
		% + No. 40	64
Tested By	NU	Test Method	AASHTO T 89 & T 90
Date Received	04-25-2024		
Test Date	05-01-2024	Prepared	Dry

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Number of Blows	Water Content (%)	Liquid Limit
20.72	18.73	11.07	18	26.0	25
19.71	17.95	11.07	22	25.6	
20.03	18.30	11.05	35	23.9	



PLASTIC LIMIT AND PLASTICITY INDEX

Wet Soil and Tare Mass (g)	Dry Soil and Tare Mass (g)	Tare Mass (g)	Water Content (%)	Plastic Limit	Plasticity Index
25.69	23.38	11.07	18.8	19	6
25.63	23.36	11.02	18.4		

Remarks:

Reviewed By REL

Stantec

Gradation Analysis

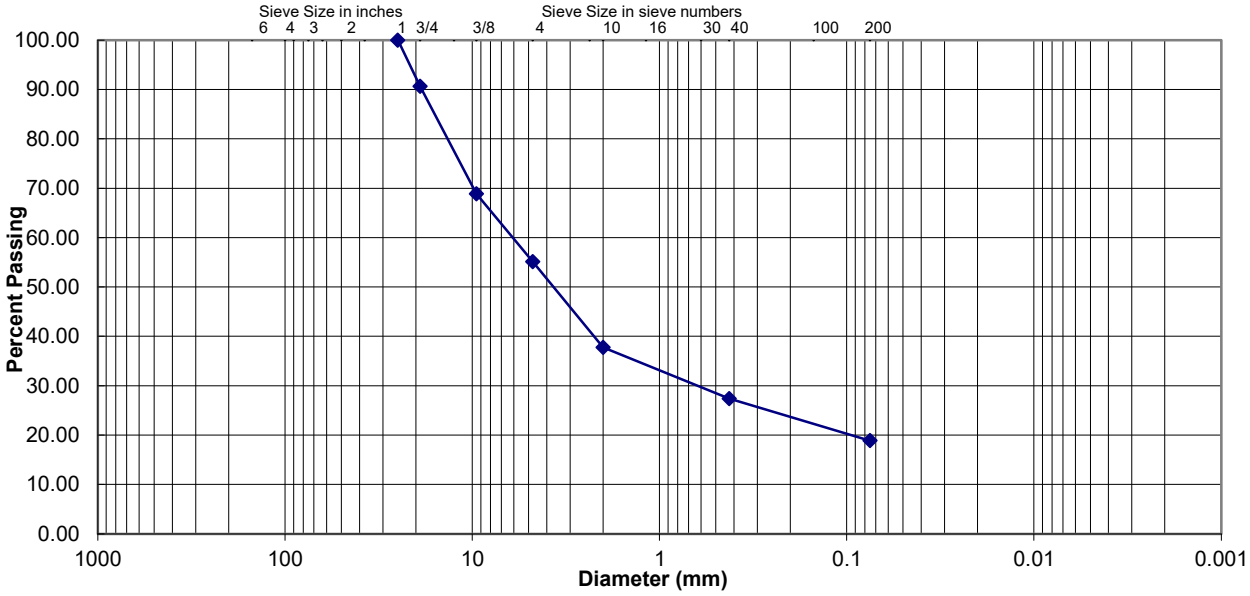
AASHTO T 88

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	660-C, 6.0'-7.5'	Lab ID	24
Preparation Method	AASHTO T 11 Method A	Date Received	04-25-2024
Soak Time (min)	1200	Preparation Date	05-14-2024
Particle Shape	Angular	Test Date	05-15-2024
Particle Hardness	Hard and Durable		
Sample Dry Mass (g)	440.74	Analysis Based on Total Sample.	
Moisture Content (%)	0.0		

Sieve Size	Grams Retained	% Retained	% Passing
1"	0.00	0.0	100.0
3/4"	41.04	9.3	90.7
3/8"	96.24	21.8	68.9
No. 4	60.42	13.7	55.1
No. 10	76.48	17.4	37.8
No. 40	45.91	10.4	27.4
No. 200	37.46	8.5	18.9
Pan	83.19	18.9	---

% Gravel	62.2
% Sand	18.9
% Fines	18.9
Fines Classification	CL-ML
D_{10} (mm)	N/A
D_{30} (mm)	N/A
D_{60} (mm)	N/A
Cu	N/A
Cc	N/A

Particle Size Distribution



Comments

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Version: 20170216
Approved By: RJ

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Cincinnati, Ohio

Reported By: REL
Report Date: 05/22/2024

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Gradation Analysis

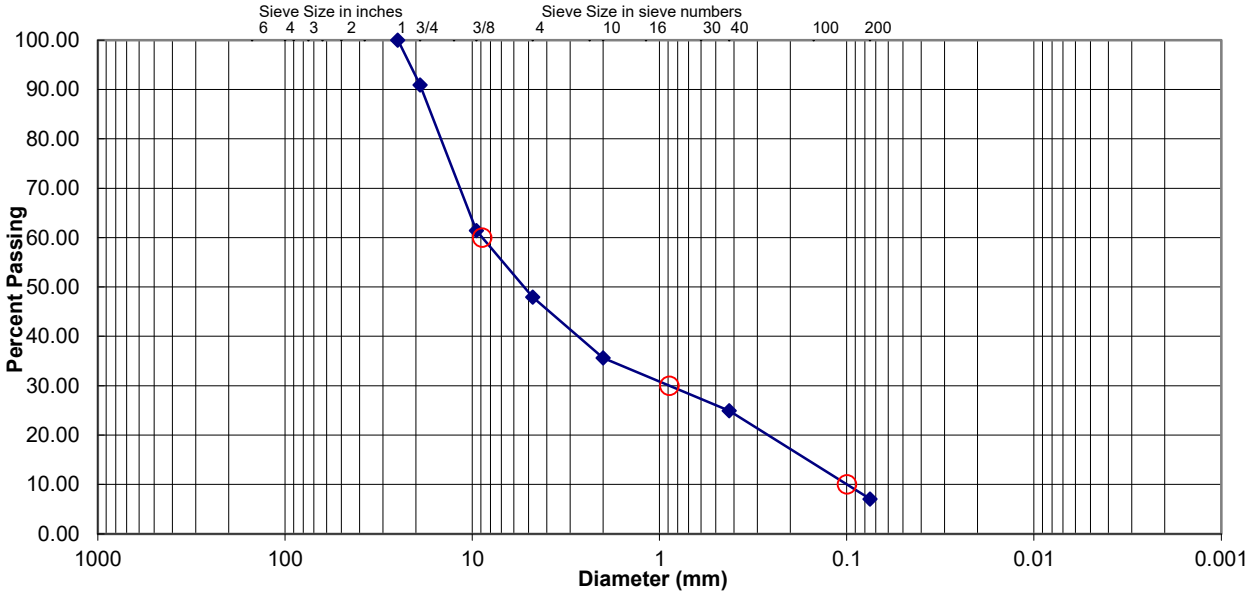
AASHTO T 88

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	599-A, 1.0'-2.5'	Lab ID	25
Preparation Method	AASHTO T 11 Method A	Date Received	04-25-2024
Soak Time (min)	1200	Preparation Date	04-29-2024
Particle Shape	Angular	Test Date	04-30-2024
Particle Hardness	Hard and Durable		
Sample Dry Mass (g)	102.87	Analysis Based on Total Sample.	
Moisture Content (%)	0.1		

Sieve Size	Grams Retained	% Retained	% Passing
1"	0.00	0.0	100.0
3/4"	9.35	9.1	90.9
3/8"	30.35	29.5	61.4
No. 4	13.83	13.4	48.0
No. 10	12.68	12.3	35.6
No. 40	11.04	10.7	24.9
No. 200	18.36	17.8	7.1
Pan	7.26	7.1	---

% Gravel	64.4
% Sand	28.6
% Fines	7.1
Fines Classification	ML
D_{10} (mm)	0.0998
D_{30} (mm)	0.8866
D_{60} (mm)	8.8350
Cu	88.50
Cc	0.89

Particle Size Distribution



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Cincinnati, Ohio

Reported By: REL
Report Date: 05/22/2024

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Gradation Analysis

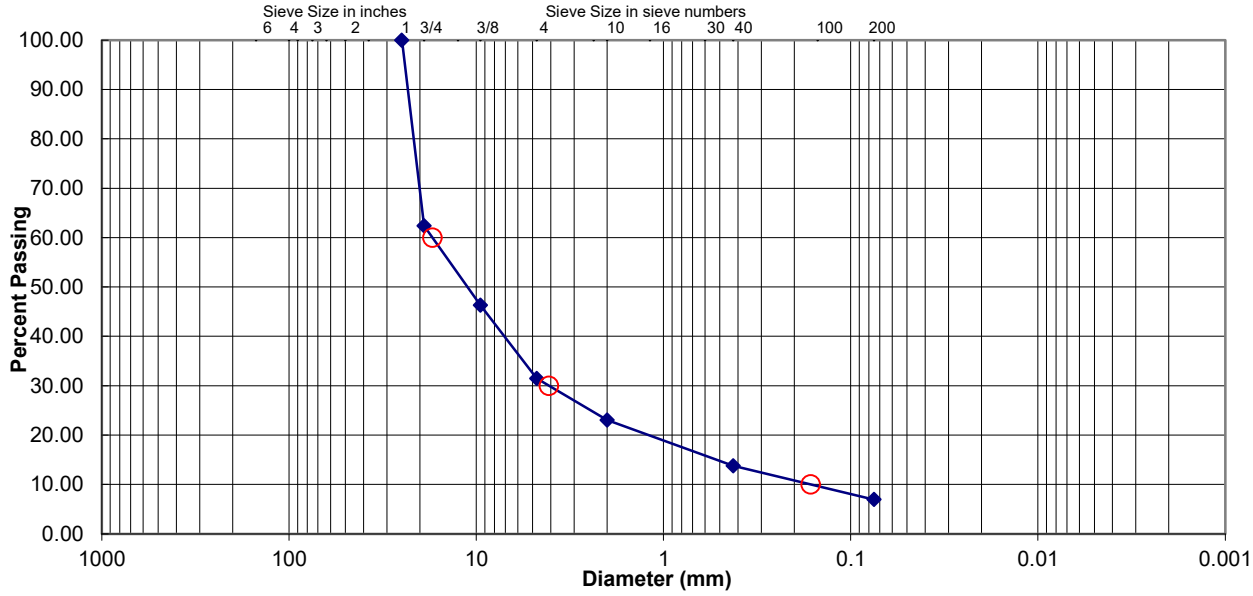
ASTM D 422

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	633-B, 18.5'-20.0'	Lab ID	52
Preparation Method	ASTM D 1140 Method A	Date Received	04-25-2024
Soak Time (min)	1200	Preparation Date	05-06-2024
Particle Shape	Angular	Test Date	05-07-2024
Particle Hardness	Hard and Durable		
Sample Dry Mass (g)	432.84	Analysis Based on Total Sample.	
Moisture Content (%)	0.7		

Sieve Size	Grams Retained	% Retained	% Passing
1"	0.00	0.0	100.0
3/4"	162.78	37.6	62.4
3/8"	69.49	16.1	46.3
No. 4	64.44	14.9	31.5
No. 10	36.50	8.4	23.0
No. 40	40.04	9.3	13.8
No. 200	29.59	6.8	6.9
Pan	30.00	6.9	---

% Gravel	68.5
% Sand	24.5
% Fines	6.9
Fines Classification	ML
D_{10} (mm)	0.1634
D_{30} (mm)	4.0934
D_{60} (mm)	17.1353
Cu	104.87
Cc	5.98

Particle Size Distribution



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Gradation Analysis

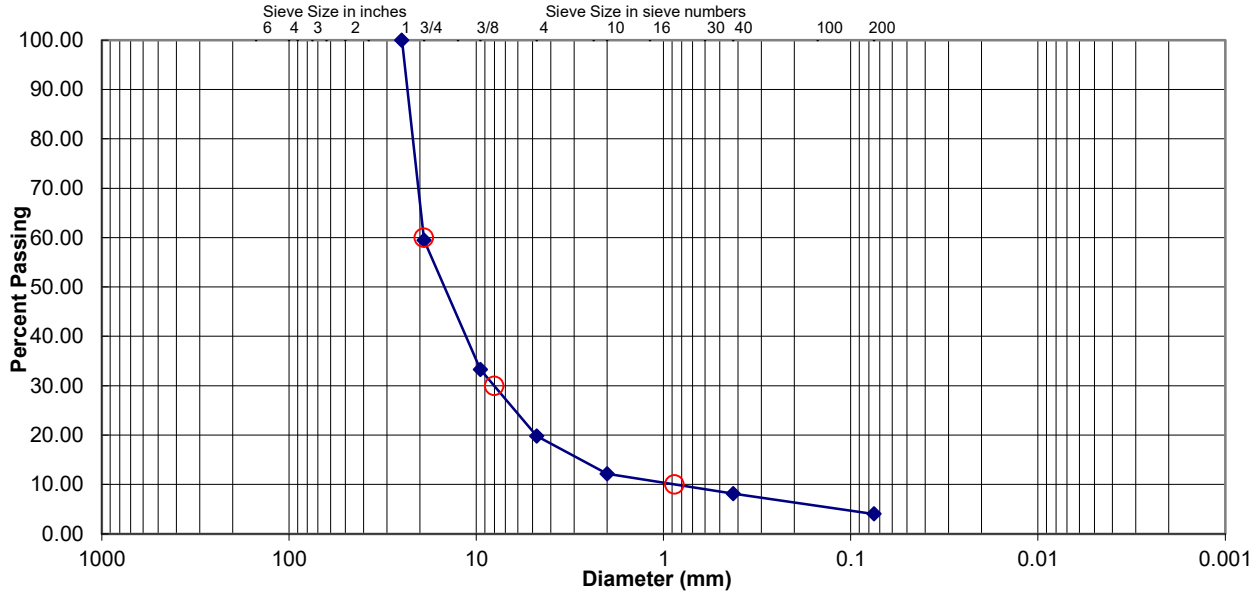
AASHTO T 88

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	590-B, 4.0'-5.5'	Lab ID	65
Preparation Method	AASHTO T 11 Method A	Date Received	04-25-2024
Soak Time (min)	1200	Preparation Date	04-29-2024
Particle Shape	Angular	Test Date	04-30-2024
Particle Hardness	Hard and Durable		
Sample Dry Mass (g)	107.49	Analysis Based on Total Sample.	
Moisture Content (%)	0.1		

Sieve Size	Grams Retained	% Retained	% Passing
1"	0.00	0.0	100.0
3/4"	43.58	40.5	59.5
3/8"	28.15	26.2	33.3
No. 4	14.46	13.5	19.8
No. 10	8.27	7.7	12.1
No. 40	4.28	4.0	8.1
No. 200	4.41	4.1	4.0
Pan	4.34	4.0	---

% Gravel	87.9
% Sand	8.1
% Fines	4.0
Fines Classification	ML
D_{10} (mm)	0.8761
D_{30} (mm)	8.0277
D_{60} (mm)	19.0700
Cu	21.77
Cc	3.86

Particle Size Distribution



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Report Date: 05/22/2024

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Gradation Analysis

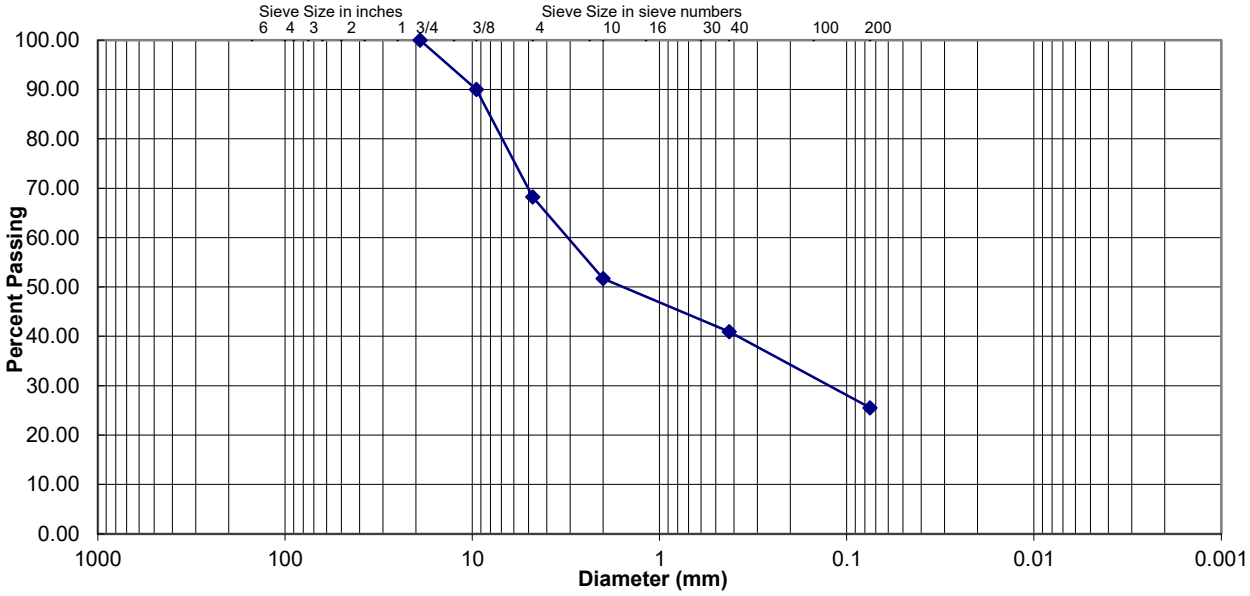
AASHTO T 88

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Source	590-B, 6.5'-8.0'	Lab ID	66
Preparation Method	AASHTO T 11 Method A	Date Received	04-25-2024
Soak Time (min)	1200	Preparation Date	04-29-2024
Particle Shape	Angular	Test Date	04-30-2024
Particle Hardness	Hard and Durable		
Sample Dry Mass (g)	92.76	Analysis Based on Total Sample.	
Moisture Content (%)	0.0		

Sieve Size	Grams Retained	% Retained	% Passing
3/4"	0.00	0.0	100.0
3/8"	9.25	10.0	90.0
No. 4	20.24	21.8	68.2
No. 10	15.34	16.5	51.7
No. 40	9.95	10.7	40.9
No. 200	14.30	15.4	25.5
Pan	23.68	25.5	---

% Gravel	48.3
% Sand	26.1
% Fines	25.5
Fines Classification	ML
D_{10} (mm)	N/A
D_{30} (mm)	N/A
D_{60} (mm)	N/A
Cu	N/A
Cc	N/A

Particle Size Distribution



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Cincinnati, Ohio

Reported By: REL
Report Date: 05/22/2024

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Moisture Content of Soil

AASHTO T 265

Project Name TN ERFO FS CHRKE804 2020-2(1)

Project Number 2026252329

Tested By JP

Test Method AASHTO

Maximum Particle Size in Sample	No. 40	No. 4	1/2"	1"	2"	
Recommended Minimum Mass (g)	10	100	300	500	1,000	

Material Type: Stratified, Laminated, Lensed, Homogeneous, Disturbed

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
659-A, 1.0'-2.5'	1	5/8/24	Dist	No. 4			No	31.83	70.89	66.82	11.6
659-A, 3.5'-5.0'	3	5/8/24	Dist	No. 4			No	32.01	63.21	60.95	7.8
659-A, 6.0'-6.7'	4	5/8/24	Dist	No. 4			No	32.14	122.09	120.01	2.4
659-B, 1.0'-2.5'	6	5/19/24	Dist	No. 4			No	30.57	36.95	36.70	4.1
659-B, 3.5'-5.0'	7	5/19/24	Dist	No. 4			No	32.50	35.85	35.70	4.7
659-B, 6.0'-7.5'	8	5/19/24	Dist	No. 4			No	31.88	35.71	34.91	26.4
659-B, 8.5'-8.8'	9	5/8/24	Dist	No. 4			No	32.31	131.59	128.63	3.1
660-A, 1.0'-2.5'	10	4/29/24	Dist	No. 4			No	32.06	72.56	67.74	13.5
660-A, 3.5'-5.0'	12	4/29/24	Dist	No. 4			No	32.31	98.13	91.59	11.0
660-A, 6.0'-7.5'	13	4/29/24	Dist	No. 4			No	31.83	68.26	64.83	10.4
660-B, 1.0'-2.5'	15	4/29/24	Dist	No. 4			No	31.88	78.71	72.28	15.9
660-B, 3.5'-5.0'	16	4/29/24	Dist	No. 4			No	32.15	73.83	68.48	14.7
660-B, 6.0'-7.5'	17	4/29/24	Dist	No. 4			No	32.01	76.71	72.18	11.3
660-B, 8.5'-10.0'	19	5/19/24	Dist	No. 4			No	31.80	92.71	87.28	9.8
660-B, 11.0'-12.5'	20	5/19/24	Dist	No. 4			No	32.19	75.26	71.23	10.3
660-B, 13.5'-15.0'	21	5/19/24	Dist	No. 4			No	30.95	79.35	75.31	9.1
660-C, 1.0'-2.5'	22	4/29/24	Dist	No. 4			No	31.65	92.23	84.98	13.6
660-C, 3.5'-5.0'	23	4/29/24	Dist	No. 4			No	30.57	63.54	58.21	19.3
660-C, 6.0'-7.5'	24	4/29/24	Dist	No. 4			No	30.63	105.05	100.09	7.1
599-A, 1.0'-2.5'	25	4/26/24	Dist	No. 4			No	32.18	87.24	86.66	1.1
599-B, 0.0'-1.5'	27	4/26/24	Dist	No. 4			No	31.74	110.63	104.94	7.8
599-B, 1.5'-3.0'	28	4/26/24	Dist	No. 4			No	32.31	132.33	120.59	13.3
599-B, 3.5'-4.4'	29	4/26/24	Dist	No. 4			No	30.94	135.35	123.67	12.6
633-A, 1.0'-2.5'	31	5/8/24	Dist	No. 4			No	30.94	73.18	70.54	6.7
633-A, 3.5'-5.0'	32	5/8/24	Dist	No. 4			No	32.18	118.52	113.52	6.1
633-A, 6.0'-7.5'	34	5/8/24	Dist	No. 4			No	30.96	67.80	65.46	6.8
633-A, 8.5'-10.0'	35	5/8/24	Dist	No. 4			No	32.33	64.76	62.86	6.2
633-A, 11.0'-12.5'	37	5/15/24	Dist	No. 4			No	32.32	64.93	62.91	6.6

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Moisture Content of Soil

AASHTO T 265

Project Name TN ERFO FS CHRKE804 2020-2(1)

Project Number 2026252329

Tested By JP

Test Method AASHTO

Maximum Particle Size in Sample	No. 40	No. 4	1/2"	1"	2"	
Recommended Minimum Mass (g)	10	100	300	500	1,000	

Material Type: Stratified, Laminated, Lensed, Homogeneous, Disturbed

Source	Lab ID	Date Tested	Material Type	Maximum Particle Size	Material Excluded Amount	Material Excluded Size	Pass Min. Mass? (Y/N)	Can Weight (g)	Wet Soil & Can Weight (g)	Dry Soil & CanWeight (g)	Moisture Content (%)
633-A, 13.5'-15.0'	38	5/15/24	Dist	No. 4			No	32.07	63.06	61.20	6.4
633-A, 16.0'-17.5'	40	5/15/24	Dist	No. 4			No	32.01	63.33	59.99	11.9
633-A, 18.5'-20.0'	41	5/15/24	Dist	No. 4			No	30.96	63.22	61.57	5.4
633-B, 1.0'-2.5'	43	4/29/24	Dist	No. 4			No	32.32	115.23	111.36	4.9
633-B, 3.5'-5.0'	44	4/29/24	Dist	No. 4			No	30.69	92.38	88.75	6.3
633-B, 6.0'-7.5'	46	4/29/24	Dist	No. 4			No	32.17	93.87	89.59	7.5
633-B, 8.5'-10.0'	47	4/29/24	Dist	No. 4			No	30.93	89.63	85.39	7.8
633-B, 11.0'-12.5'	49	4/29/24	Dist	No. 4			No	30.97	133.27	121.44	13.1
633-B, 13.5'-15.0'	50	4/29/24	Dist	No. 4			No	31.81	135.49	121.17	16.0
633-B, 16.0'-17.5'	51	4/29/24	Dist	No. 4			No	32.06	125.72	115.69	12.0
633-B, 18.5'-20.0'	52	4/29/24	Dist	No. 4			No	31.13	88.71	86.48	4.0
590-A, 1.5'-3.0'	54	5/8/24	Dist	No. 4			No	32.17	75.00	73.89	2.7
590-A, 4.0'-5.5'	55	5/8/24	Dist	No. 4			No	31.81	94.31	93.29	1.7
590-A, 6.5'-8.0'	56	5/8/24	Dist	No. 4			No	31.66	113.27	113.14	0.2
590-A, 9.0'-10.5'	58	5/19/24	Dist	No. 4			No	32.17	83.15	81.67	3.0
590-A, 11.5'-13.0'	59	5/19/24	Dist	No. 4			No	30.92	66.24	65.22	3.0
590-A, 14.0'-15.0'	60	5/19/24	Dist	No. 4			No	30.94	64.01	63.27	2.3
590-A, 15.0'-15.5'	62	4/26/24	Dist	No. 4			No	32.34	91.56	82.69	17.6
590-A, 16.5'-18.0'	63	4/26/24	Dist	No. 4			No	32.03	66.35	62.78	11.6
590-B, 1.5'-3.0'	64	4/26/24	Dist	No. 4			No	32.08	66.78	64.62	6.6
590-B, 4.0'-5.5'	65	4/26/24	Dist	No. 4			No	30.93	61.12	61.05	0.2
590-B, 6.5'-8.0'	66	4/26/24	Dist	No. 4			No	30.95	61.44	60.98	1.5

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Determination of pH of Soils

ASTM D 4972

Project Name TN ERFO FS CHRKE804 2020(1) Project No. 2026252329

pH Meter ID PH-1 Balance ID BL-3 Thermometer ID TH-16 Date 5/15/2024 Technician JP

Meter Standardized prior to first test? [X] Yes Method A [X] B [ ]

Sample Source	Lab ID	Maximum Particle Size Used in Test*,[1]	Mixing Container ID	Mass of Soil (grams)	Slurry Temp at Time of Test (°C)	**pH in Water**	Mixing Container ID	Mass of Soil	Slurry Temp at Time of Test (°C)	**pH in Calcium Chloride Solution**
659-A, 3.5'-5.0', 6.0'-6.7'	2	No. 10	ph-9	10.03	23.8	**6.7**	ph-5	10.01	23.7	**6.5**
*Description of Material Excluded from Test and Special Selection or Preparation if Applicable:									*N/A	[ ]
Description and Classification of Soil: Poorly Graded Gravel with Clay and Sand										
659-B, 1.0'-2.5', 3.5'-5.0', 6.0'-7.5'	5	No. 10	ph-5	10.07	22.8	**8.3**	ph-8	10.04	22.9	**7.6**
*Description of Material Excluded from Test and Special Selection or Preparation if Applicable.									*N/A	[ ]
Description and Classification of Soil: Well Graded Gravel with Clay and Sand										
660-A, 3.5'-5.0', 6.0'-7.5'	11	No. 10	ph-8	10.06	23.6	**6.5**	ph-6	10.04	23.8	**5.9**
*Description of Material Excluded from Test and Special Selection or Preparation if Applicable.									*N/A	[ ]
Description and Classification of Soil: Silty Gravel with Sand										
660-B, 8.5'-10.0', 11.0'-12.5', 13.5'-15.0'	18	No. 10	ph-6	10.01	22.7	**7.3**	ph-1	10.01	22.7	**6.7**
*Description of Material Excluded from Test and Special Selection or Preparation if Applicable.									*N/A	[ ]
Description and Classification of Soil: Clayey Gravel with Sand										
599-B, 0.0'-1.5', 1.5'-3.0', 3.5'-4.4'	26	No. 10	ph-5	10.07	23.8	**6.0**	ph-9	10.04	23.8	**5.3**
*Description of Material Excluded from Test and Special Selection or Preparation if Applicable.									*N/A	[ ]
Description and Classification of Soil: Silty, Clayey, Sand with Gravel										

pH Meter Standardization check using pH 7.0 Buffer Solution at completion of testing or after 10 tests

Reading 7.0 *If result is less than 6.9 or greater than 7.1 then re-standardize pH meter and retest previous specimens*

[1] *If soil or soil fractions with particles larger than 2.0 mm are used, the results may be significantly different*

Reviewed By: REL

Stantec

Determination of pH of Soils

ASTM D 4972

Project Name TN ERFO FS CHRKE804 2020(1) Project No. 2026252329

pH Meter ID PH-1 Balance ID BL-3 Thermometer ID TH-16 Date 5/15/2024 Technician JP

Meter Standardized prior to first test? [X] Yes Method A [X] B [ ]

Sample Source	Lab ID	Maximum Particle Size Used in Test*,[1]	Mixing Container ID	Mass of Soil (grams)	Slurry Temp at Time of Test (°C)	**pH in Water**	Mixing Container ID	Mass of Soil	Slurry Temp at Time of Test (°C)	**pH in Calcium Chloride Solution**
633-A, 1.0'-2.5', 3.5'-5.0'	30	No. 10	ph-6	10.05	23.8	**7.1**	ph-8	10.01	23.7	**6.1**
*Description of Material Excluded from Test and Special Selection or Preparation if Applicable:									*N/A	[ ]
Description and Classification of Soil: Well-Graded Gravel with Clay and Sand										
633-A, 6.0'-7.5', 8.5'-10.0'	33	No. 10	ph-9	10.07	23.8	**6.6**	ph-5	10.03	23.8	**5.9**
*Description of Material Excluded from Test and Special Selection or Preparation if Applicable.									*N/A	[ ]
Description and Classification of Soil: Silty, Clayey Sand with Gravel										
633-A, 11.0'-12.5', 13.5'-15.0'	36	No. 10	ph-2	10.05	22.9	**6.8**	ph-4	10.08	22.8	**6.0**
*Description of Material Excluded from Test and Special Selection or Preparation if Applicable.									*N/A	[ ]
Description and Classification of Soil: Silty, Clayey Sand with Gravel										
633-B, 1.0'-2.5', 3.5'-5.0'	42	No. 10	ph-6	10.06	23.7	**6.5**	ph-8	10.01	23.8	**5.7**
*Description of Material Excluded from Test and Special Selection or Preparation if Applicable.									*N/A	[ ]
Description and Classification of Soil: Well-Graded Gravel with Clay and Sand										
633-B, 11.0'-12.5', 13.5'-15.0', 16.0'-17.5'	48	No. 10	ph-9	10.04	24.0	**6.3**	ph-5	10.05	24	**5.6**
*Description of Material Excluded from Test and Special Selection or Preparation if Applicable.									*N/A	[ ]
Description and Classification of Soil: Poorly Graded Gravel with Silt and Sand										

pH Meter Standardization check using pH 7.0 Buffer Solution at completion of testing or after 10 tests

Reading 7.1 *If result is less than 6.9 or greater than 7.1 then re-standardize pH meter and retest previous specimens*

[1] *If soil or soil fractions with particles larger than 2.0 mm are used, the results may be significantly different*

Reviewed By: REL

Stantec

Determination of pH of Soils

ASTM D 4972

Project Name TN ERFO FS CHRKE804 2020(1) Project No. 2026252329

pH Meter ID PH-1 Balance ID BL-3 Thermometer ID TH-16 Date 5/15/2024 Technician JP

Meter Standardized prior to first test? [X] Yes Method A [X] B [ ]

Sample Source	Lab ID	Maximum Particle Size Used in Test*,[1]	Mixing Container ID	Mass of Soil (grams)	Slurry Temp at Time of Test (°C)	**pH in Water**	Mixing Container ID	Mass of Soil	Slurry Temp at Time of Test (°C)	**pH in Calcium Chloride Solution**
590-A, 1.5'-3.0', 4.0'-5.5'	53	No. 10	ph-5	10.02	24.2	**6.0**	ph-6	10.04	24.0	**5.2**
*Description of Material Excluded from Test and Special Selection or Preparation if Applicable:									*N/A	[ ]
Description and Classification of Soil: Silty, Clayey Gravel with Sand										
590-A, 9.0'-10.5', 11.5'-13.0', 14.0'-15.5'	57	No. 10	ph-9	10.05	22.5	**6.7**	ph-6	10.01	22.9	**6.1**
*Description of Material Excluded from Test and Special Selection or Preparation if Applicable.									*N/A	[ ]
Description and Classification of Soil: Silty, Clayey Gravel with Sand										
590-A, 14.0'-15.5', 16.5'-18.0'	61	No. 10	ph-8	10.01	24.2	**5.3**	ph-9	10.03	24.2	**4.2**
*Description of Material Excluded from Test and Special Selection or Preparation if Applicable.									*N/A	[ ]
Description and Classification of Soil: Silty, Clayey Sand with Gravel										

pH Meter Standardization check using pH 7.0 Buffer Solution at completion of testing or after 10 tests

Reading 7.1 *If result is less than 6.9 or greater than 7.1 then re-standardize pH meter and retest previous specimens*

[1] *If soil or soil fractions with particles larger than 2.0 mm are used, the results may be significantly different*

Reviewed By: REL

Stantec

Measurement of Soil Resistivity Using the Two-Electrode Soil Box Method

Soil Sample Measurement
ASTM G 187

Project TN ERFO FS CHRKE804 2020-2(1)

Project Number 2026252329
Date Received 06/06/2024

Soil Box Width (cm) 3.000
Soil Box Height (cm) 2.400
Electrode Distance (cm) 10.800
Soil Box Factor 0.67

Source	Lab ID	Date	Soil Temp. (°C)	Measured Soil Resistance (Ω)	Temp. Correction Factor (Ω)	Temp. Corrected Resistance (Ω)	Resistivity @ 15.5°C (Ω*cm)
659-B, 1.0'-2.5', 3.5'-5.0', 6.0'-7.5'	5	06-11-2024	21.7	17000	1.155	19635	13090.4
660-B, 8.5'-10.0', 11.0'-12.5', 13.5'-15.0'	18	06-11-2024	21.7	38000	1.155	43890	29260.9
590-A, 9.0'-10.5', 11.5'-13.0', 14.0'-15.5'	57	06-11-2024	20	11000	1.1125	12237.5	8158.59

Comments Lab ID5 was mostly gravel. Not enough sample for test if gravel was excluded.
Lab ID57 included some gravels. Not enough sample for test if all gravel was excluded.

Reviewed By RHB

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Version: 20170216
Approved By: RJ

Stantec

Uniaxial Compressive Strength of Intact Rock Core Specimens

ASTM D 7012, Method C

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Lithology	Shale, grey, slightly strong	Lab ID	UCR-68
Hole Number	659-A	Depth (ft)	20.5'-20.9'
Date Received	04/30/2024		

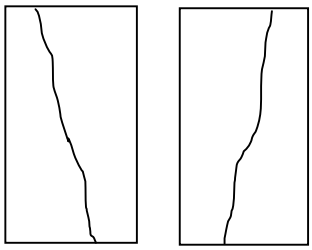
Temperature (°C)	22.6	Moisture Condition	As Prepared, Moist	Date Tested	05/16/2024

Side Planeness	N/A	Height (in)	4.448	Wet Unit Weight (pcf)	166.1
Perpendicularity	N/A	Diameter (in)	1.983	Dry Unit Weight (pcf)	N/A
End Planeness	N/A	Area (in^2)	3.089	Moisture Content (%)	N/A
Parallelism	N/A				

Dimensions were not confirmed.

Loading Rate (lbf/sec)	43
Peak Load (lbf)	7316
Failure Type	Cone and Split
Compressive Strength (psi)	2368
Compressive Strength (psf)	340992
Compressive Strength (tsf)	171

Failure Sketches



Comments Fragile nature of specimen inhibited preparation, required capping of ends with Hydro-Stone. Dimensional tolerances were not confirmed.

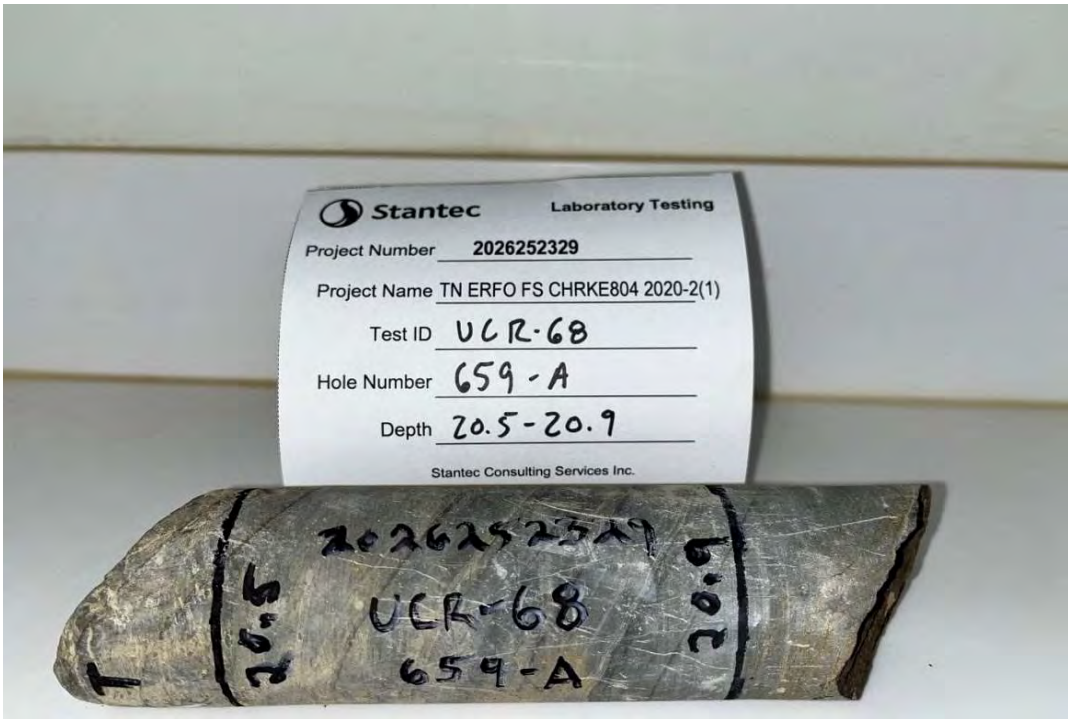
Reviewed By REL

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Shale, grey, slightly strong
Lab ID UCR-68
Hole Number 659-A
Depth (ft) 20.5'-20.9'
Test Type Uniaxial Compressive Strength of Intact Rock Core

As Received



Core Preparation

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Shale, grey, slightly strong
Lab ID UCR-68
Hole Number 659-A
Depth (ft) 20.5'-20.9'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Core Preparation

Post Test

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Shale, grey, slightly strong
Lab ID UCR-68
Hole Number 659-A
Depth (ft) 20.5'-20.9'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Post Test

Stantec

Uniaxial Compressive Strength of Intact Rock Core Specimens

ASTM D 7012, Method C

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Lithology	Shale, grey, slightly strong	Lab ID	UCR-69
Hole Number	659-B	Depth (ft)	13.4'-13.8'
Date Received	04/30/2024		

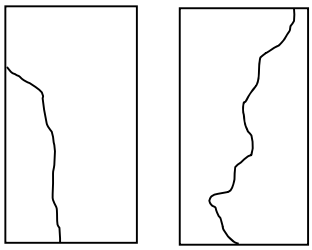
Temperature (°C)	22.4	Moisture Condition	As Prepared, Moist	Date Tested	05/16/2024

Side Planeness	N/A	Height (in)	4.942	Wet Unit Weight (pcf)	170.2
Perpendicularity	N/A	Diameter (in)	1.983	Dry Unit Weight (pcf)	N/A
End Planeness	N/A	Area (in^2)	3.089	Moisture Content (%)	N/A
Parallelism	N/A				

Dimensions were not confirmed.

Loading Rate (lbf/sec)	31
Peak Load (lbf)	6468
Failure Type	Cone and Split
Compressive Strength (psi)	2094
Compressive Strength (psf)	301536
Compressive Strength (tsf)	151

Failure Sketches



Comments Fragile nature of specimen inhibited preparation, required capping of ends with Hydro-Stone. Dimensional tolerances were not confirmed.

Reviewed By REL

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Shale, grey, slightly strong
Lab ID UCR-69
Hole Number 659-B
Depth (ft) 13.4'-13.8'
Test Type Uniaxial Compressive Strength of Intact Rock Core

As Received

Core Preparation

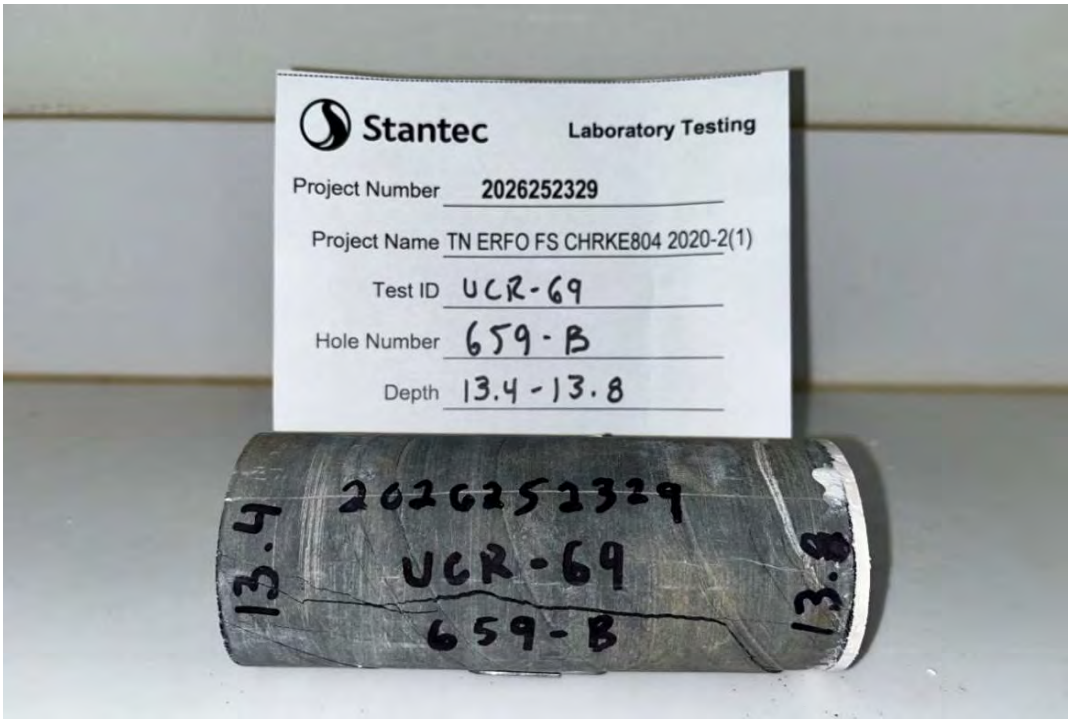
Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Shale, grey, slightly strong
Lab ID UCR-69
Hole Number 659-B
Depth (ft) 13.4'-13.8'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Core Preparation

Post Test



Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Shale, grey, slightly strong
Lab ID UCR-69
Hole Number 659-B
Depth (ft) 13.4'-13.8'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Post Test

Stantec

Uniaxial Compressive Strength of Intact Rock Core Specimens

ASTM D 7012, Method C

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Lithology	Shale, grey, slightly strong	Lab ID	UCR-70
Hole Number	659-B	Depth (ft)	16.7'-17.1'
Date Received	04/30/2024		

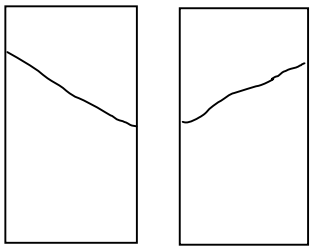
Temperature (°C)	22.8	Moisture Condition	As Prepared, Moist	Date Tested	05/16/2024

Side Planeness	N/A	Height (in)	4.215	Wet Unit Weight (pcf)	169.0
Perpendicularity	N/A	Diameter (in)	1.980	Dry Unit Weight (pcf)	N/A
End Planeness	N/A	Area (in^2)	3.080	Moisture Content (%)	N/A
Parallelism	N/A				

Dimensions were not confirmed.

Loading Rate (lbf/sec)	12
Peak Load (lbf)	2626
Failure Type	Shear
Compressive Strength (psi)	853
Compressive Strength (psf)	122832
Compressive Strength (tsf)	61

Failure Sketches



Comments Primary failure occurred along tilted bedding.
Fragile nature of specimen inhibited preparation, required capping of ends with Hydro-Stone.
Dimensional tolerances were not confirmed.

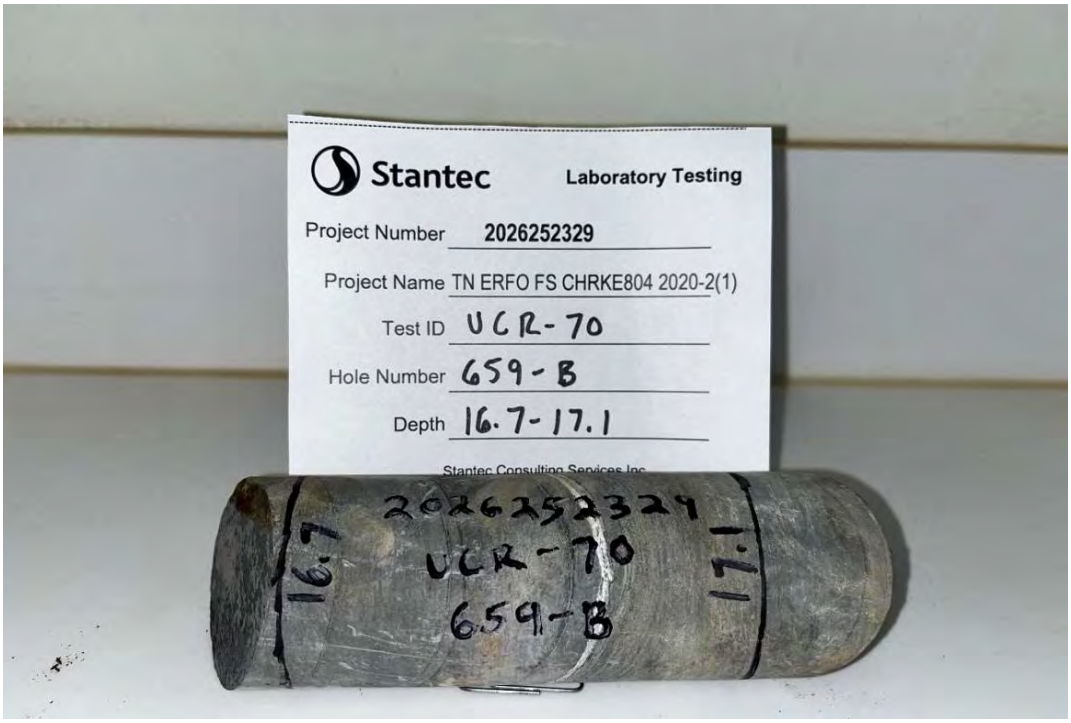
Reviewed By REL

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Shale, grey, slightly strong
Lab ID UCR-70
Hole Number 659-B
Depth (ft) 16.7'-17.1'
Test Type Uniaxial Compressive Strength of Intact Rock Core

As Received



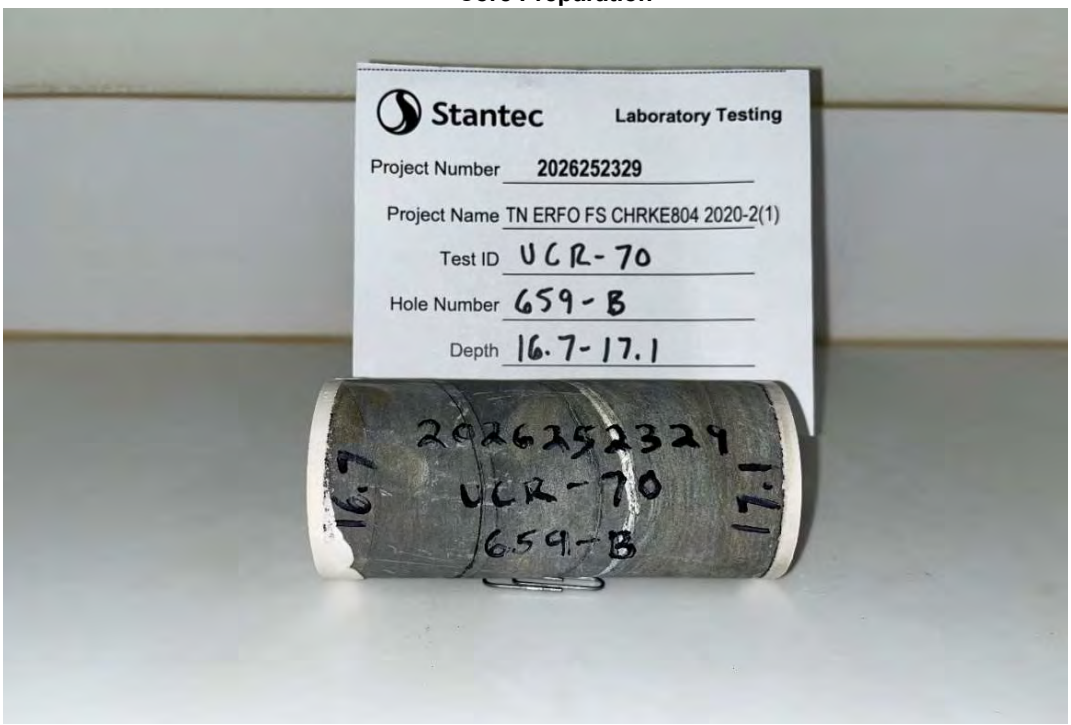
Core Preparation

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Shale, grey, slightly strong
Lab ID UCR-70
Hole Number 659-B
Depth (ft) 16.7'-17.1'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Core Preparation



Post Test

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Shale, grey, slightly strong
Lab ID UCR-70
Hole Number 659-B
Depth (ft) 16.7'-17.1'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Post Test

Stantec

Uniaxial Compressive Strength of Intact Rock Core Specimens

ASTM D 7012, Method C

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Lithology	Limestone interbedded with Shale, grey, strong	Lab ID	UCR-71
Hole Number	660-A	Depth (ft)	15.5'-15.9'
Date Received	04/30/2024		

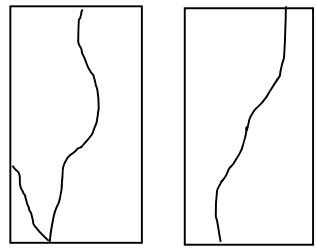
Temperature (°C)	22.6	Moisture Condition	As Prepared, Moist	Date Tested	05/16/2024

Side Planeness	N/A	Height (in)	4.377	Wet Unit Weight (pcf)	162.7
Perpendicularity	N/A	Diameter (in)	1.982	Dry Unit Weight (pcf)	N/A
End Planeness	N/A	Area (in^2)	3.084	Moisture Content (%)	N/A
Parallelism	N/A				

Dimensions were not confirmed.

Loading Rate (lbf/sec)	34
Peak Load (lbf)	8808
Failure Type	Cone and Split
Compressive Strength (psi)	2856
Compressive Strength (psf)	411264
Compressive Strength (tsf)	206

Failure Sketches



Comments Fragile nature of specimen inhibited preparation, required capping of ends with Hydro-Stone. Dimensional tolerances were not confirmed.

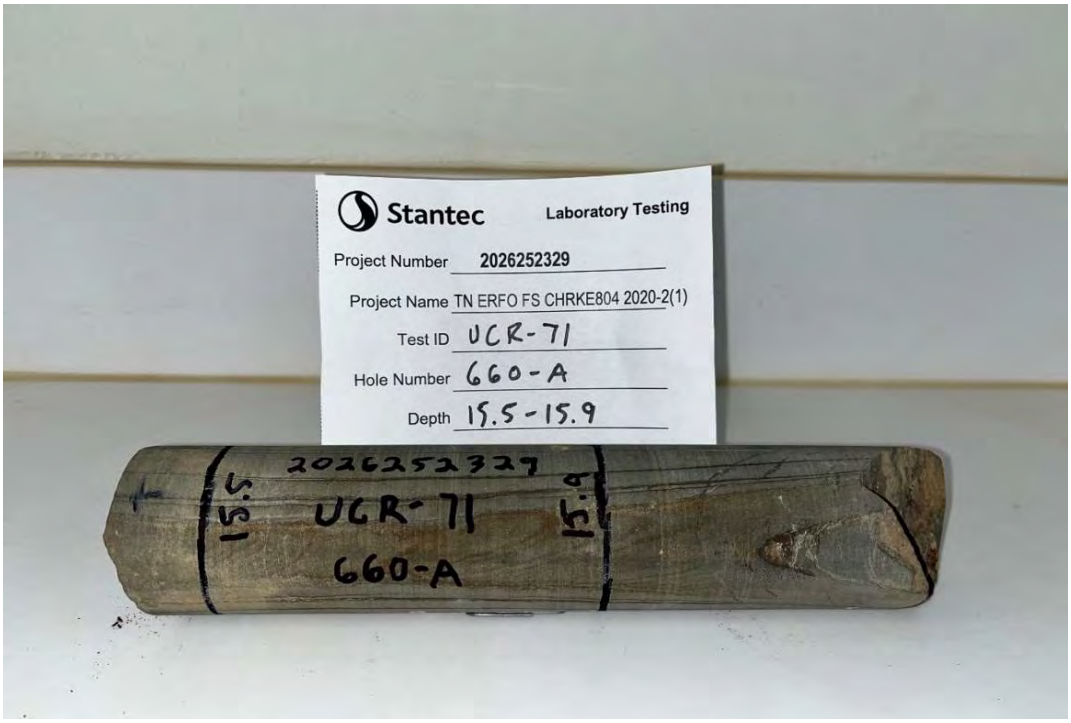
Reviewed By REL

Stantec

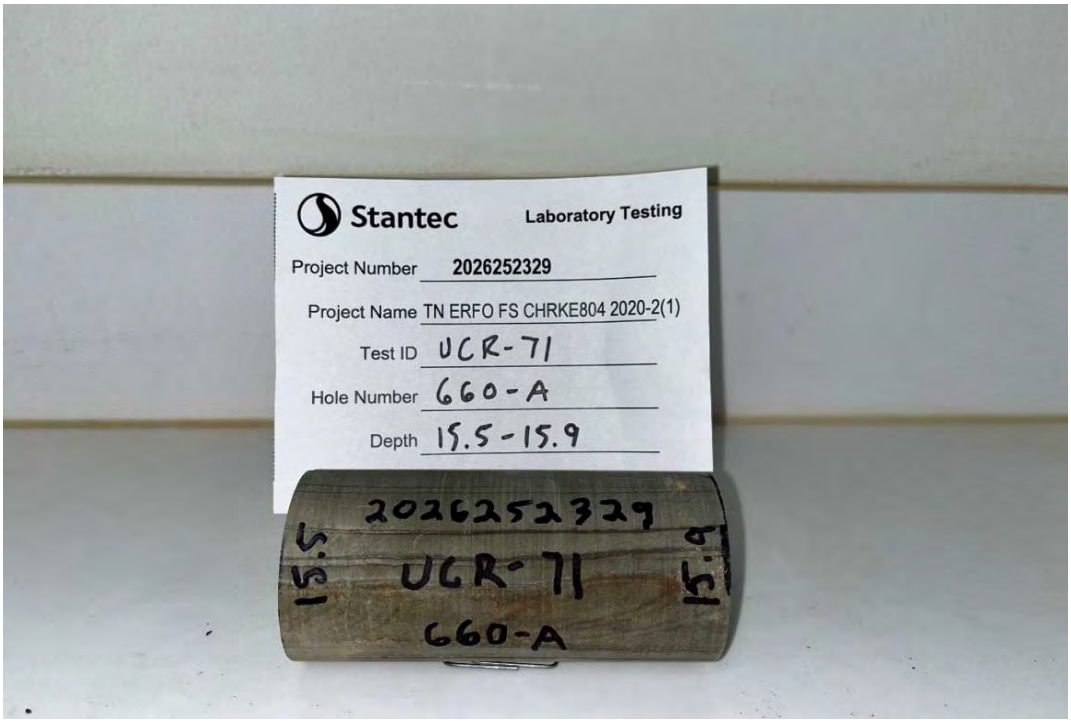
Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Limestone interbedded with Shale, grey, strong
Lab ID UCR-71
Hole Number 660-A
Depth (ft) 15.5'-15.9'
Test Type Uniaxial Compressive Strength of Intact Rock Core

As Received



Core Preparation

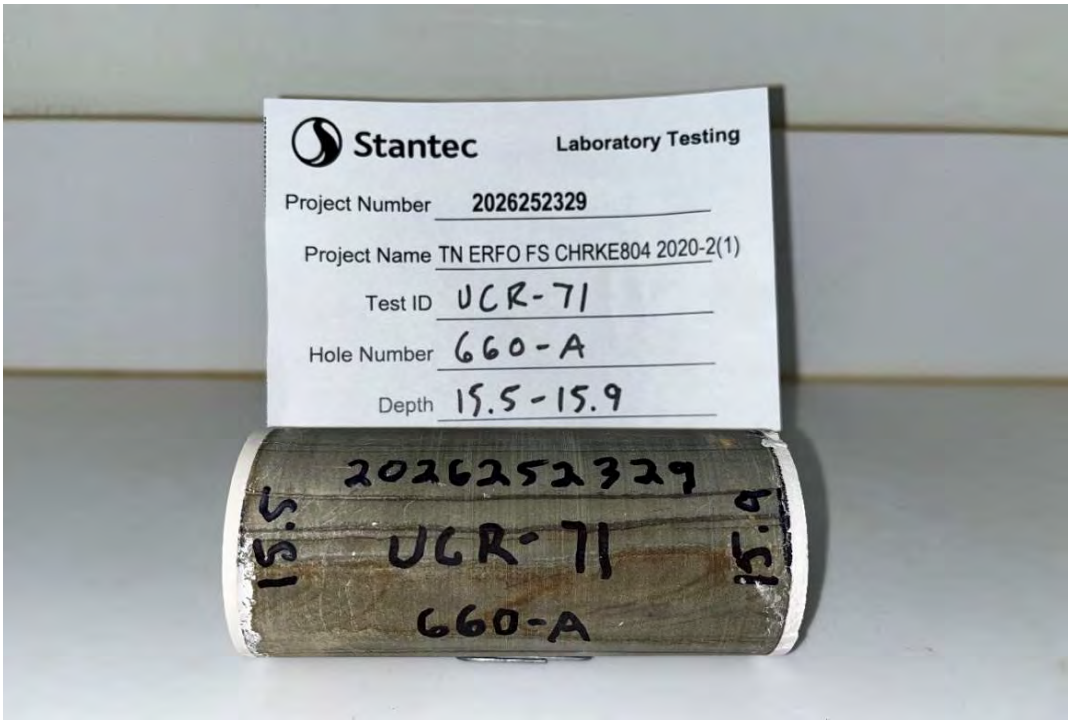


Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Limestone interbedded with Shale, grey, strong
Lab ID UCR-71
Hole Number 660-A
Depth (ft) 15.5'-15.9'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Core Preparation



Post Test

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Limestone interbedded with Shale, grey, strong
Lab ID UCR-71
Hole Number 660-A
Depth (ft) 15.5'-15.9'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Post Test

Stantec

Uniaxial Compressive Strength of Intact Rock Core Specimens

ASTM D 7012, Method C

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Lithology	Interbedded Shale and Limestone, grey, slightly strong	Lab ID	UCR-72
Hole Number	660-C	Depth (ft)	10.5'-10.9'
Date Received	04/30/2024		

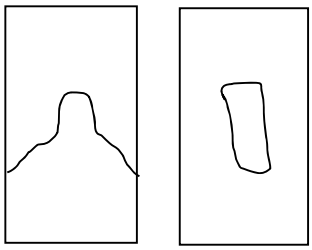
Temperature (°C)	22.7	Moisture Condition	As Prepared, Moist	Date Tested	05/16/2024

Side Planeness	N/A	Height (in)	4.312	Wet Unit Weight (pcf)	164.5
Perpendicularity	N/A	Diameter (in)	1.983	Dry Unit Weight (pcf)	N/A
End Planeness	N/A	Area (in^2)	3.089	Moisture Content (%)	N/A
Parallelism	N/A				

Dimensions were not confirmed.

Loading Rate (lbf/sec)	13
Peak Load (lbf)	3948
Failure Type	Shear
Compressive Strength (psi)	1278
Compressive Strength (psf)	184032
Compressive Strength (tsf)	92

Failure Sketches



Comments Primary failure occurred along tilted bedding.
Fragile nature of specimen inhibited preparation, required capping of ends with Hydro-Stone.
Dimensional tolerances were not confirmed.

Reviewed By REL

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Interbedded Shale and Limestone, grey, slightly strong
Lab ID UCR-72
Hole Number 660-C
Depth (ft) 10.5'-10.9'
Test Type Uniaxial Compressive Strength of Intact Rock Core

As Received

Core Preparation

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Interbedded Shale and Limestone, grey, slightly strong
Lab ID UCR-72
Hole Number 660-C
Depth (ft) 10.5'-10.9'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Core Preparation

Post Test

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Interbedded Shale and Limestone, grey, slightly strong
Lab ID UCR-72
Hole Number 660-C
Depth (ft) 10.5'-10.9'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Post Test

Stantec

Uniaxial Compressive Strength of Intact Rock Core Specimens

ASTM D 7012, Method C

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Lithology	Dolostone, grey, strong	Lab ID	UCR-73
Hole Number	599-A	Depth (ft) 17.3'-17.7'	Date Received 04/30/2024

Temperature (°C) 23.6 Moisture Condition As Prepared, Moist Date Tested 05/17/2024

Side Planeness	N/A	Height (in)	4.294	Wet Unit Weight (pcf)	174.8
Perpendicularity	N/A	Diameter (in)	1.992	Dry Unit Weight (pcf)	N/A
End Planeness	N/A	Area (in^2)	3.117	Moisture Content (%)	N/A
Parallelism	N/A				

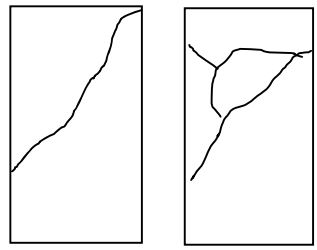
Dimensions were not confirmed.

Loading Rate (lbf/sec) 82
Peak Load (lbf) 33950

Failure Type Cone and Shear

Compressive Strength (psi) 10890
Compressive Strength (psf) 1568160
Compressive Strength (tsf) 784

Failure Sketches



Comments Fragile nature of specimen inhibited preparation, required capping of ends with Hydro-Stone. Dimensional tolerances were not confirmed.

Reviewed By REL

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Dolostone, grey, strong
Lab ID UCR-73
Hole Number 599-A
Depth (ft) 17.3'-17.7'
Test Type Uniaxial Compressive Strength of Intact Rock Core

As Received

Core Preparation

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Dolostone, grey, strong
Lab ID UCR-73
Hole Number 599-A
Depth (ft) 17.3'-17.7'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Core Preparation

Post Test

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Dolostone, grey, strong
Lab ID UCR-73
Hole Number 599-A
Depth (ft) 17.3'-17.7'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Post Test

Stantec

Uniaxial Compressive Strength of Intact Rock Core Specimens

ASTM D 7012, Method C

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Lithology	Dolostone, grey, strong	Lab ID	UCR-74
Hole Number	599-B	Depth (ft) 6.7'-7.1'	Date Received 04/30/2024

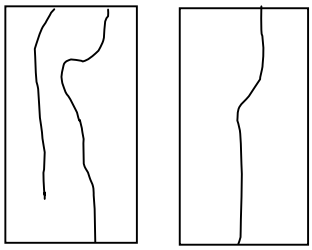
Temperature (°C) 23.4 Moisture Condition As Prepared, Moist Date Tested 05/17/2024

Side Planeness	N/A	Height (in)	4.941	Wet Unit Weight (pcf)	174.0
Perpendicularity	N/A	Diameter (in)	1.994	Dry Unit Weight (pcf)	N/A
End Planeness	N/A	Area (in^2)	3.124	Moisture Content (%)	N/A
Parallelism	N/A				

Dimensions were not confirmed.

Loading Rate (lbf/sec)	107
Peak Load (lbf)	41950
Failure Type	Cone and Split
Compressive Strength (psi)	13430
Compressive Strength (psf)	1933920
Compressive Strength (tsf)	967

Failure Sketches



Comments Fragile nature of specimen inhibited preparation, required capping of ends with Hydro-Stone. Dimensional tolerances were not confirmed.

Reviewed By REL

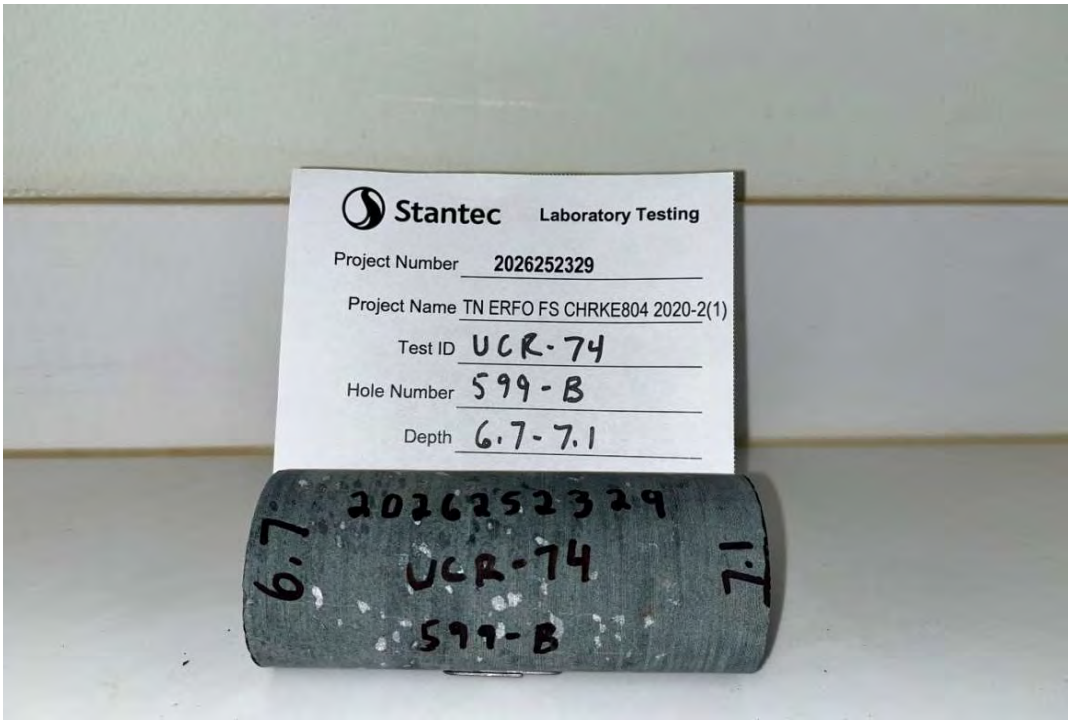
Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Dolostone, grey, strong
Lab ID UCR-74
Hole Number 599-B
Depth (ft) 6.7'-7.1'
Test Type Uniaxial Compressive Strength of Intact Rock Core

As Received

Core Preparation

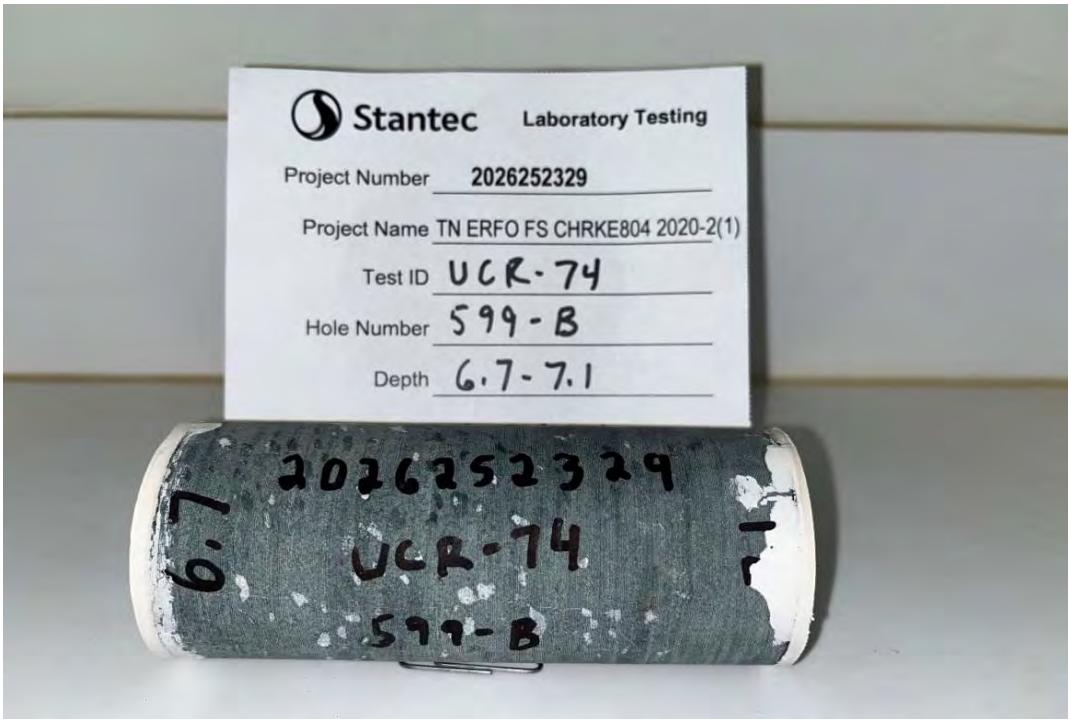


Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Dolostone, grey, strong
Lab ID UCR-74
Hole Number 599-B
Depth (ft) 6.7'-7.1'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Core Preparation



Post Test

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Dolostone, grey, strong
Lab ID UCR-74
Hole Number 599-B
Depth (ft) 6.7'-7.1'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Post Test

Stantec

Uniaxial Compressive Strength of Intact Rock Core Specimens

ASTM D 7012, Method C

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Lithology	Dolostone, grey, strong	Lab ID	UCR-75
Hole Number	599-B	Depth (ft) 14.2'-14.6'	Date Received 04/30/2024

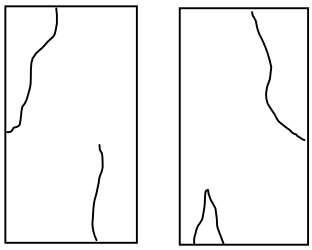
Temperature (°C)	23.1	Moisture Condition	As Prepared, Moist	Date Tested	05/17/2024

Side Planeness	N/A	Height (in)	4.565	Wet Unit Weight (pcf)	174.6
Perpendicularity	N/A	Diameter (in)	1.992	Dry Unit Weight (pcf)	N/A
End Planeness	N/A	Area (in^2)	3.115	Moisture Content (%)	N/A
Parallelism	N/A				

Dimensions were not confirmed.

Loading Rate (lbf/sec)	73
Peak Load (lbf)	36810
Failure Type	Cone and Shear
Compressive Strength (psi)	11820
Compressive Strength (psf)	1702080
Compressive Strength (tsf)	851

Failure Sketches



Comments Fragile nature of specimen inhibited preparation, required capping of ends with Hydro-Stone. Dimensional tolerances were not confirmed.

Reviewed By REL

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Dolostone, grey, strong
Lab ID UCR-75
Hole Number 599-B
Depth (ft) 14.2'-14.6'
Test Type Uniaxial Compressive Strength of Intact Rock Core

As Received

Core Preparation

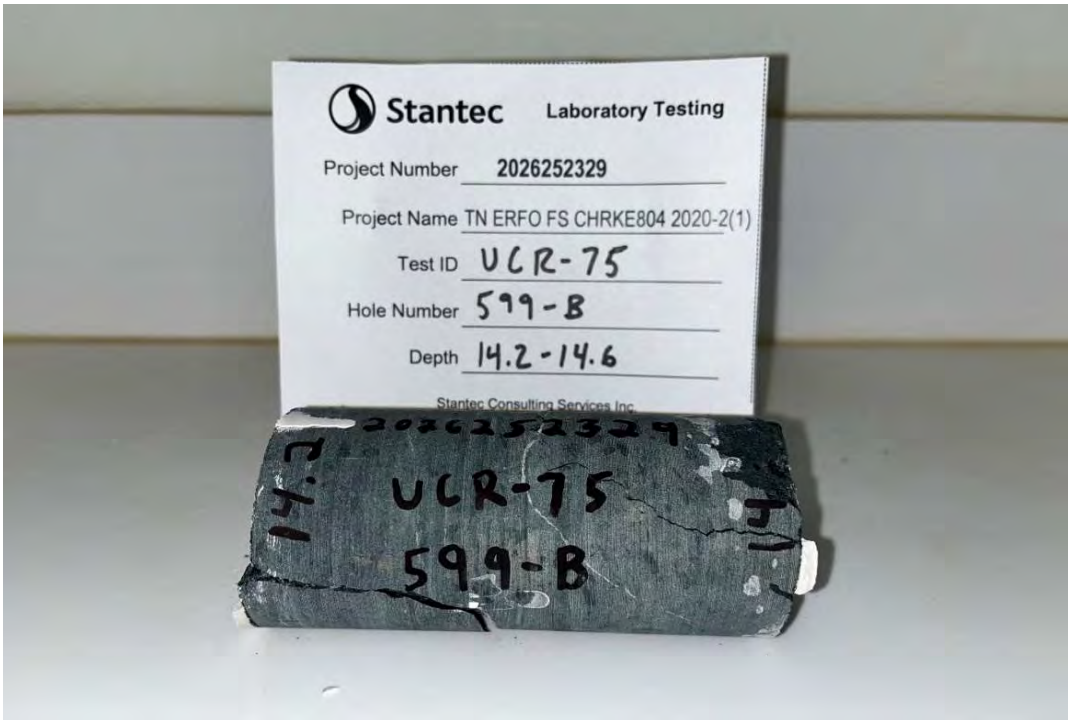
Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Dolostone, grey, strong
Lab ID UCR-75
Hole Number 599-B
Depth (ft) 14.2'-14.6'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Core Preparation

Post Test



Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Dolostone, grey, strong
Lab ID UCR-75
Hole Number 599-B
Depth (ft) 14.2'-14.6'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Post Test

Stantec

Uniaxial Compressive Strength of Intact Rock Core Specimens

ASTM D 7012, Method C

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Lithology	Sandy dolostone, light grey, strong	Lab ID	UCR-76
Hole Number	590-A	Depth (ft)	25.6'-26.0'
Date Received	04/30/2024		

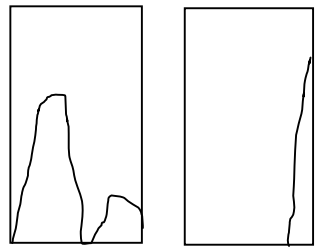
Temperature (°C)	23.4	Moisture Condition	As Prepared, Moist	Date Tested	05/17/2024

Side Planeness	N/A	Height (in)	4.800	Wet Unit Weight (pcf)	165.0
Perpendicularity	N/A	Diameter (in)	1.992	Dry Unit Weight (pcf)	N/A
End Planeness	N/A	Area (in^2)	3.117	Moisture Content (%)	N/A
Parallelism	N/A				

Dimensions were not confirmed.

Loading Rate (lbf/sec)	69
Peak Load (lbf)	36910
Failure Type	Cone and Shear
Compressive Strength (psi)	11840
Compressive Strength (psf)	1704960
Compressive Strength (tsf)	853

Failure Sketches



Comments Fragile nature of specimen inhibited preparation, required capping of ends with Hydro-Stone. Dimensional tolerances were not confirmed.

Reviewed By REL

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Sandy dolostone, light grey, strong
Lab ID UCR-76
Hole Number 590-A
Depth (ft) 25.6'-26.0'
Test Type Uniaxial Compressive Strength of Intact Rock Core

As Received

Core Preparation

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Sandy dolostone, light grey, strong
Lab ID UCR-76
Hole Number 590-A
Depth (ft) 25.6'-26.0'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Core Preparation

Post Test

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Sandy dolostone, light grey, strong
Lab ID UCR-76
Hole Number 590-A
Depth (ft) 25.6'-26.0'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Post Test

Stantec

Uniaxial Compressive Strength of Intact Rock Core Specimens

ASTM D 7012, Method C

Project Name	TN ERFO FS CHRKE804 2020-2(1)	Project Number	2026252329
Lithology	Shale, grey, strong, interbedded	Lab ID	UCR-77
Hole Number	590-A	Depth (ft)	29.3'-29.8'
Date Received	04/30/2024		

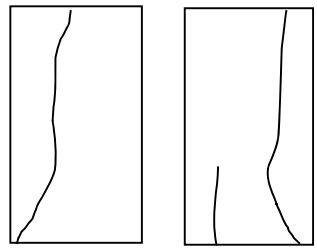
Temperature (°C)	23.1	Moisture Condition	As Prepared, Moist	Date Tested	09/18/1901

Side Planeness	N/A	Height (in)	4.786	Wet Unit Weight (pcf)	162.9
Perpendicularity	N/A	Diameter (in)	1.975	Dry Unit Weight (pcf)	N/A
End Planeness	N/A	Area (in^2)	3.065	Moisture Content (%)	N/A
Parallelism	N/A				

Dimensions were not confirmed.

Loading Rate (lbf/sec)	71
Peak Load (lbf)	26040
Failure Type	Cone and Split
Compressive Strength (psi)	8500
Compressive Strength (psf)	1224000
Compressive Strength (tsf)	612

Failure Sketches



Comments Fragile nature of specimen inhibited preparation, required capping of ends with Hydro-Stone. Dimensional tolerances were not confirmed.

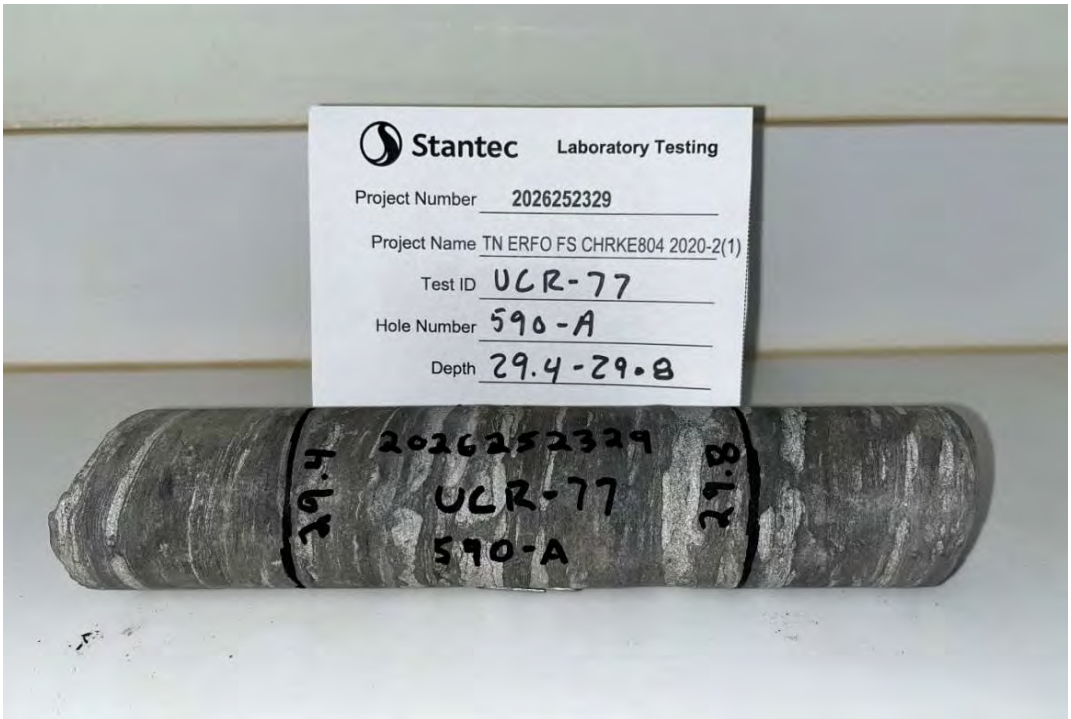
Reviewed By REL

Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Shale, grey, strong, interbedded
Lab ID UCR-77
Hole Number 590-A
Depth (ft) 29.3'-29.8'
Test Type Uniaxial Compressive Strength of Intact Rock Core

As Received



Core Preparation

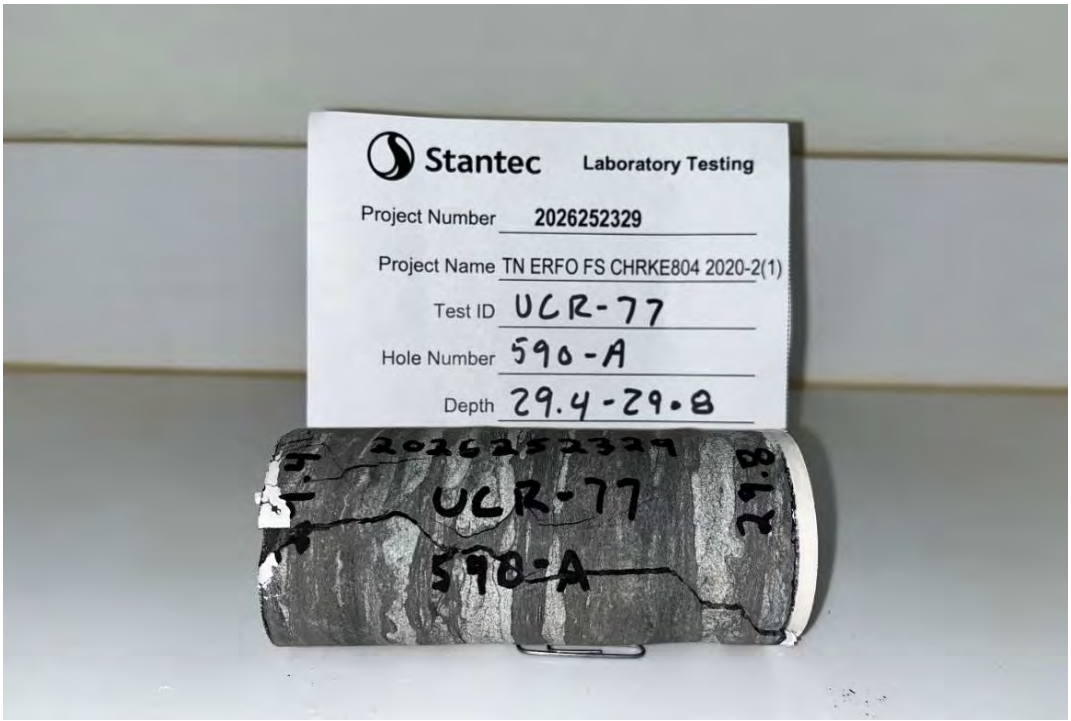
Stantec

Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Shale, grey, strong, interbedded
Lab ID UCR-77
Hole Number 590-A
Depth (ft) 29.3'-29.8'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Core Preparation

Post Test



Stantec

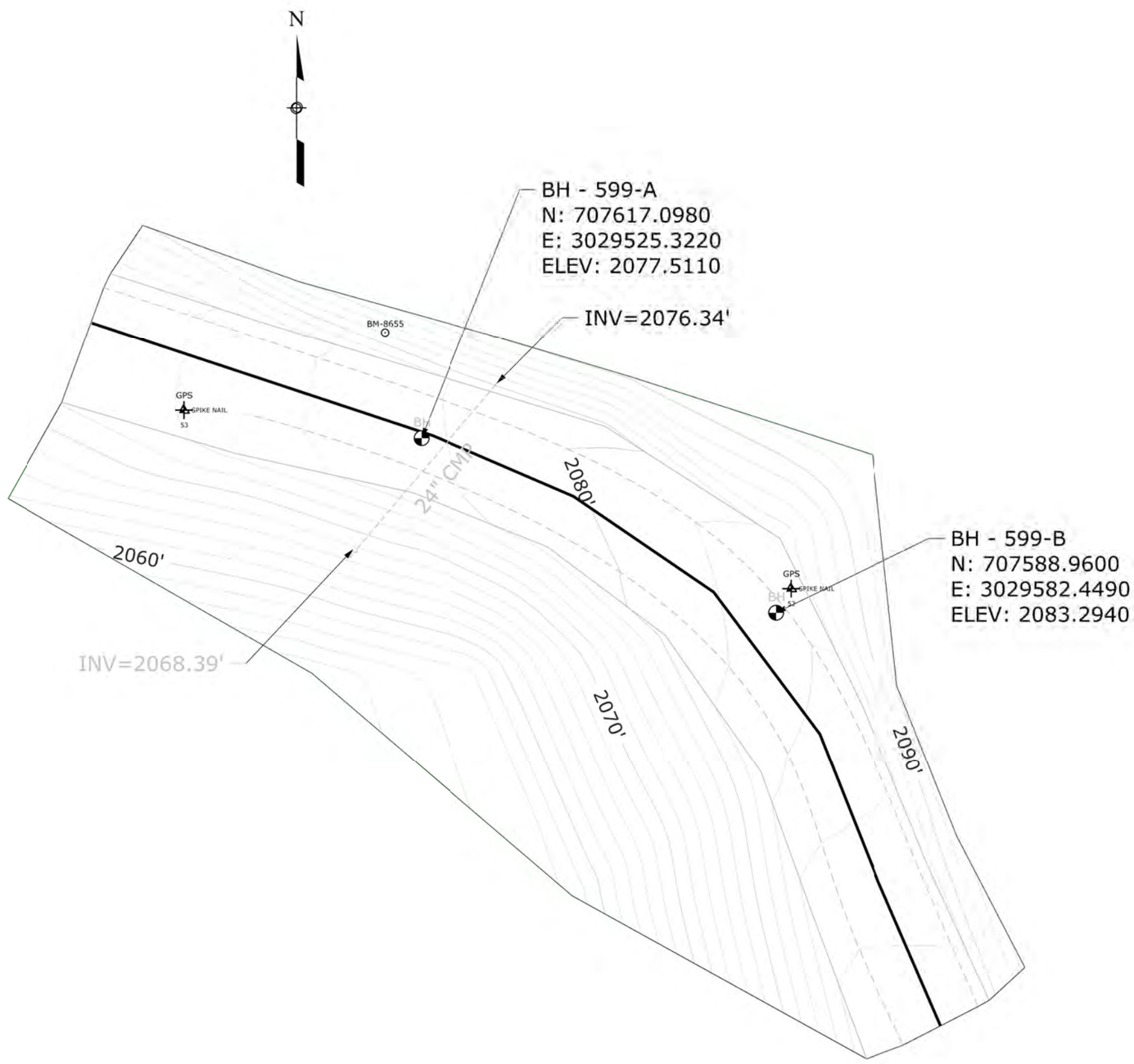
Photo Report

Project Name TN ERFO FS CHRKE804 2020-2(1)
Project Number 2026252329
Lithology Shale, grey, strong, interbedded
Lab ID UCR-77
Hole Number 590-A
Depth (ft) 29.3'-29.8'
Test Type Uniaxial Compressive Strength of Intact Rock Core

Post Test

APPENDIX D
Subsurface Profiles

Briar Creek
MP 599 and MP 633



MP 599 - EXISTING SITE

c:\pw_working\infra03\rakes\d0147835\Briar Creek.dgn [MP 599-1 (Sheet)]
6 June 2024 9:11 PM

SUBSURFACE DIAGRAM
BORINGS 599-A, 599-B

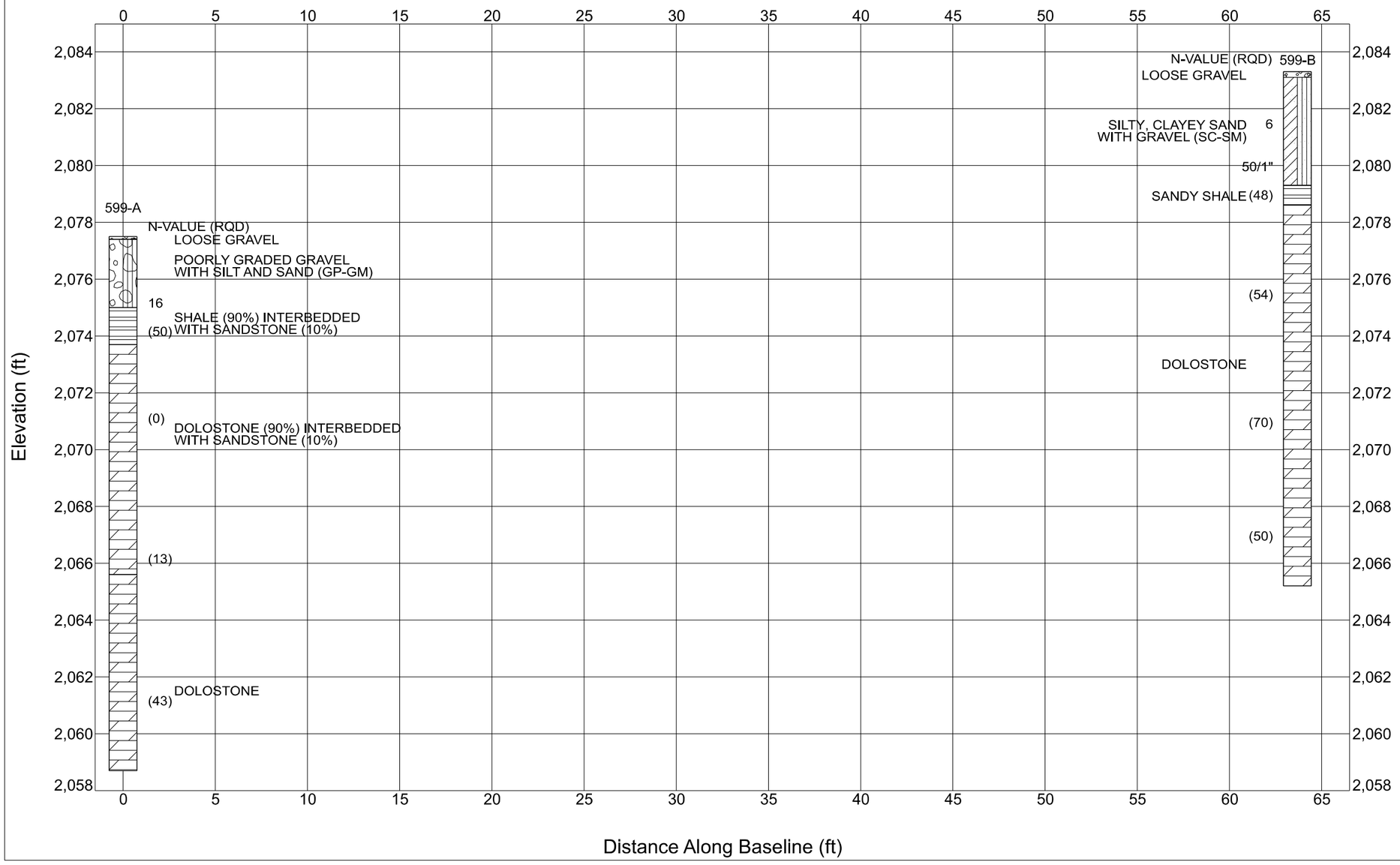
Stantec

CLIENT FHWA

PROJECT NUMBER 2026252329

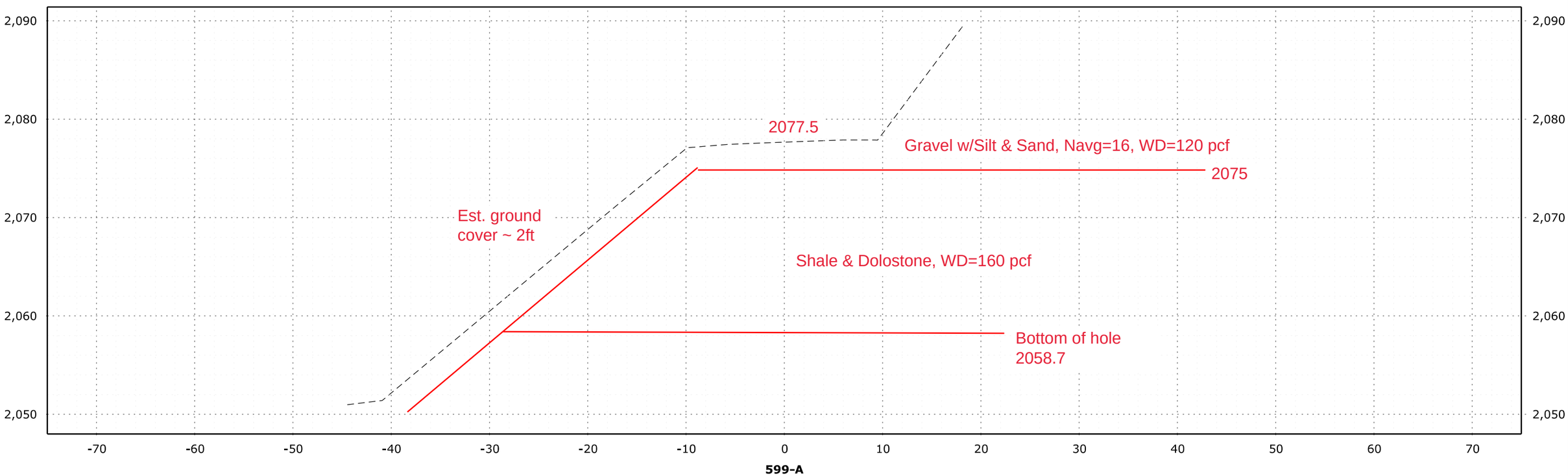
PROJECT NAME TN ERFO FS CHRKE804 2020-2(1)

PROJECT LOCATION Cherokee National Forest, TN



NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
	599-A



FHWA, Office of Federal Lands Highway

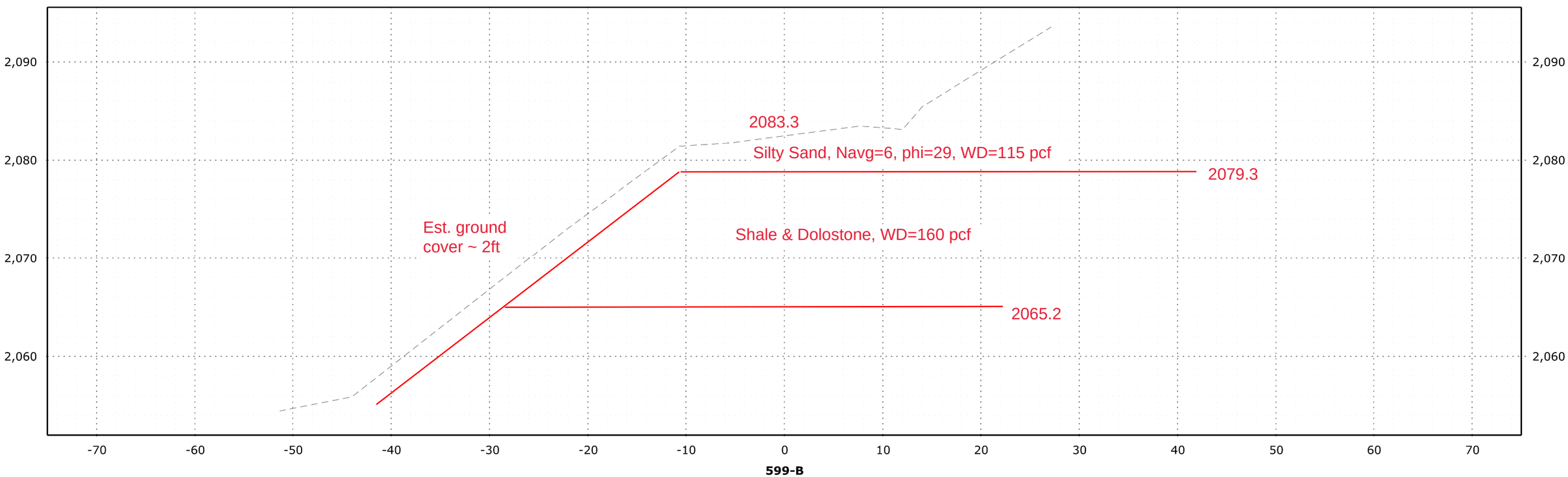
BOREHOLE 599-A

c:\pw_working\infra03\trakes\d0147835\Briar Creek.dgn [599-A (Sheet)]

6 June 2024 8:51 PM

NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
	599-B



FHWA, Office of Federal Lands Highway

BOREHOLE 599-B

c:\pw_working\infra03\lrakes\d0147835\Briar Creek.dgn [599-B (Sheet)]

6 June 2024 3:51 PM

NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
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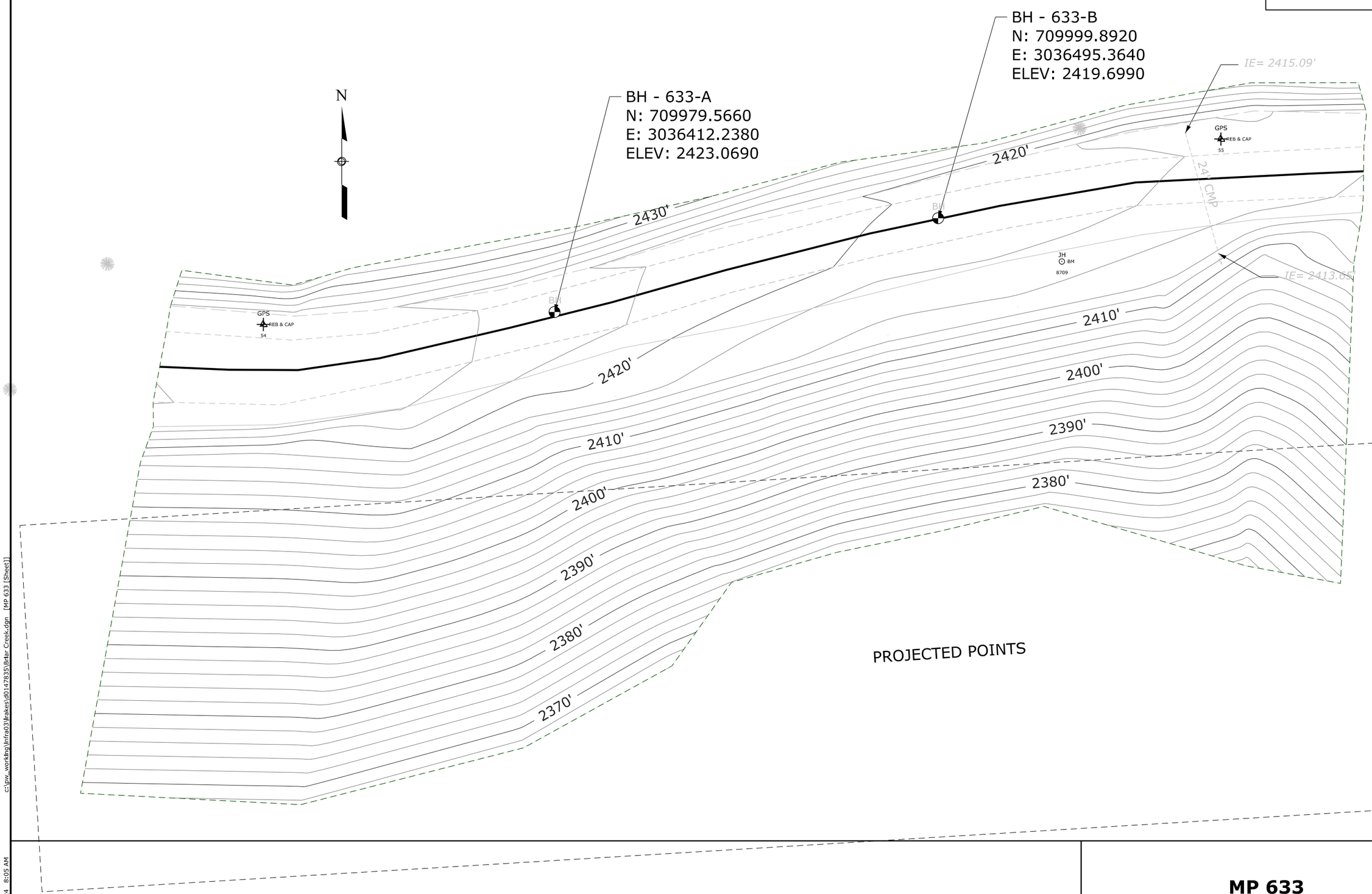


MP 633

c:\pw_working\infra03\krakes\d0147835\Briar Creek.dgn [MP 633 (Sheet)]

26 June 2024 8:05 AM

SUBSURFACE DIAGRAM
BORINGS 633-A, 633-B

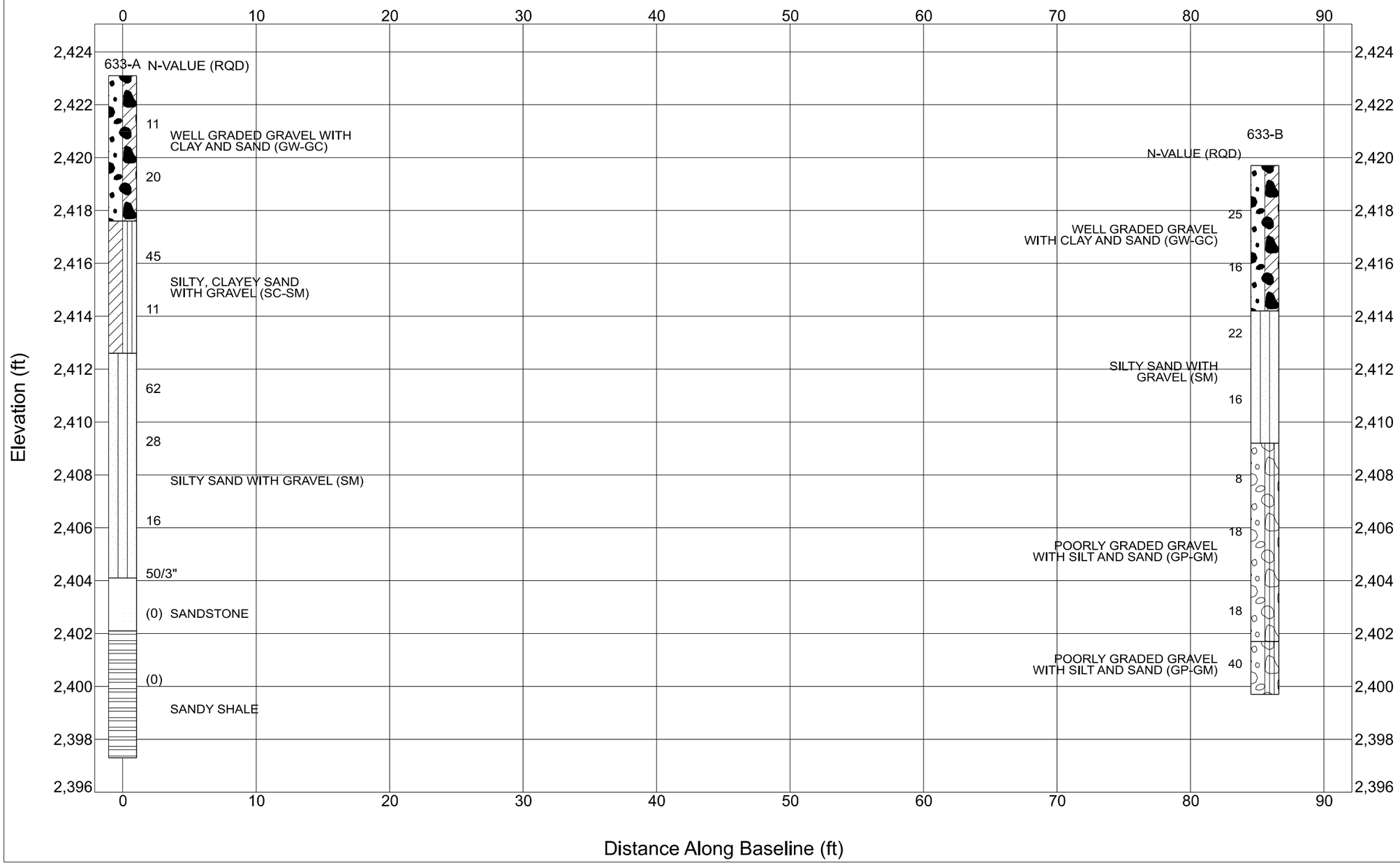
Stantec

CLIENT FHWA

PROJECT NUMBER 2026252329

PROJECT NAME TN ERFO FS CHRKE804 2020-2(1)

PROJECT LOCATION Cherokee National Forest, TN



NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
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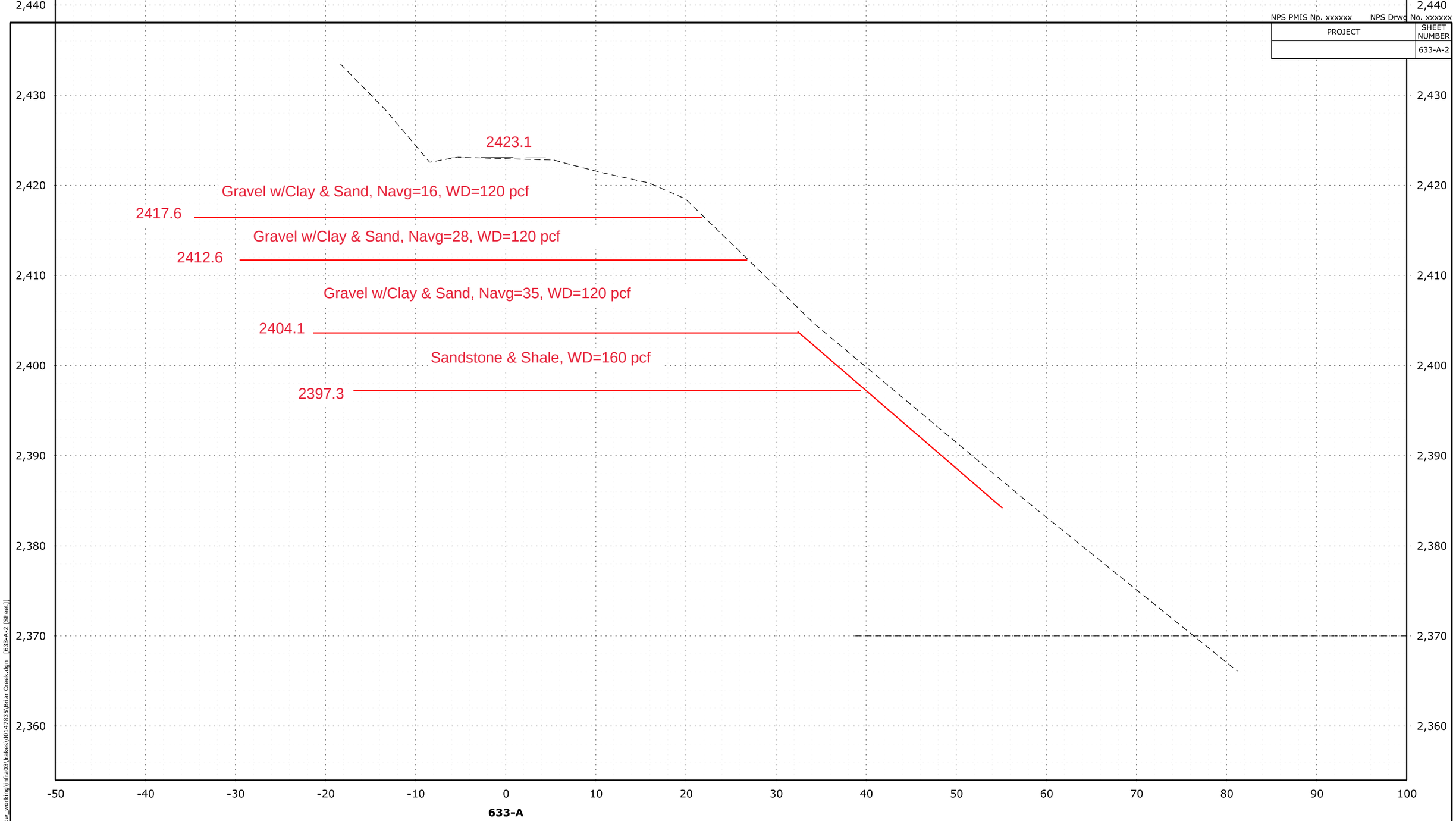


FHWA, Office of Federal Lands Highway

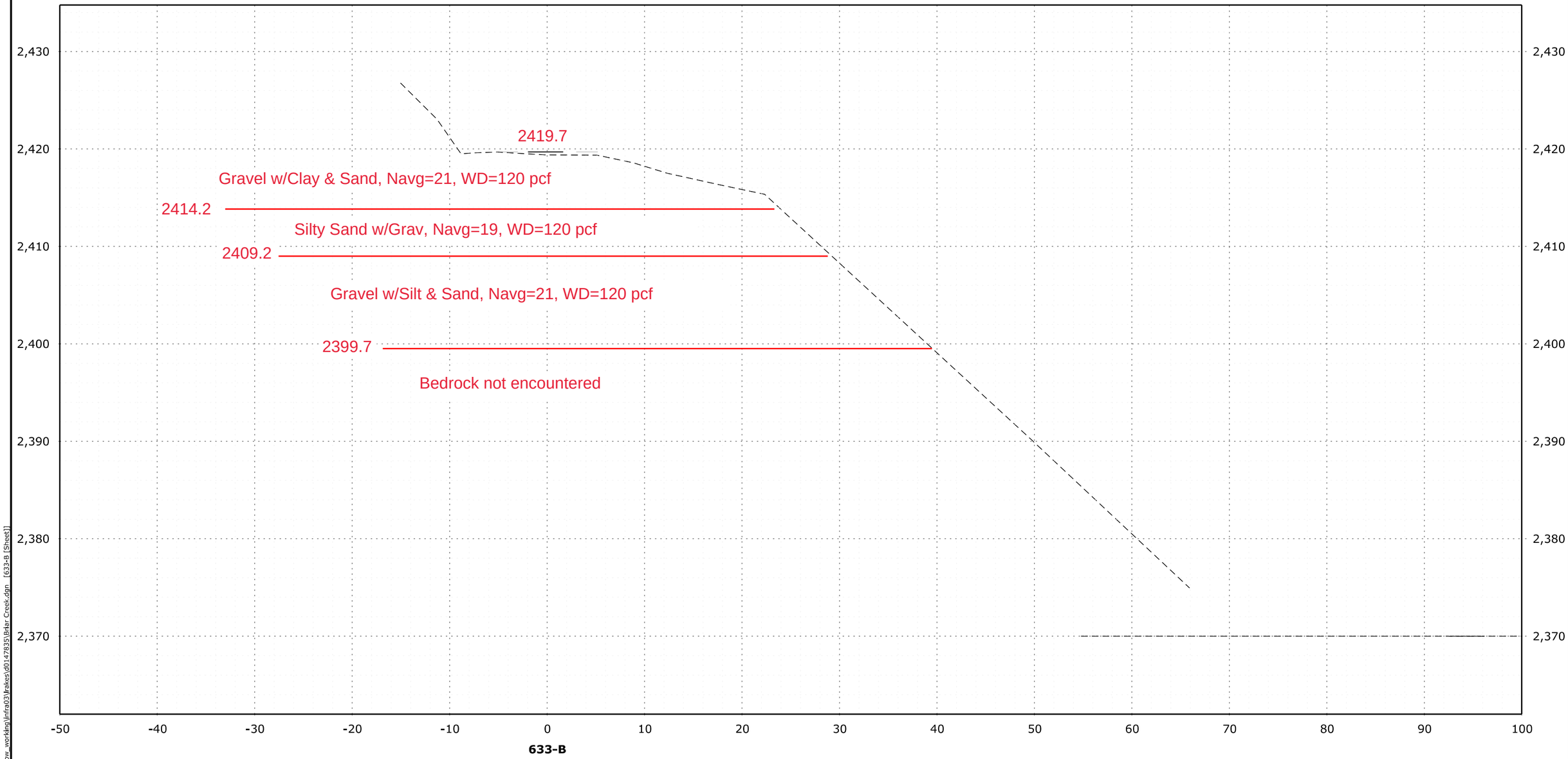
BOREHOLE 633-A

c:\pw_working\infra03\krakes\d0147835\Briar Creek.dgn [633-A-2 [Sheet]]

26 June 2024 8:07 AM

NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
	633-B



FHWA, Office of Federal Lands Highway

BOREHOLE 633-B

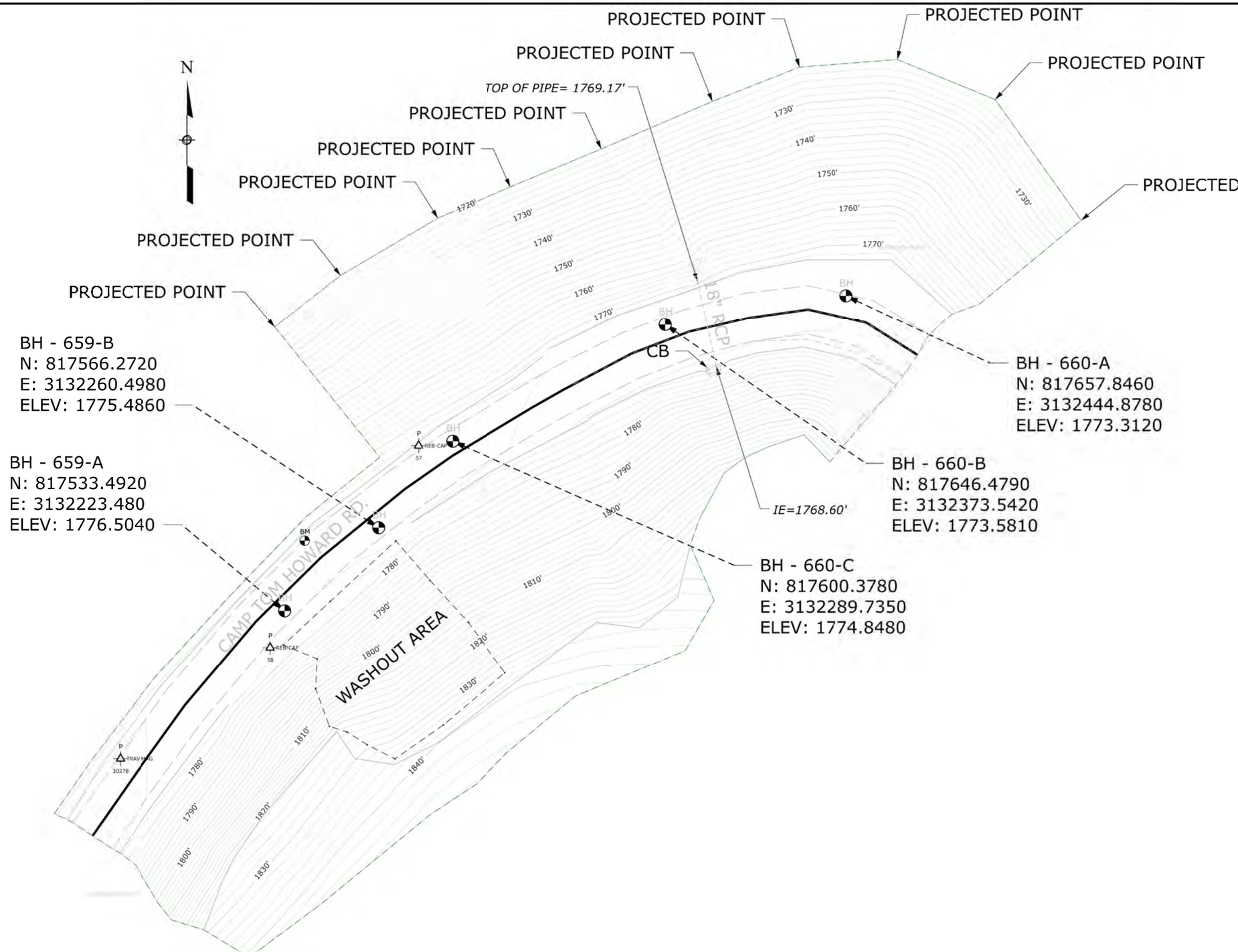
c:\pw_working\infra03\trakes\d0147835\Briar Creek.dgn [633-B (Sheet)]

26 June 2024 8:07 AM

Flatwoods
MP 659 and MP 660

NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
	MP 659



MP 659 & 660

c:\pw_working\infra03\rakes\d0147835\Flatwoods.dgn [MP 659 (Sheet)]

25 June 2024 11:10 AM

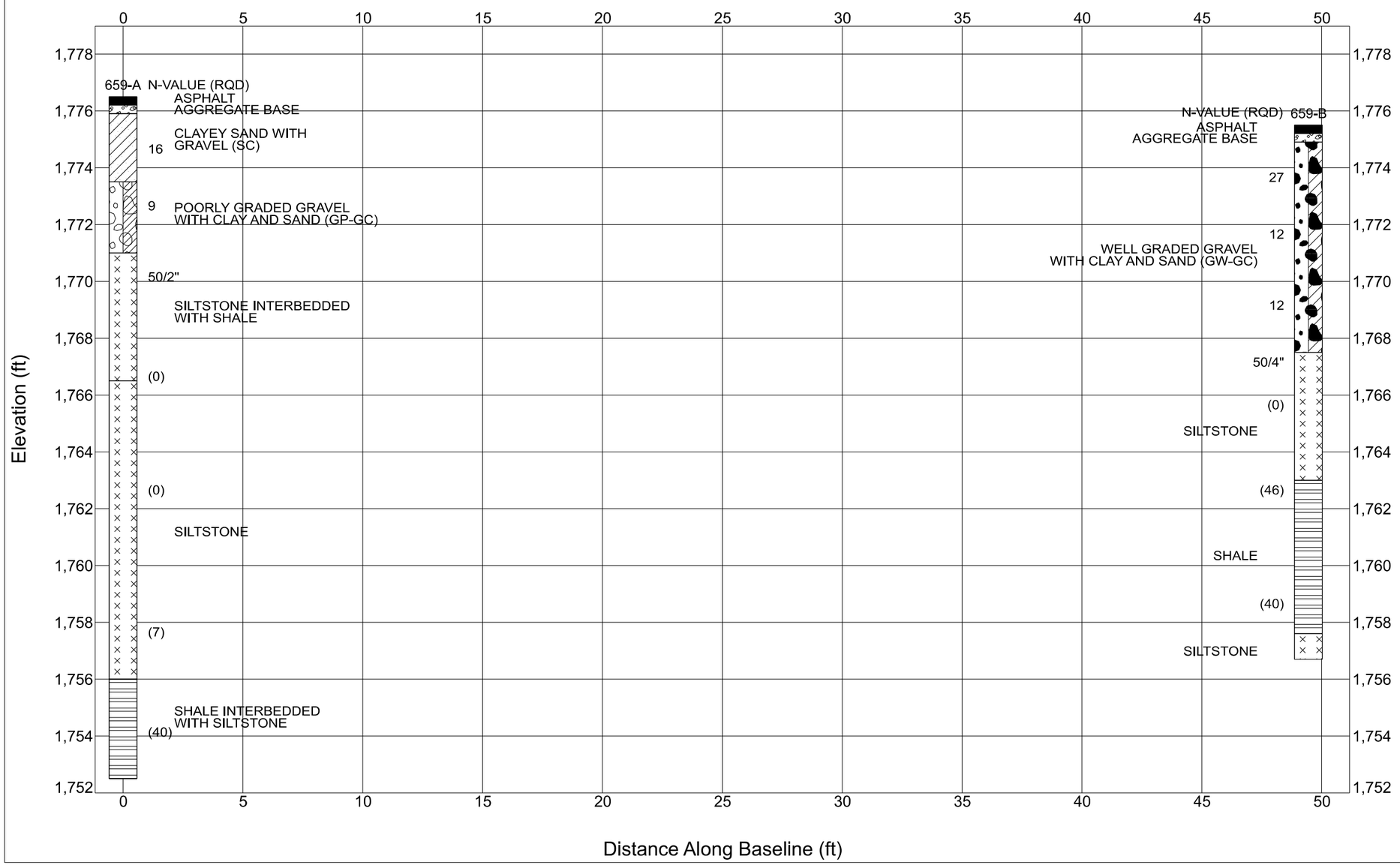
SUBSURFACE DIAGRAM
BORINGS 659-A, 659-B

CLIENT FHWA

PROJECT NUMBER 2026252329

PROJECT NAME TN ERFO FS CHRKE804 2020-2(1)

PROJECT LOCATION Cherokee National Forest, TN



SUBSURFACE DIAGRAM
BORINGS 660-A, 660-B, 660-C

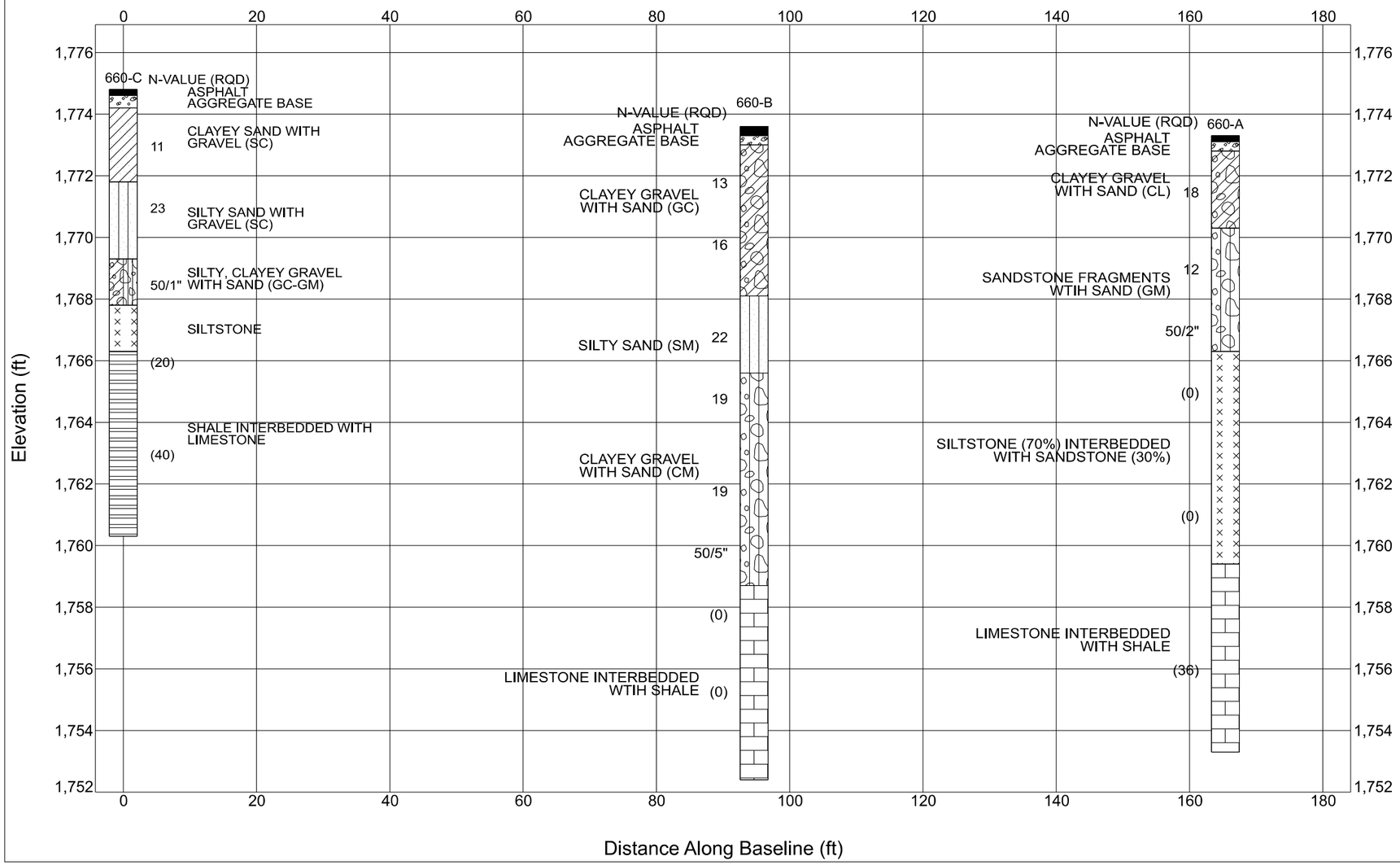
Stantec

CLIENT FHWA

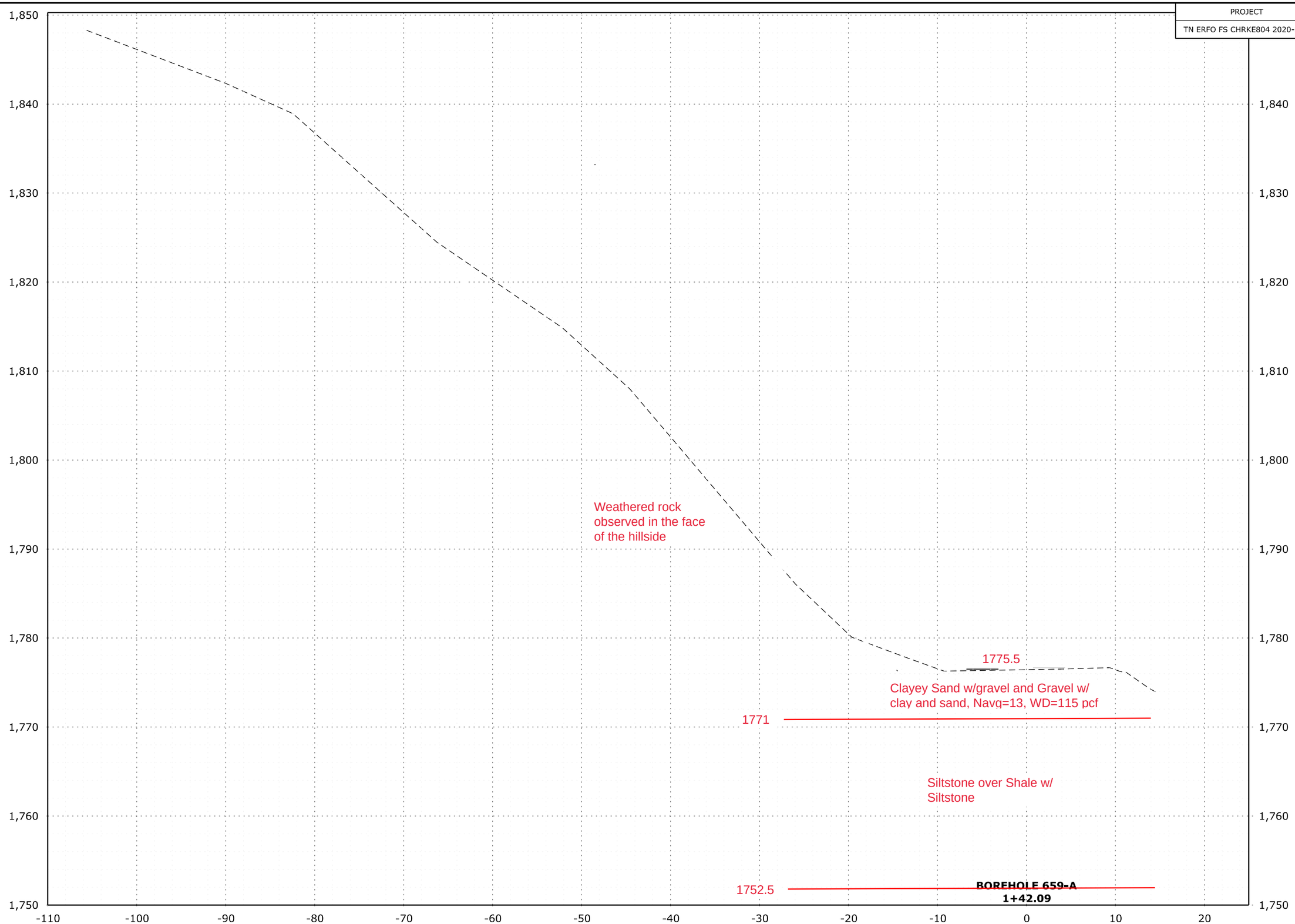
PROJECT NUMBER 2026252329

PROJECT NAME TN ERFO FS CHRKE804 2020-2(1)

PROJECT LOCATION Cherokee National Forest, TN

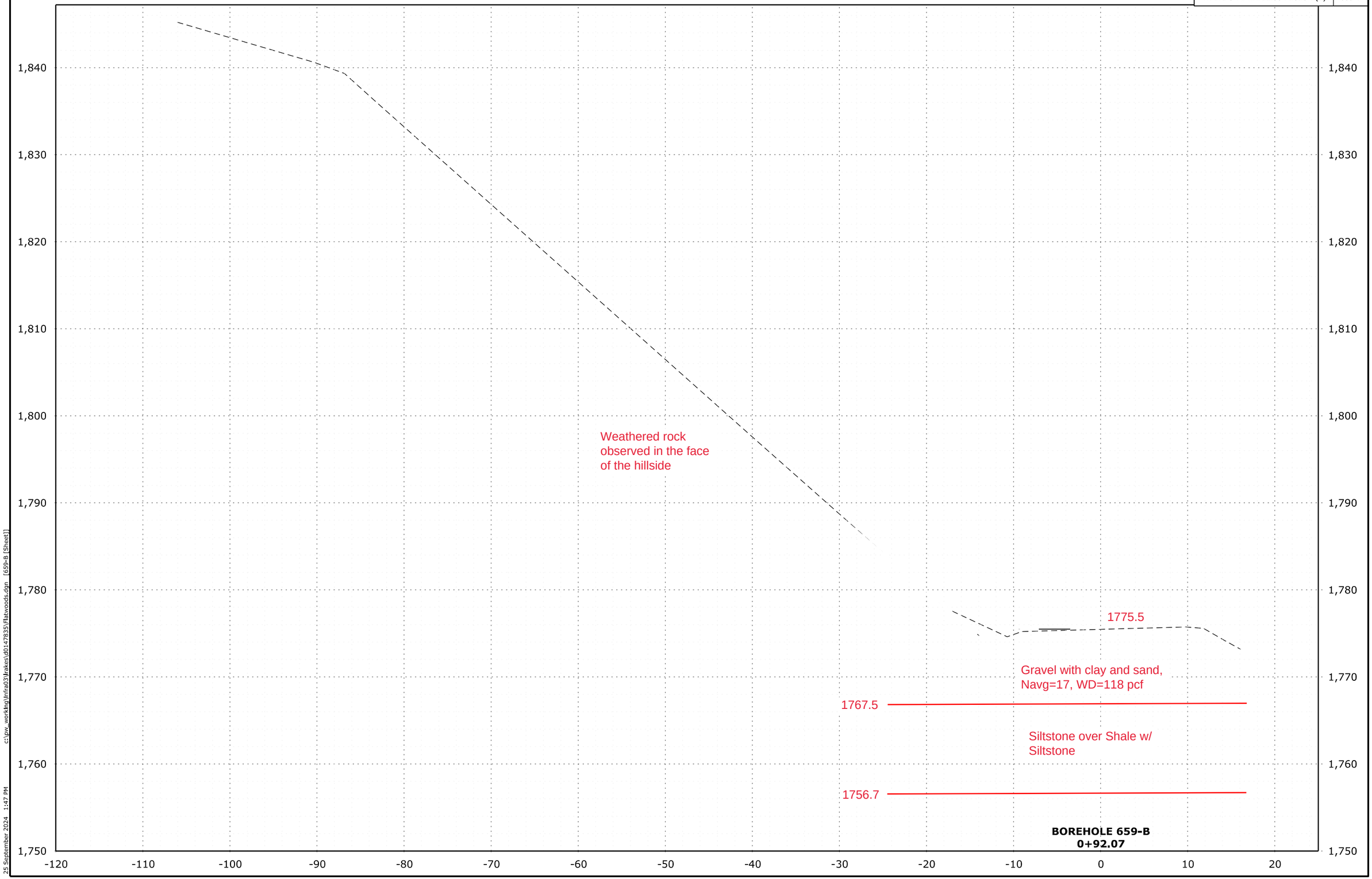


PROJECT	SHEET NUMBER
TN ERFO FS CHRKE804 2020-2(1)	659-A



25 September 2024 1:42 PM c:\pw_working\infra03\rakes\d0147835\Flatwoods.dgn (659-A [Sheet])

PROJECT	SHEET NUMBER
TN ERFO FS CHRKE804 2020-2(1)	659-B



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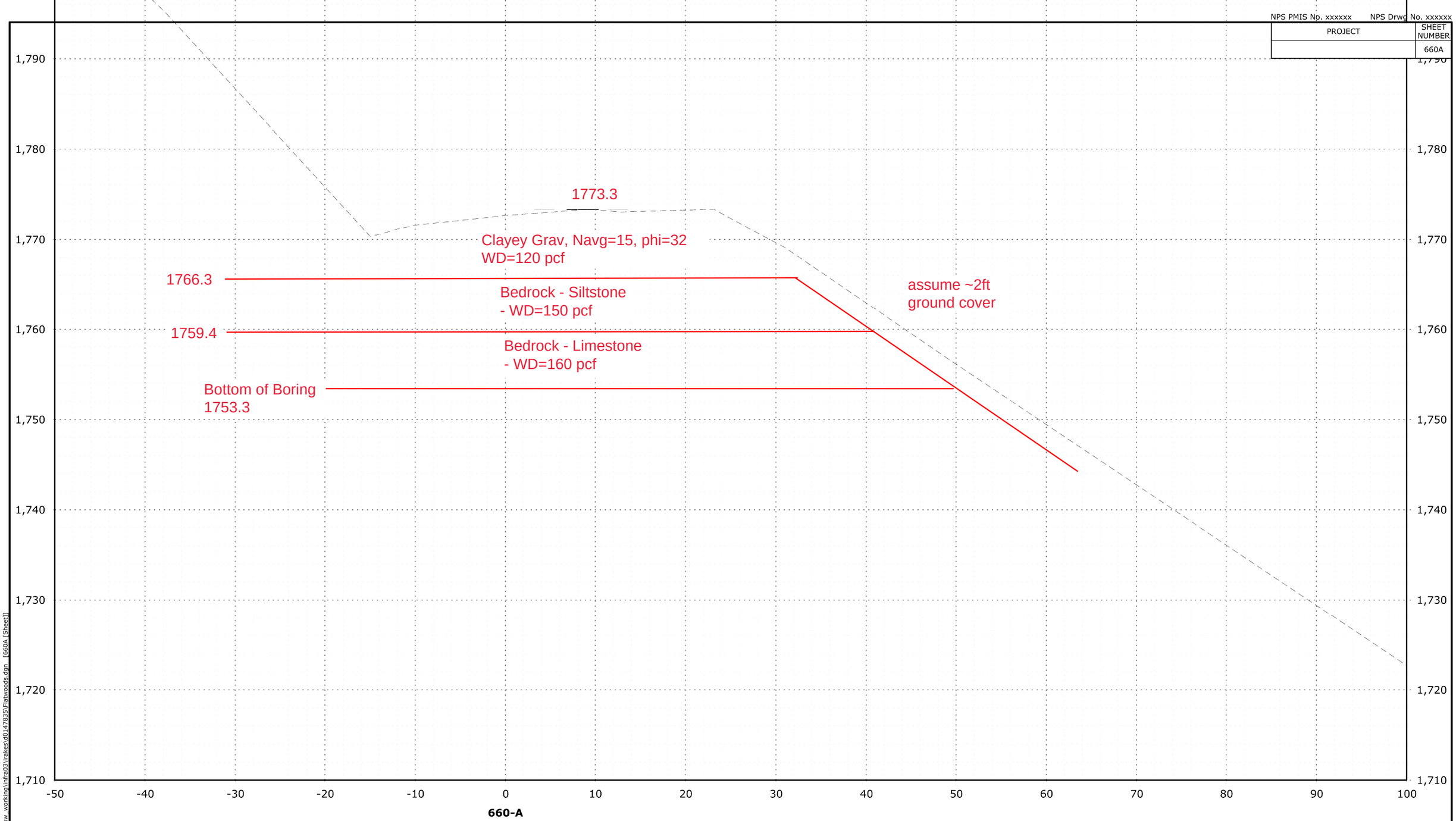
NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
	660A



FHWA, Office of Federal Lands Highway

BOREHOLE 660-A

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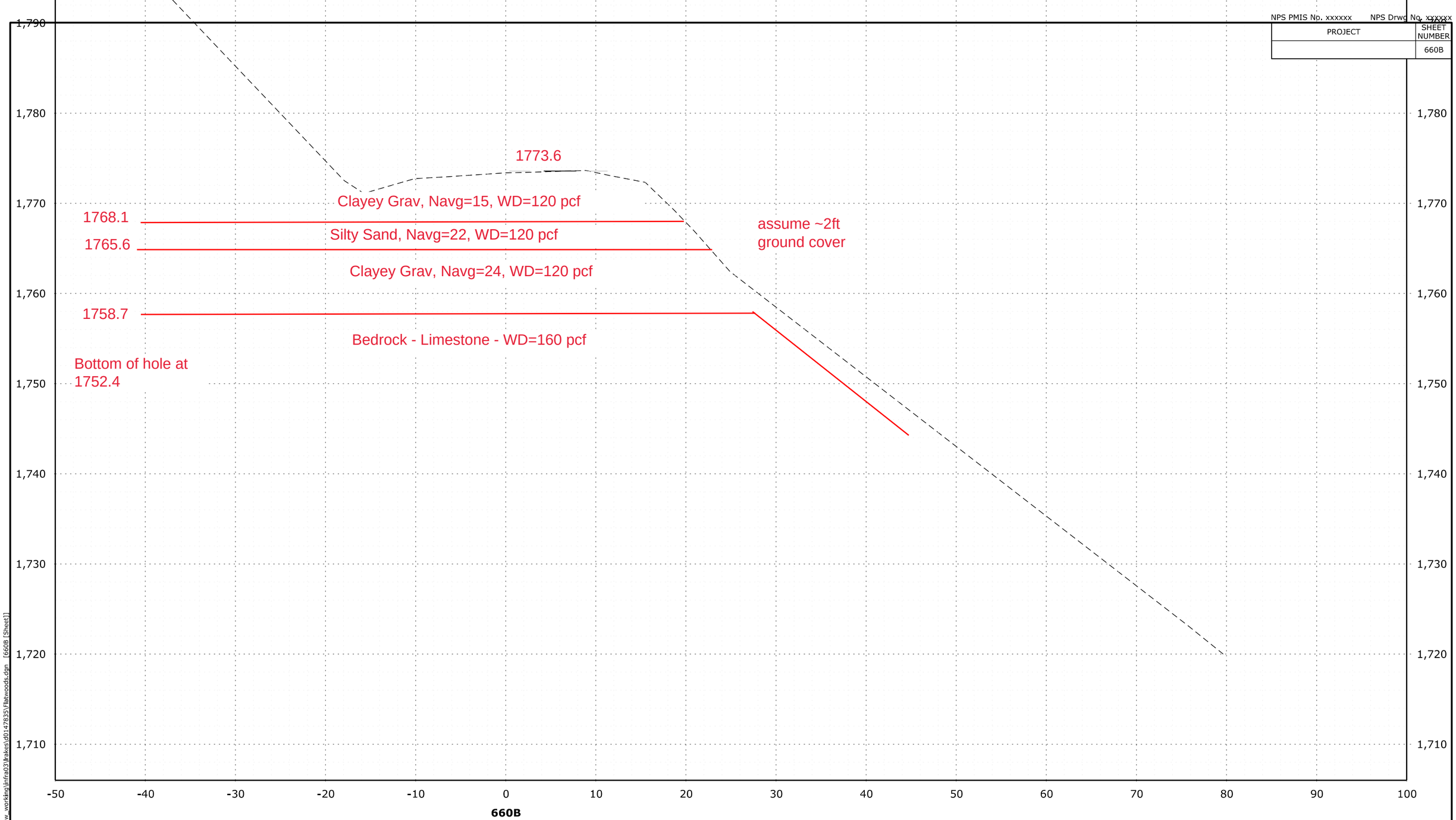
25 June 2024 12:38 AM

NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
	660B



FHWA, Office of Federal Lands Highway

BOREHOLE 660-B

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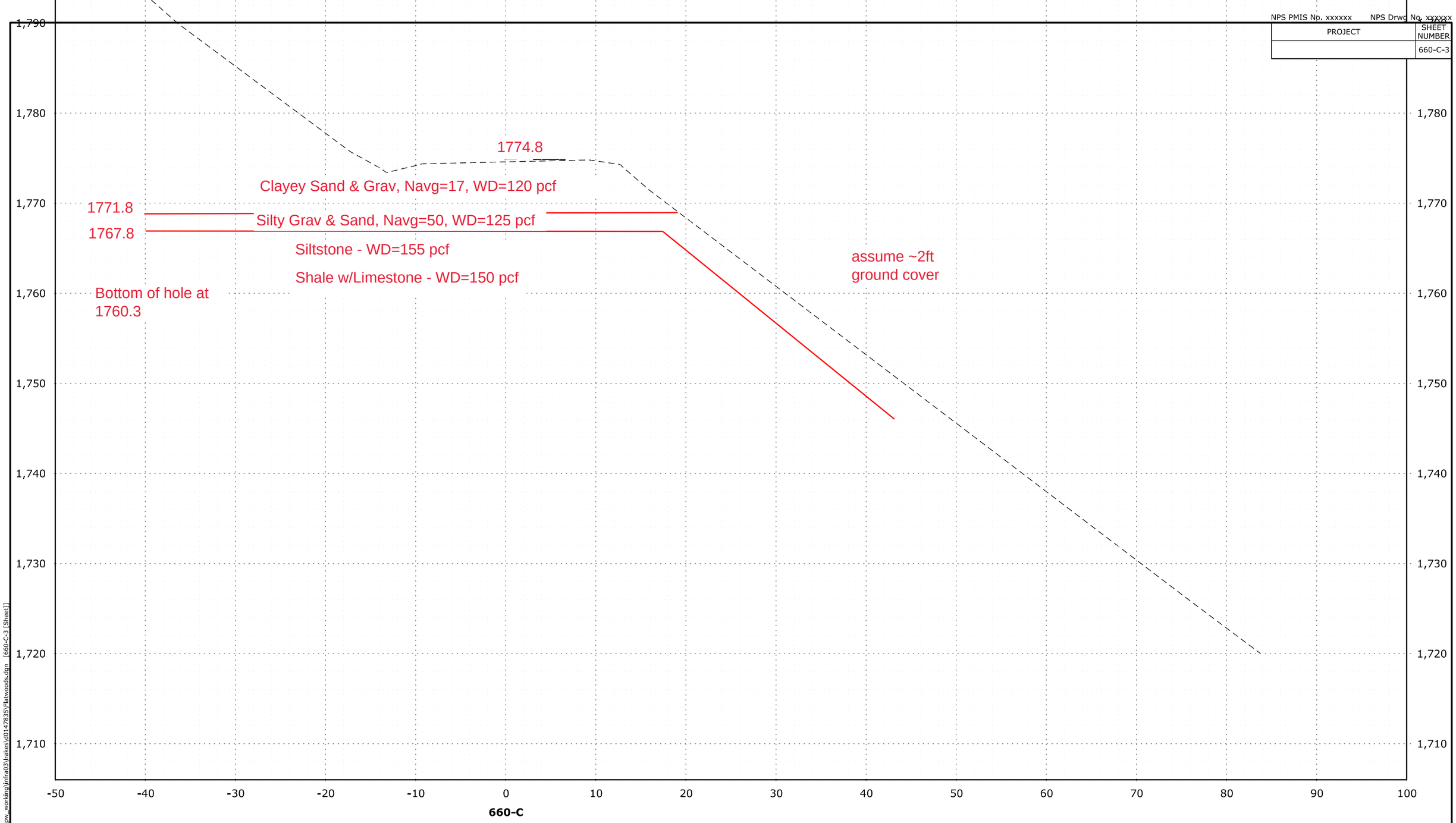
25 June 2024 2:45 PM

NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
	660-C-3



FHWA, Office of Federal Lands Highway

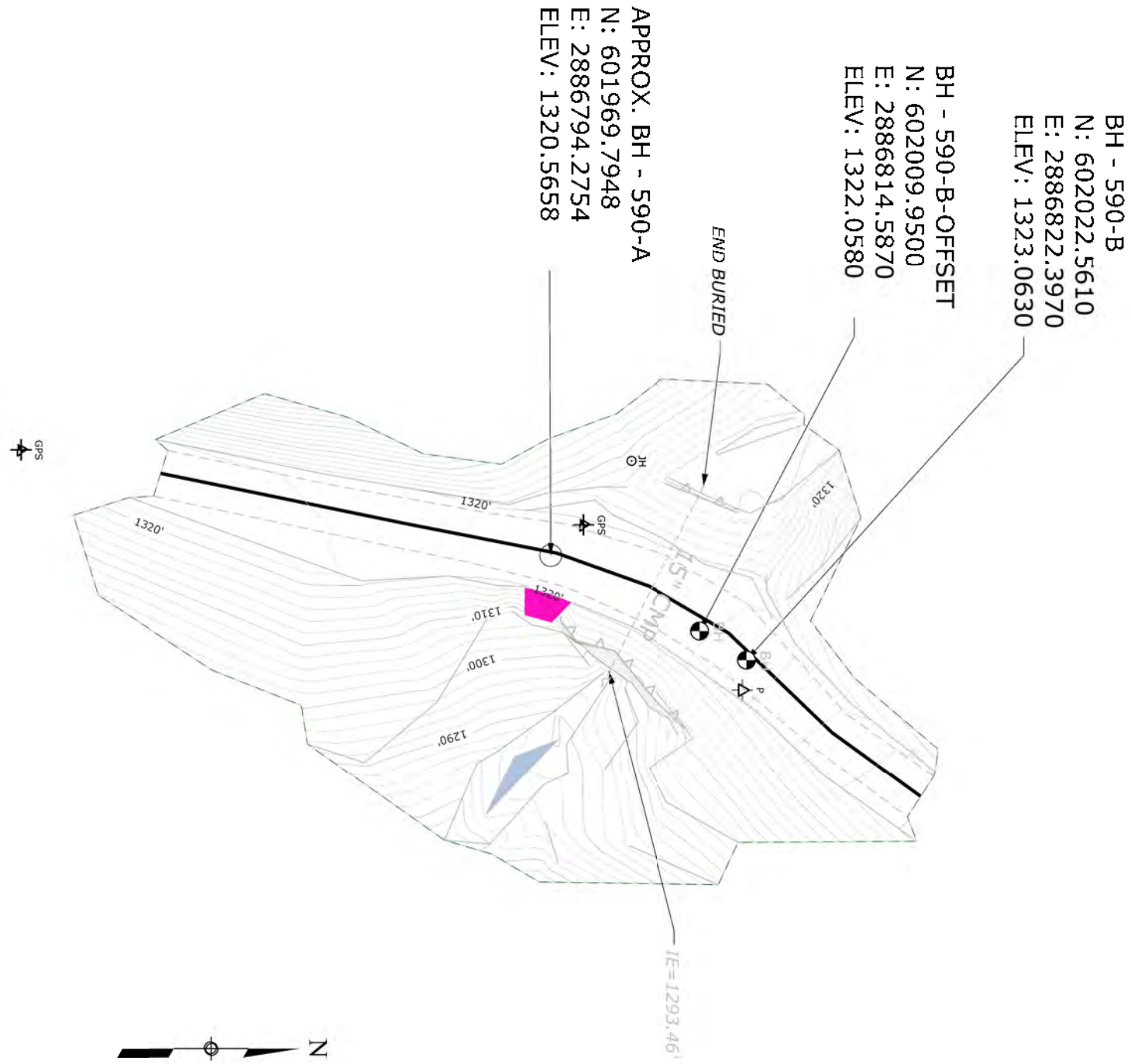
BOREHOLE 660-C

c:\pw_working\infra03\Wakes\d0147835\Flatwoods.dgn [660-C-3 (Sheet)]

25 June 2024 2:45 PM

Paint Mountain
MP 590

MP 590



PROJECT NUMBER	
Plan 1	

SUBSURFACE DIAGRAM
BORINGS 590-A, 590-B, 590-B2

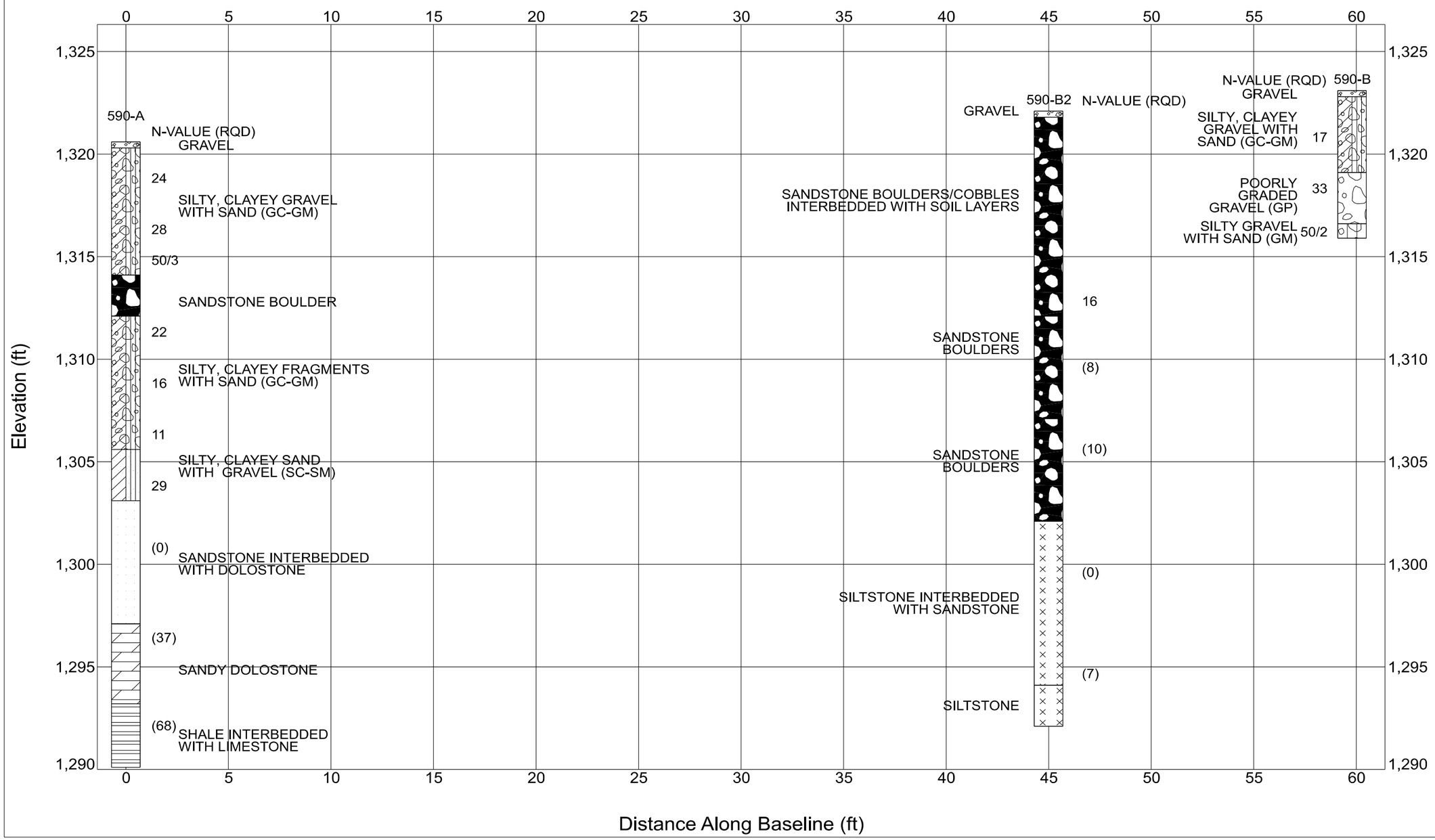
Stantec

CLIENT FHWA

PROJECT NUMBER 2026252329

PROJECT NAME TN ERFO FS CHRKE804 2020-2(1)

PROJECT LOCATION Cherokee National Forest, TN



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PROJECT	SHEET NUMBER
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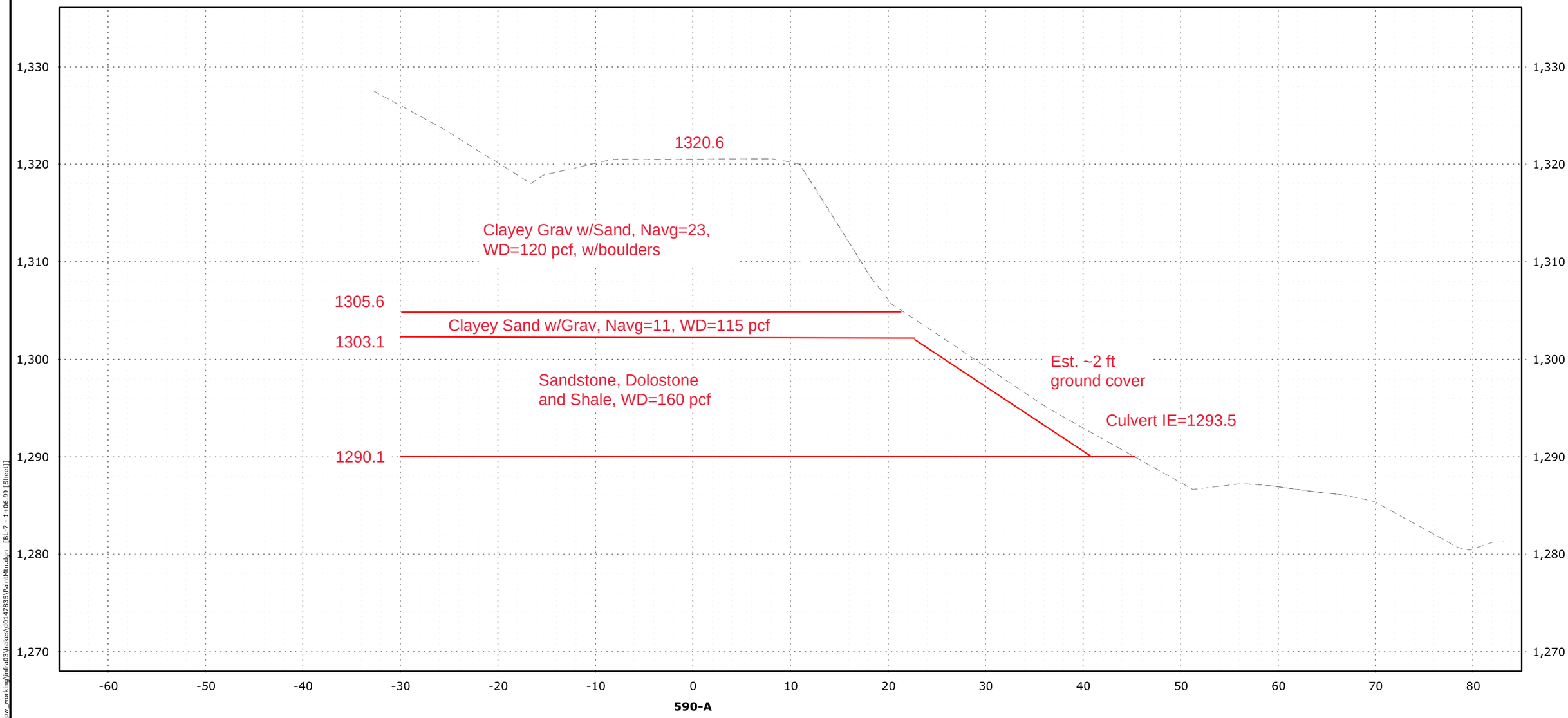

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BOREHOLE 590-A

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25 June 2024 10:46 AM

NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
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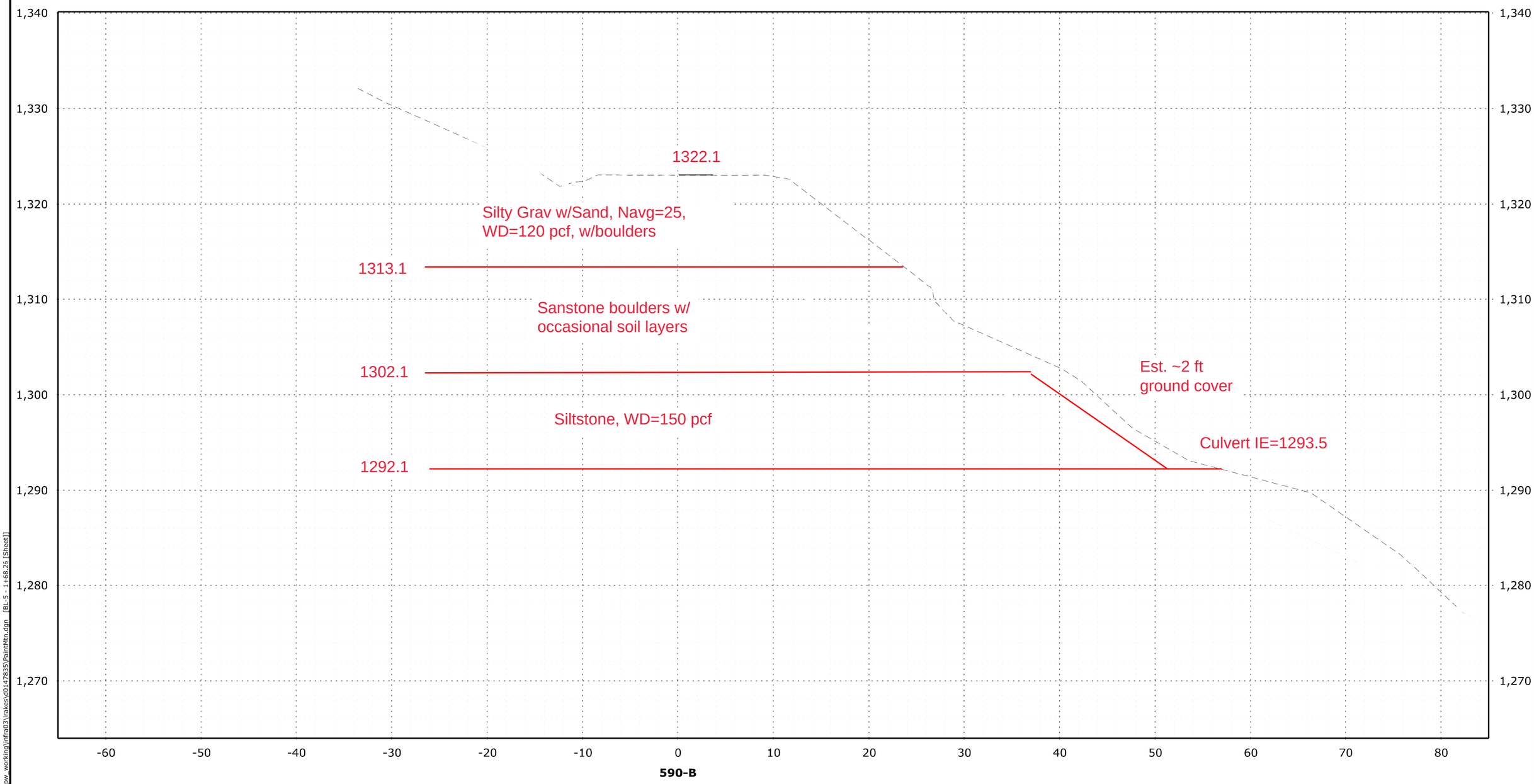

FHWA, Office of Federal Lands Highway

BOREHOLE 590-B

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25 June 2024 10:48 AM

NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
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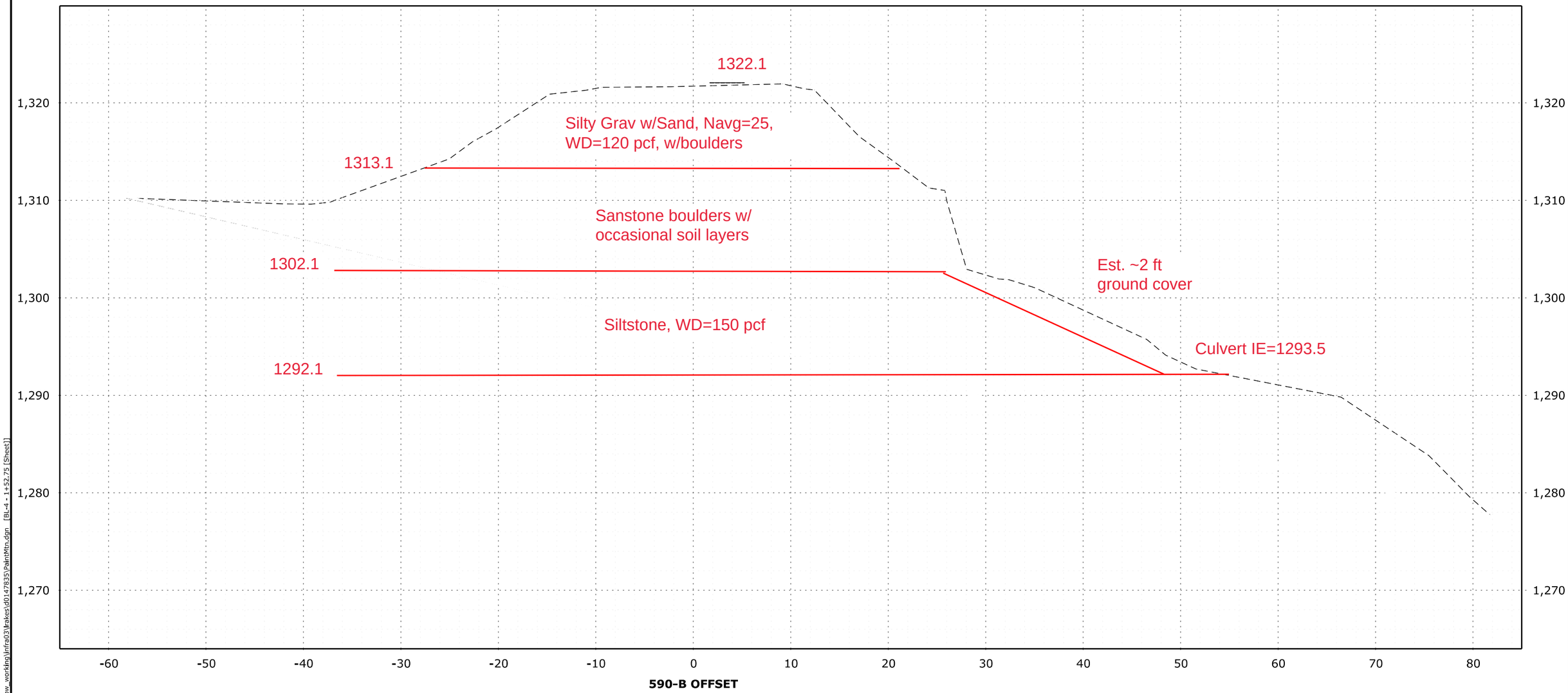

FHWA, Office of Federal Lands Highway

BOREHOLE 590-B OFFSET

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25 June 2024 2:58 PM

APPENDIX E
MSE Wall Analyses

Seismic Site Class

Seismic Site Class Analysis

Briar Creek

Boring: 633-B
N-average

	N-value	Depth	Range	Range/N
Sand	25	2.5	2.5	0.10
	16	5	2.5	0.16
	22	7.5	2.5	0.11
	16	10	2.5	0.16
	8	12.5	2.5	0.31
	18	15	2.5	0.14
	18	17.5	2.5	0.14
	40	20	2.5	0.06
Rock	100	25	5	0.05
	100	30	5	0.05
	100	35	5	0.05
	100	40	5	0.05
	100	45	5	0.05
	100	50	5	0.05
	100	55	5	0.05
	100	60	5	0.05
	100	65	5	0.05
	100	70	5	0.05
	100	75	5	0.05
	100	80	5	0.05
	100	85	5	0.05
	100	90	5	0.05
	100	95	5	0.05
	100	100	5	0.05

For Site Class = C

	%			
PGA	11.7	0.117		
Ss	22.1	0.221		
S1	6.2	0.062		
Fpga	0.1<PGA<0.2	1.2		
Fa	Ss<0.25	1.2		
Fv	S1<0.1	1.7		
SD1		0.11	<	0.15
	Seismic Zone =	**1**		
As	0.14			

Σ Range/N 1.98
N = 50.5 bpf

In accordance with Method B and based on AASHTO Table 3.10.3.1-1 Site Class Definitions the Site Class = C (N>50 bpf) over 100 ft.

Seismic Site Class Analysis

Flatwoods

Boring: 660-B
N-average

	N-value	Depth	Range	Range/N
Sand	13	2.5	2.5	0.19
	16	5	2.5	0.16
	22	7.5	2.5	0.11
	19	10	2.5	0.13
	19	12.5	2.5	0.13
	33	15	2.5	0.08
Rock	100	20	5	0.05
	100	25	5	0.05
	100	30	5	0.05
	100	35	5	0.05
	100	40	5	0.05
	100	45	5	0.05
	100	50	5	0.05
	100	55	5	0.05
	100	60	5	0.05
	100	65	5	0.05
	100	70	5	0.05
	100	75	5	0.05
	100	80	5	0.05
	100	85	5	0.05
	100	90	5	0.05
	100	95	5	0.05
	100	100	5	0.05

	%			
PGA	11.2	0.112		
Ss	21.6	0.216		
S1	6	0.06		
Fpga	0.1<PGA<0.2	1.2		
Fa	Ss<0.25	1.2		
Fv	S1<0.1	1.7		
SD1		0.102	<	0.15
	Seismic Zone =	**1**		
As	0.13			

Σ Range/N 1.65
N = 60.6 bpf

In accordance with Method B and based on AASHTO Table 3.10.3.1-1 Site Class Definitions the Site Class = C (N>50 bpf) over 100 ft.

Seismic Site Class Analysis

Paint Mountain

Boring: 590-A
N-average

	N-value	Depth	Range	Range/N
Sand	24	2.5	2.5	0.10
	28	5	2.5	0.09
	50	7.5	2.5	0.05
	22	10	2.5	0.11
	16	12.5	2.5	0.16
	11	15	2.5	0.23
	10	17.5	2.5	0.25
Rock	100	22.5	5	0.05
	100	27.5	5	0.05
	100	32.5	5	0.05
	100	37.5	5	0.05
	100	42.5	5	0.05
	100	47.5	5	0.05
	100	52.5	5	0.05
	100	57.5	5	0.05
	100	62.5	5	0.05
	100	67.5	5	0.05
	100	72.5	5	0.05
	100	77.5	5	0.05
	100	82.5	5	0.05
	100	87.5	5	0.05
	100	92.5	5	0.05
	100	97.5	5	0.05
	100	102.5	5	0.05

	%			
PGA	13.5	0.135		
Ss	24.9	0.249		
S1	5.9	0.059		
Fpga	0.1<PGA<0.2	1.2		
Fa	Ss<0.25	1.2		
Fv	S1<0.1	1.7		
SD1		0.100	<	0.15
	Seismic Zone =	**1**		
As	0.16			

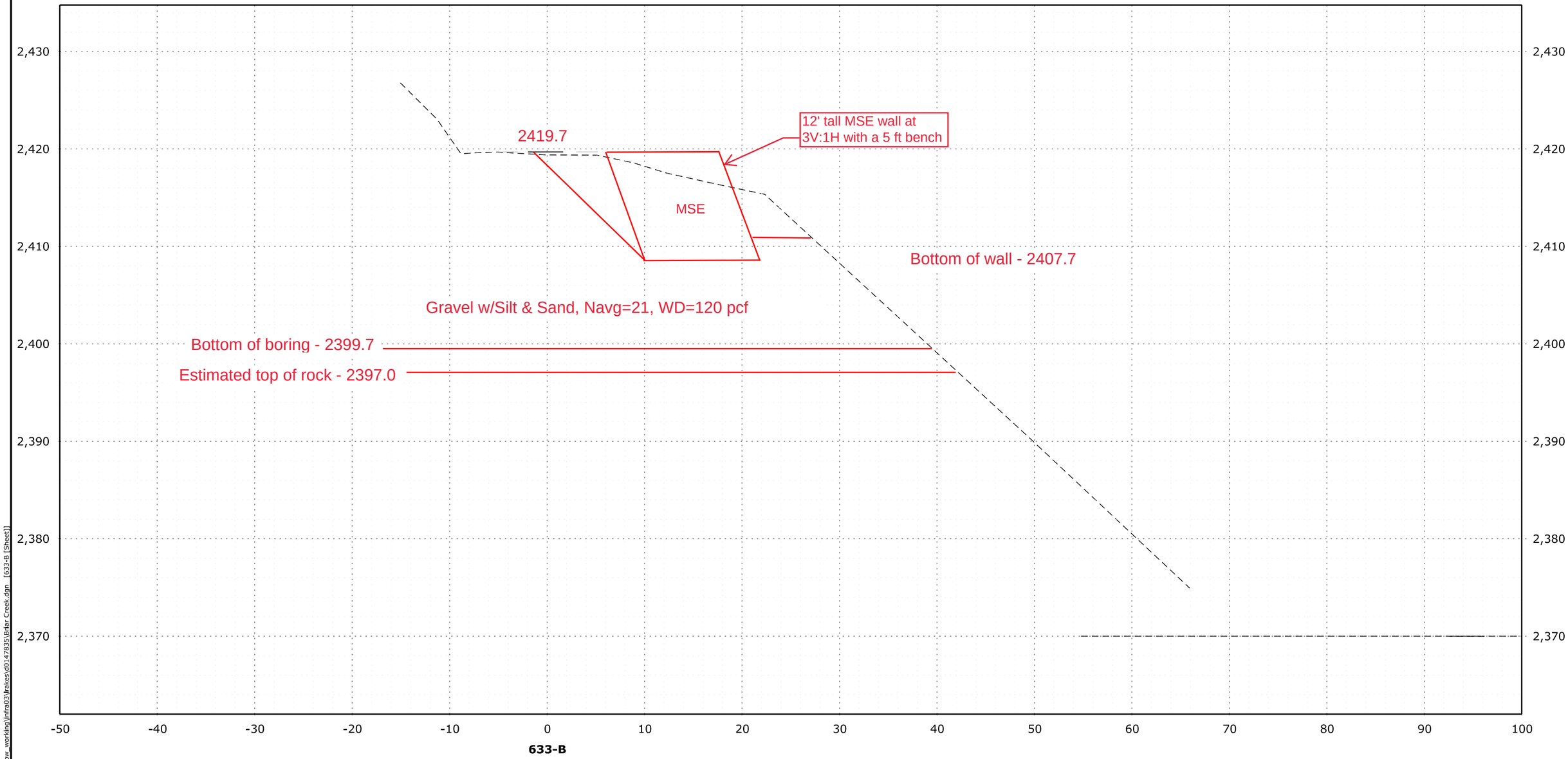
Σ Range/N 1.84
N = 55.7 bpf

In accordance with Method B and based on AASHTO Table 3.10.3.1-1 Site Class Definitions the Site Class = C (N>50 bpf) over 100 ft.

MP 633

NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
	633-B



FHWA, Office of Federal Lands Highway

BOREHOLE 633-B

c:\pw_working\infra03\trakes\d0147935\Briar Creek.dgn [633-B (Sheet)]

26 June 2024 8:07 AM

AASHTO 2017-2020
TN ERFO FS CHRKE804 2020-2(1)

MSEW+: Update # 2023.21

PROJECT IDENTIFICATION

Title: TN ERFO FS CHRKE804 2020-2(1)
Project Number: MP 633
Client: FHWA
Designer: DRP
Station Number: MP633-B

Description:

MSE system to repair slope. Slope at 1H:1V

Company's information:

Name: Stantec Consulting Services Inc.
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

File path and name: C:\Users\Dpleiman\OneDrive - Stantec\Documents\TN ERFO .....
.....\MP 633\MP633-B.BENp

Original date and time of creating this file: Wed Jun 26 15:14:35 2024

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

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SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	120.0 lb/ft ^{3}
Equivalent internal angle of friction, $\phi_{equiv.}$	36.0 °
Equivalent cohesion, $c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.1747 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 53.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.2973 (eq. 17 is utilized to calculate Ka for all batters)
(For external stability user specified δ = 20.00°)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 3.86 N γ= 4.30

SEISMICITY (using AASHTO 2017-2020)

Peak ground acceleration coeff., A = PGA = 0.117 and Site Factor, Fpga = 1.200. Maximum ground acceleration coeff., As = 0.140
Design acceleration coefficient in Internal Stability: Kh = Am = 0.140
Design acceleration coefficient in External Stability: Kh_d = 0.140 => Kh = Am = 0.140
Kh(ext.) = Fpga x PGA

Ka = 0.2973 Kae = 0.3987 In Coulomb equation for Ka, Omega was taken as ZERO and backslope inclined at angle I.
In M-O equation for Kae, Omega is always set to ZERO.
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd 12.00 [ft] { Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 9.00 ft }

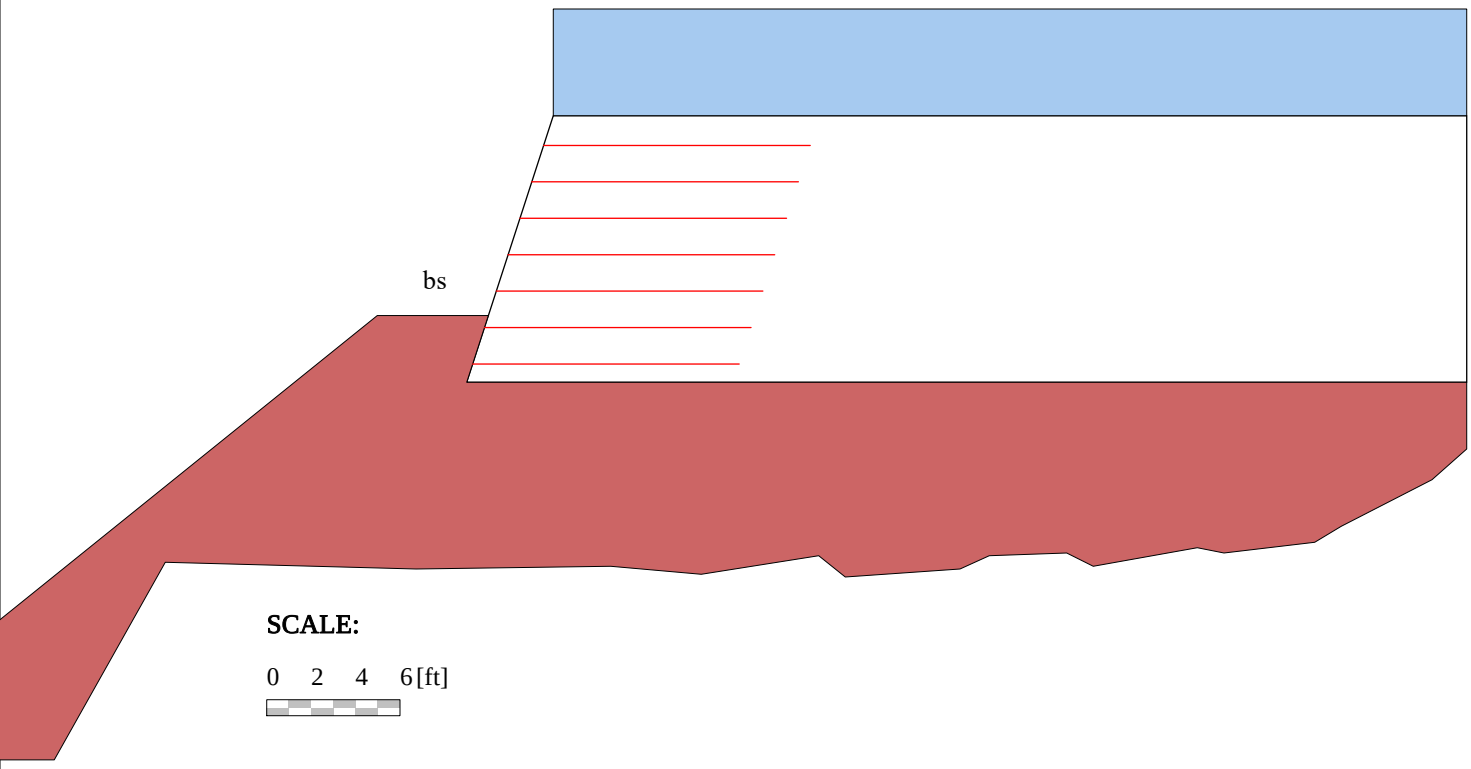
Soil in front of wall is inclined at 40.0°, Hs = 20.00 ft. and bs = 5.00 ft.

Batter, ω	18.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:



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AASHTO 2017-2020 – Load and Resisting Factors

INTERNAL STABILITY

Load factor for vertical earth pressure, EV:	$\gamma_{p\text{-}EV}$	1.35
Load factor for earthquake loads, EQ:	$\gamma_{p\text{-}EQ}$	1.00
Load factor for live load surcharge, LS: (Same as in External Stability).	$\gamma_{p\text{-}LS}$	1.75
Load factor for dead load surcharge, ES: (Same as in External Stability).	$\gamma_{p\text{-}ES}$	1.50

		Static	Combined static/seismic
Resistance factor for reinforcement tension	ϕ		
Geogrid:		0.90	1.20
Resistance factor for reinforcement tension in connectors	ϕ		
Geogrid:		0.90	1.20
Resistance factor for geosynthetic pullout	ϕ	0.90	1.20

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV		Static	Combined Static/Seismic	
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH	$\gamma_{p\text{-}EH}$	1.50
Load factor for earthquake loads, EQ (multiplies P_{AE} and P_{IR}):	$\gamma_{p\text{-}EQ}$	1.00
Load factor for live load surcharge under seismic conditions:	$(\gamma_{p\text{-}LS})_{EQ}$	1.00
Load factor for dead load surcharge under seismic conditions:	$(\gamma_{p\text{-}ES})_{EQ}$	1.00

Resistance factor for shear resistance along common interfaces		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation	Static	Combined Static/Seismic
ϕ_b	0.65	0.90

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ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity - see limit equilibrium analysis, factored bearing load = 2268 lb/ft².

Foundation Interface: Direct sliding, CDR = 2.164, Eccentricity, e/L = -0.0052, CDR-overturning = 5.25

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION CDR [connection break]	Geogrid strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.82	12.00	1	N/A					
2	2.46	12.00	1	N/A					
3	4.10	12.00	1	N/A					
4	5.74	12.00	1	N/A					
5	7.38	12.00	1	N/A					
6	9.02	12.00	1	N/A					
7	10.66	12.00	1	N/A					

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, CDR = 1.31, factored bearing load = 2052 lb/ft².

Foundation Interface: Direct sliding, CDR = 1.864, Eccentricity, e/L = 0.0911, Fs-overturning = 3.77

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION CDR [connection break]	Geogrid strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.82	12.00	1	N/A					
2	2.46	12.00	1	N/A					
3	4.10	12.00	1	N/A					
4	5.74	12.00	1	N/A					
5	7.38	12.00	1	N/A					
6	9.02	12.00	1	N/A					
7	10.66	12.00	1	N/A					

Static Conditions: CDR for bearing resistance = 8970/2268 = 3.96

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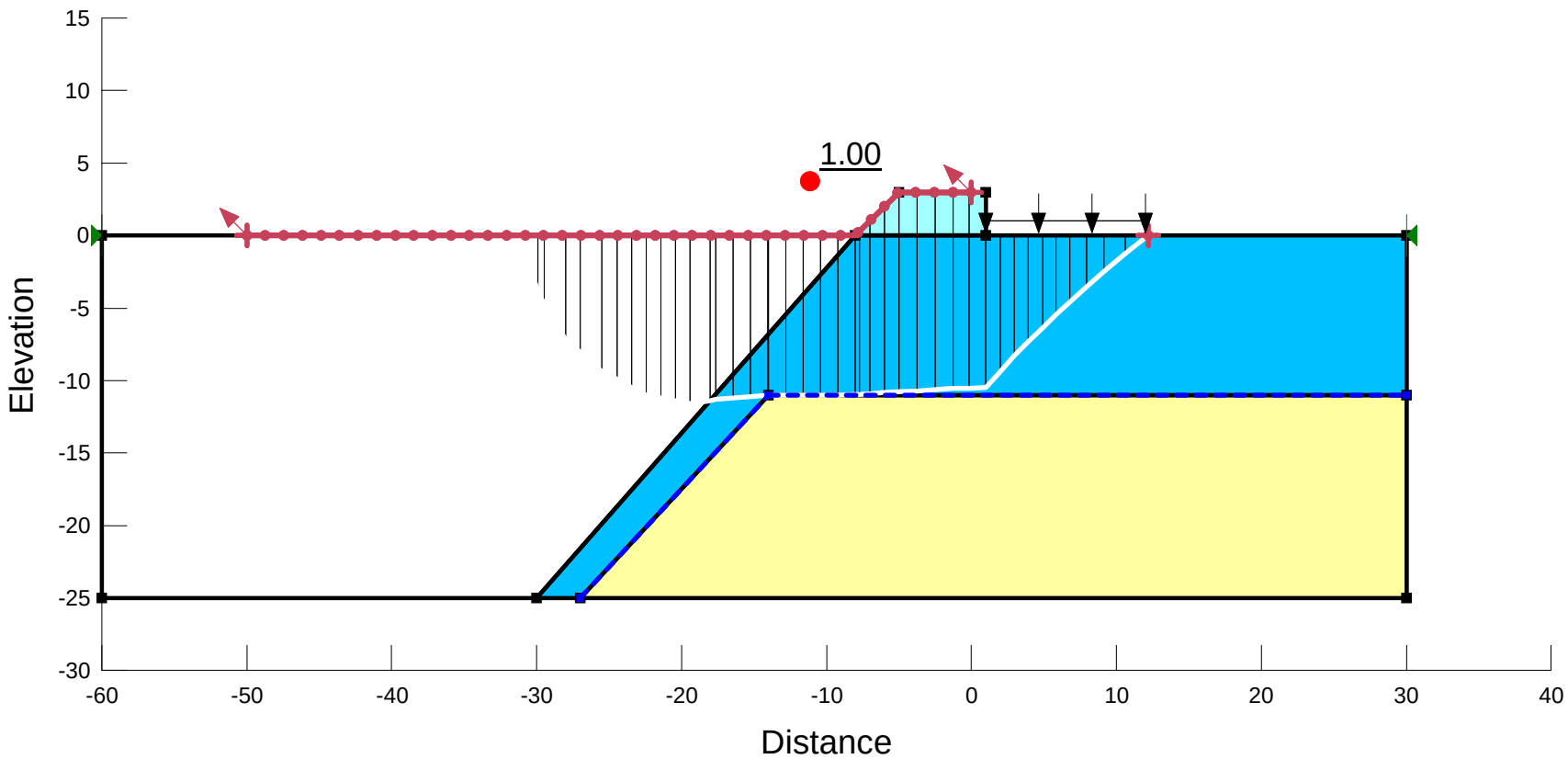
TN ERFO FS CHRKE804 2020-2(1)
MSE Wall Bearing Capacity
Limit Equilibrium Method
MP633-B

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Bearing Capacity on a 1H:1V Slope
Undrained Conditions

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Air	0.1	0	0.1
	Clayey Gravel	120	0	36
	Limestone Bedrock	160	4,000	40
	Toe Fill	120	0	30

Applied Bearing Pressure = 13,800 psf Factored
Bearing Resistance (phi=0.65) = 8970 psf



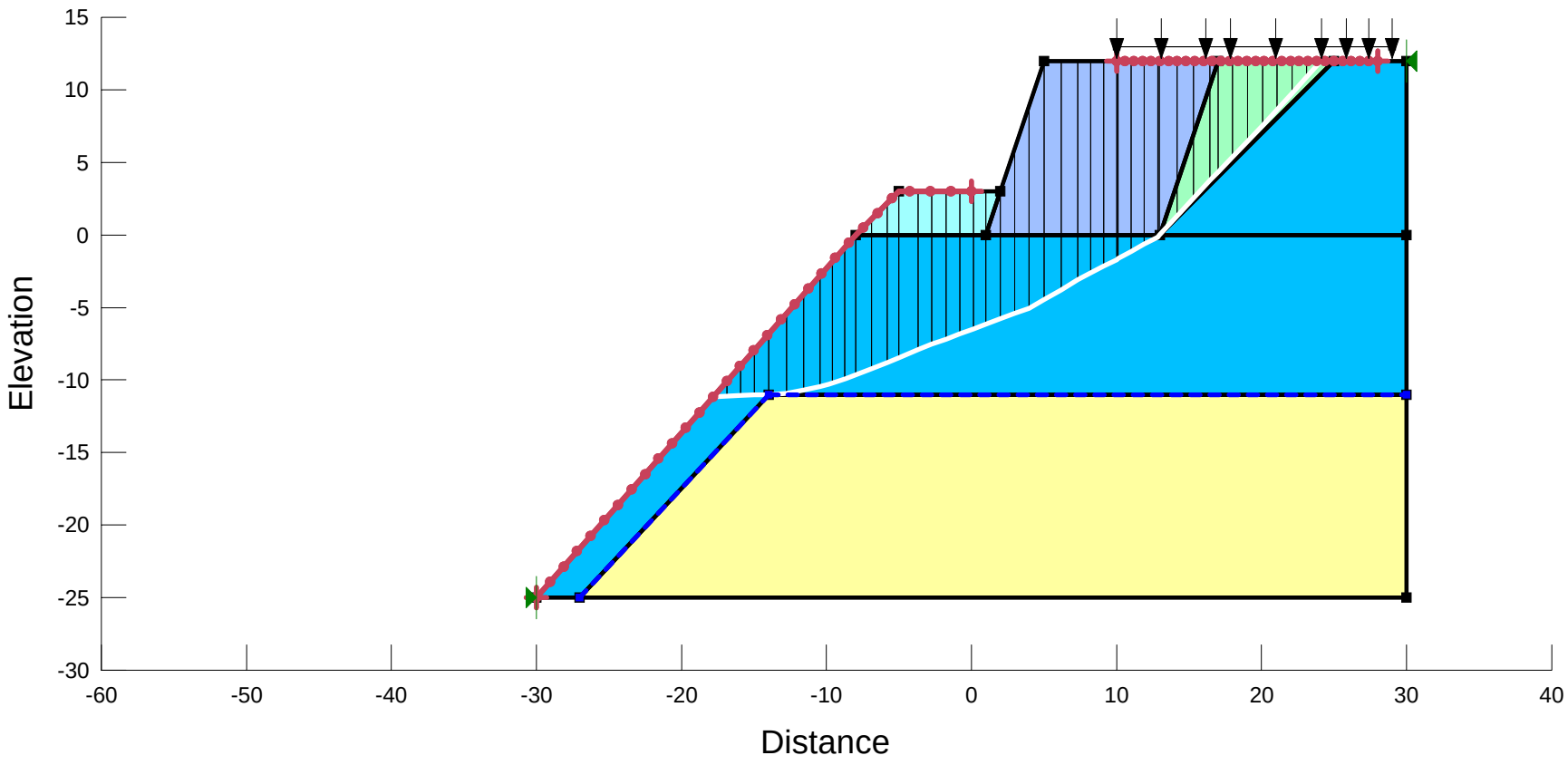
TN ERFO FS CHRKE804 2020-2(1)
MSE Wall
Global Stability Analysis
MP633-B

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Gravel w/Silty & Sand	120	0	36
	MSE Fill	120	2,000	34
	Retained Fill	120	0	30
	Sandstone Bedrock	160	4,000	40
	Toe Fill	120	0	30

Global Stability on a 1H:1V Slope
Undrained Conditions

1.36



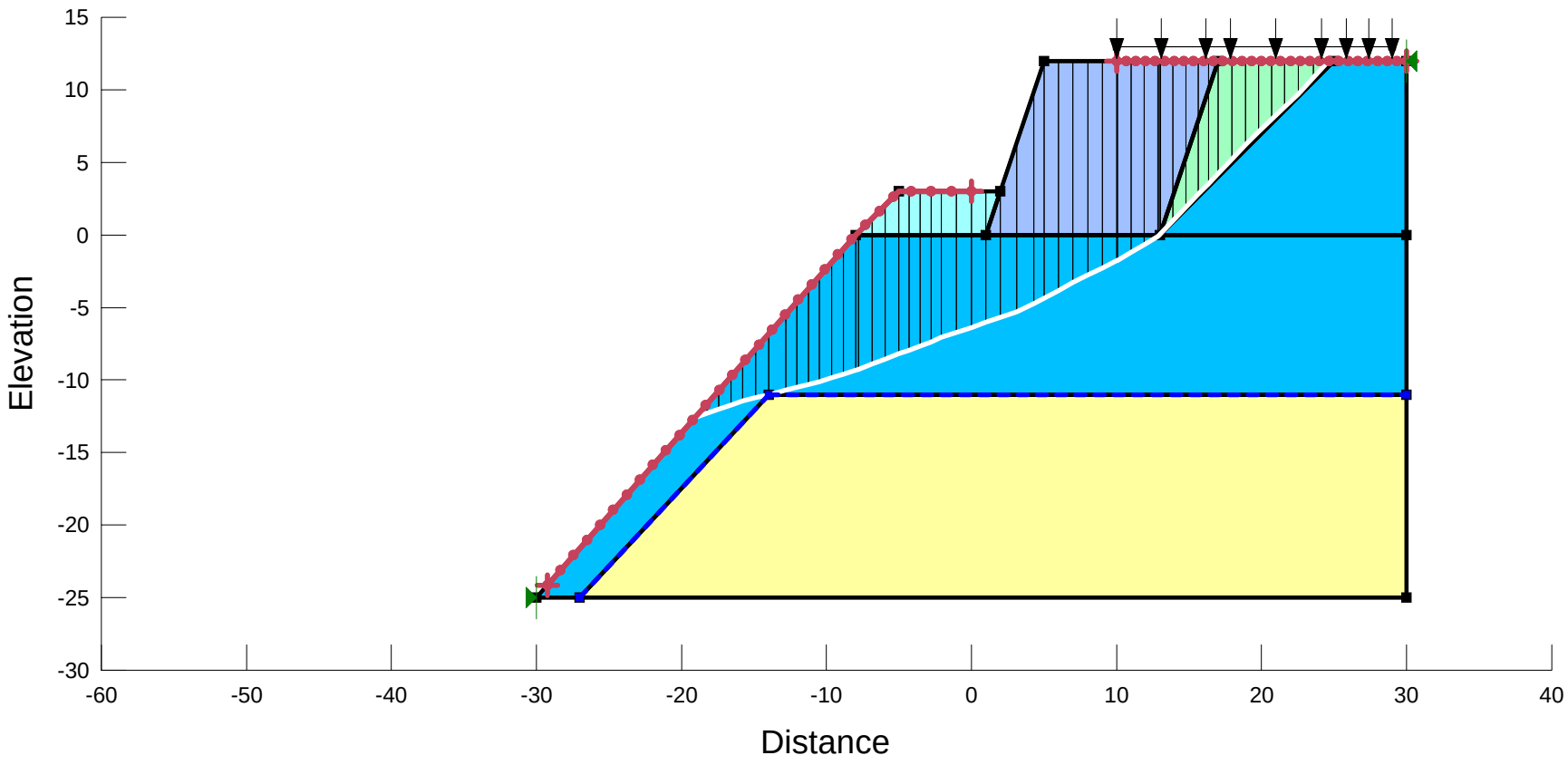
TN ERFO FS CHRKE804 2020-2(1)
MSE Wall
Global Stability Analysis
MP633-B

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Gravel w/Silty & Sand	120	0	36
	MSE Fill	120	2,000	34
	Retained Fill	120	0	30
	Sandstone Bedrock	160	4,000	40
	Toe Fill	120	0	30

Global Stability - Seismic Analysis

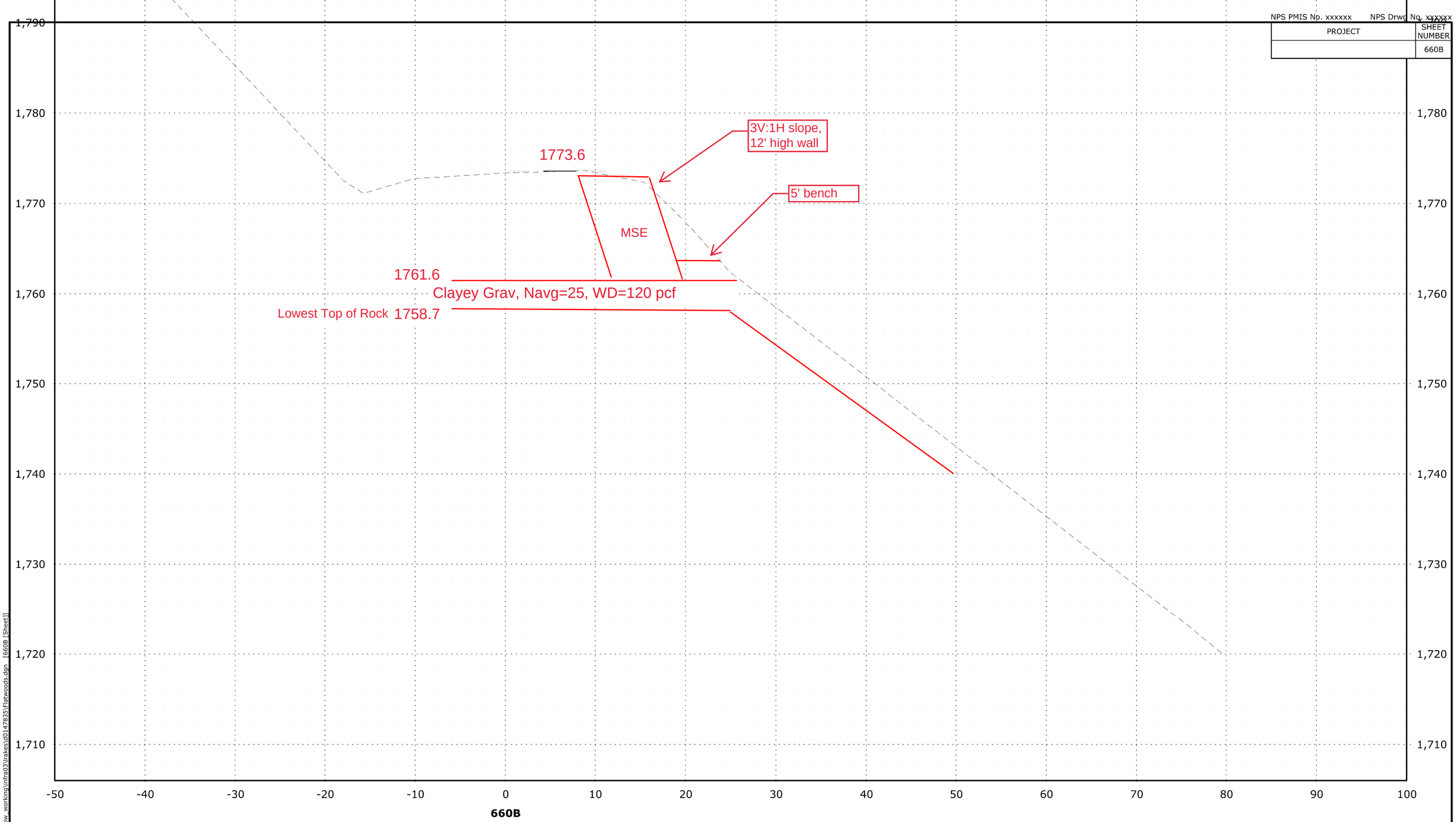
1.10



MP 660

NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
	660B



FHWA, Office of Federal Lands Highway

BOREHOLE 660-B

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25 June 2024 12:40 AM

AASHTO 2017-2020
TN ERFO FS CHRKE804 2020-2(1)

MSEW+: Update # 2023.21

PROJECT IDENTIFICATION

Title: TN ERFO FS CHRKE804 2020-2(1)
Project Number: MP 660
Client: FHWA
Designer: DRP
Station Number: MP660-B

Description:

MSE system to repair slope. Slope at 1.25H:1V

Company's information:

Name: Stantec Consulting Services Inc.
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

File path and name: C:\Users\Dpleiman\OneDrive - Stantec\Documents\TN ERFO .....
.....wnslope\MP660-B.BENp

Original date and time of creating this file: Wed Jun 26 15:14:35 2024

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

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SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	120.0 lb/ft ^{3}
Equivalent internal angle of friction, $\phi_{equiv.}$	34.0 °
Equivalent cohesion, $c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.1747 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 53.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.2973 (eq. 17 is utilized to calculate Ka for all batters)
(For external stability user specified δ = 20.00°)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 1.52 N γ= 1.48

SEISMICITY (using AASHTO 2017-2020)

Peak ground acceleration coeff., A = PGA = 0.112 and Site Factor, Fpga = 1.200. Maximum ground acceleration coeff., As = 0.134
Design acceleration coefficient in Internal Stability: Kh = Am = 0.134
Design acceleration coefficient in External Stability: Kh_d = 0.134 => Kh = Am = 0.134
Kh(ext.) = Fpga x PGA

Ka = 0.2973 Kae = 0.3936 In Coulomb equation for Ka, Omega was taken as ZERO and backslope inclined at angle I.
In M-O equation for Kae, Omega is always set to ZERO.
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd 12.00 [ft] { Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 9.00 ft }

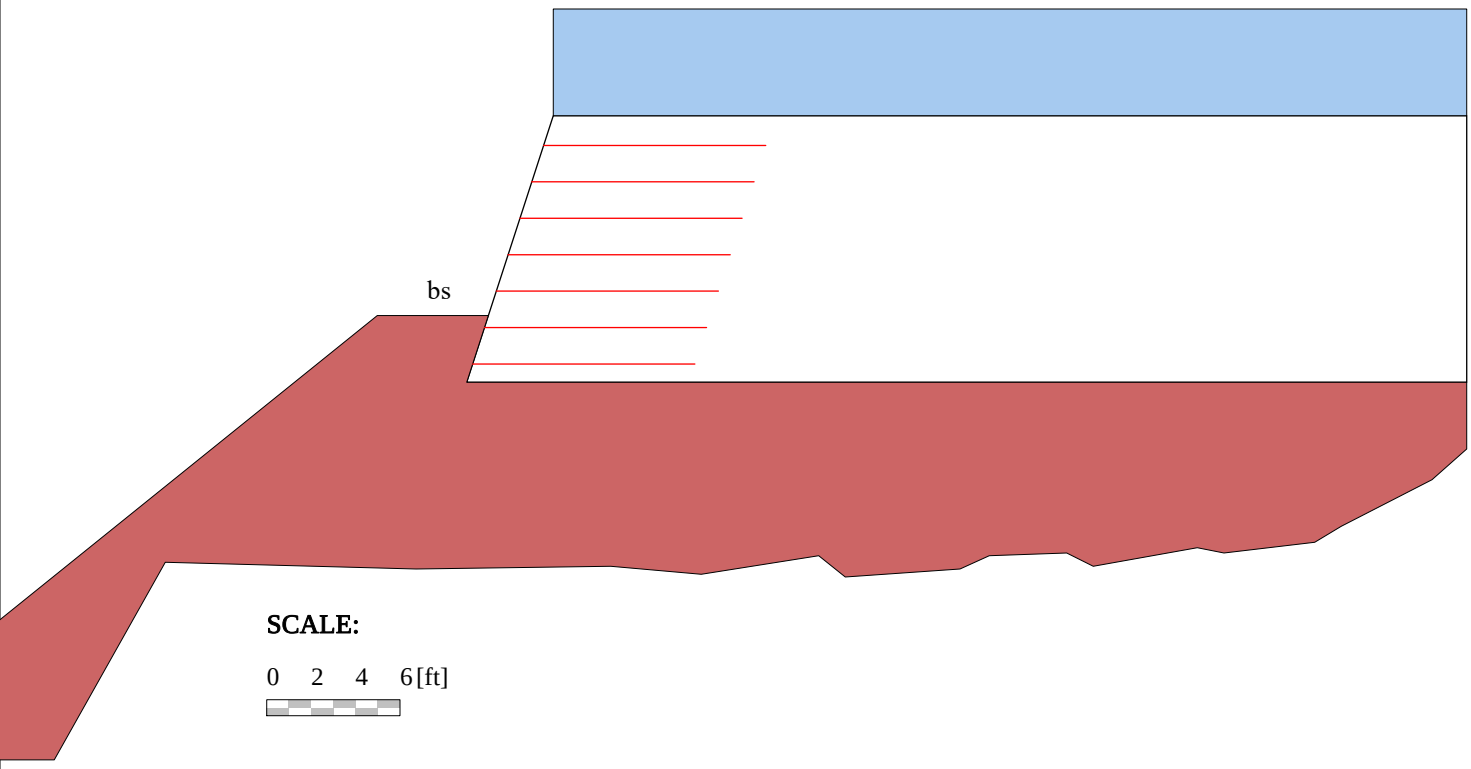
Soil in front of wall is inclined at 40.0°, Hs = 20.00 ft. and bs = 5.00 ft.

Batter, ω	18.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:



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AASHTO 2017-2020 – Load and Resisting Factors

INTERNAL STABILITY

Load factor for vertical earth pressure, EV:	$\gamma_{p\text{-}EV}$	1.35
Load factor for earthquake loads, EQ:	$\gamma_{p\text{-}EQ}$	1.00
Load factor for live load surcharge, LS: (Same as in External Stability).	$\gamma_{p\text{-}LS}$	1.75
Load factor for dead load surcharge, ES: (Same as in External Stability).	$\gamma_{p\text{-}ES}$	1.50

		Static	Combined static/seismic
Resistance factor for reinforcement tension	ϕ		
Geogrid:		0.90	1.20
Resistance factor for reinforcement tension in connectors	ϕ		
Geogrid:		0.90	1.20
Resistance factor for geosynthetic pullout	ϕ	0.90	1.20

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV		Static	Combined Static/Seismic	
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH	$\gamma_{p\text{-}EH}$	1.50
Load factor for earthquake loads, EQ (multiplies P_{AE} and P_{IR}):	$\gamma_{p\text{-}EQ}$	1.00
Load factor for live load surcharge under seismic conditions:	$(\gamma_{p\text{-}LS})_{EQ}$	1.00
Load factor for dead load surcharge under seismic conditions:	$(\gamma_{p\text{-}ES})_{EQ}$	1.00

Resistance factor for shear resistance along common interfaces		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation	Static	Combined Static/Seismic
ϕ_b	0.65	0.90

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ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity - see limit equilibrium analysis, factored bearing load = 2127 lb/ft².

Foundation Interface: Direct sliding, CDR = 1.782, Eccentricity, e/L = 0.0271, CDR-overturning = 3.73

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION CDR [connection break]	Geogrid strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.82	10.00	1	N/A					
2	2.46	10.00	1	N/A					
3	4.10	10.00	1	N/A					
4	5.74	10.00	1	N/A					
5	7.38	10.00	1	N/A					
6	9.02	10.00	1	N/A					
7	10.66	10.00	1	N/A					

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity - see limit equilibrium analysis, factored bearing load = 1965 lb/ft².

Foundation Interface: Direct sliding, CDR = 1.544, Eccentricity, e/L = 0.1401, Fs-overturning = 2.69

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION CDR [connection break]	Geogrid strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.82	10.00	1	N/A					
2	2.46	10.00	1	N/A					
3	4.10	10.00	1	N/A					
4	5.74	10.00	1	N/A					
5	7.38	10.00	1	N/A					
6	9.02	10.00	1	N/A					
7	10.66	10.00	1	N/A					

Static Conditions: CDR for bearing resistance = 7800/2127 = 3.67

Seismic Conditions: CDR for bearing capacity = 9000/1965 = 4.58

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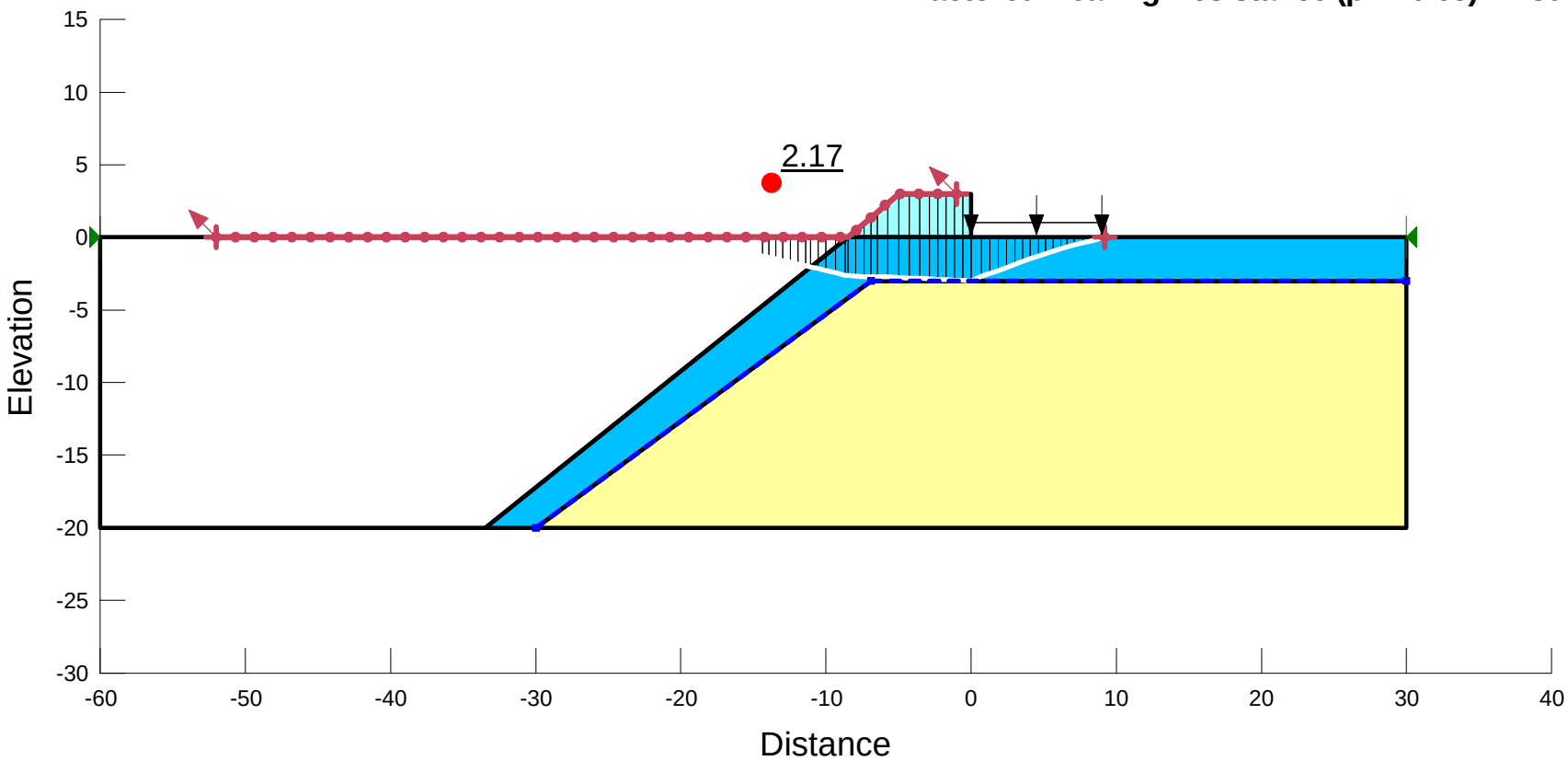
TN ERFO FS CHRKE804 2020-2(1)
MSE Wall Bearing Capacity
Limit Equilibrium Method
MP660-B

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Bearing Capacity on a 1.25H:1V Slope
Undrained Conditions

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Air	0.1	0	0.1
	Clayey Gravel	120	0	34
	Limestone Bedrock	160	4,000	40
	Toe Fill	120	0	30

Applied Bearing Pressure = 12000+ psf
Factored Bearing Resistance (phi=0.65) = 7800 psf



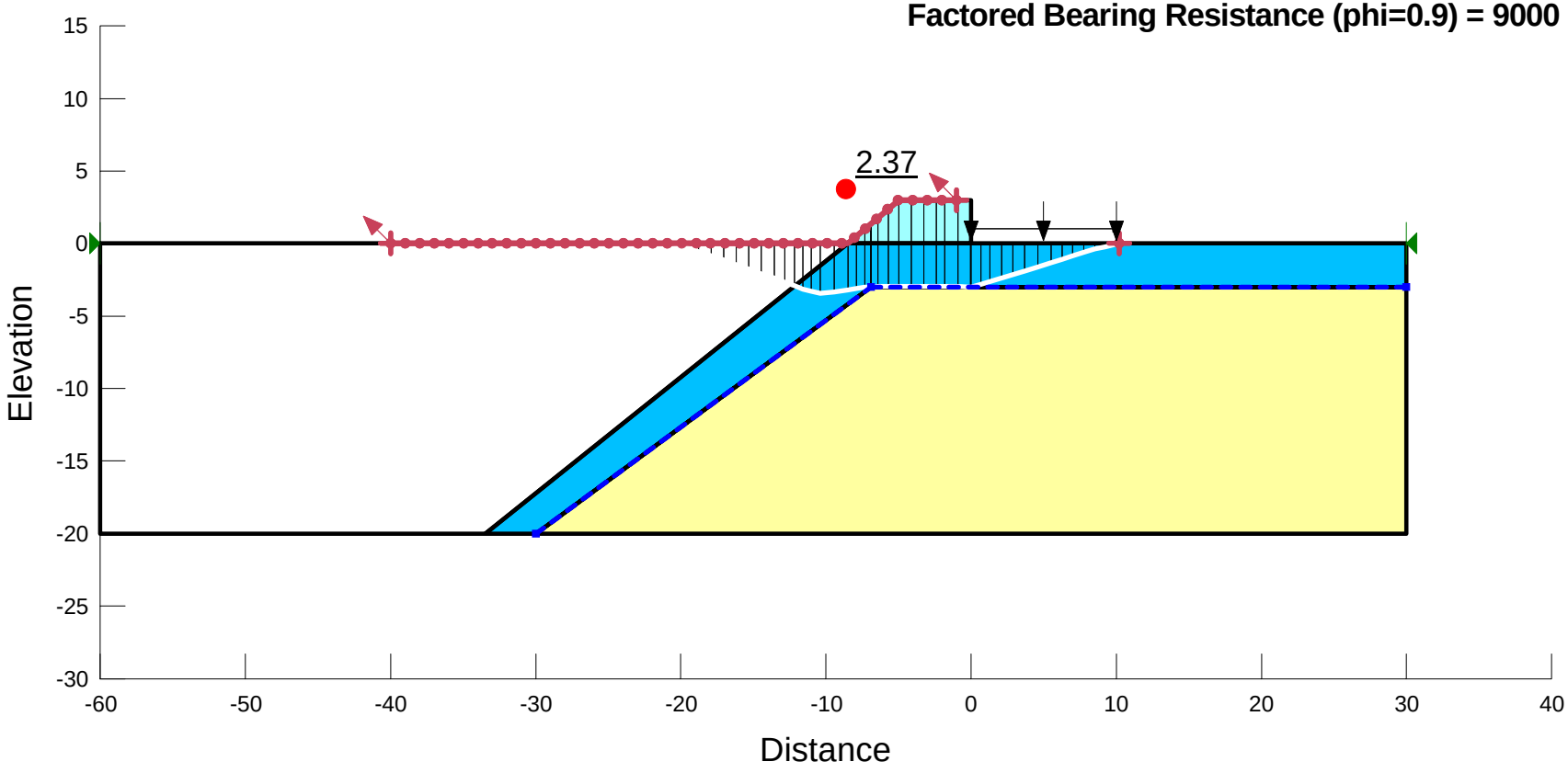
TN ERFO FS CHRKE804 2020-2(1)
MSE Wall Bearing Capacity
Limit Equilibrium Method
MP660-B

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Bearing Capacity on a 1H:1V Slope
Seismic Conditions

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Air	0.1	0	0.1
	Clayey Gravel	120	0	34
	Limestone Bedrock	160	4,000	40
	Toe Fill	120	0	30

Applied Bearing Pressure = 10000+ psf
Factored Bearing Resistance (phi=0.9) = 9000 psf



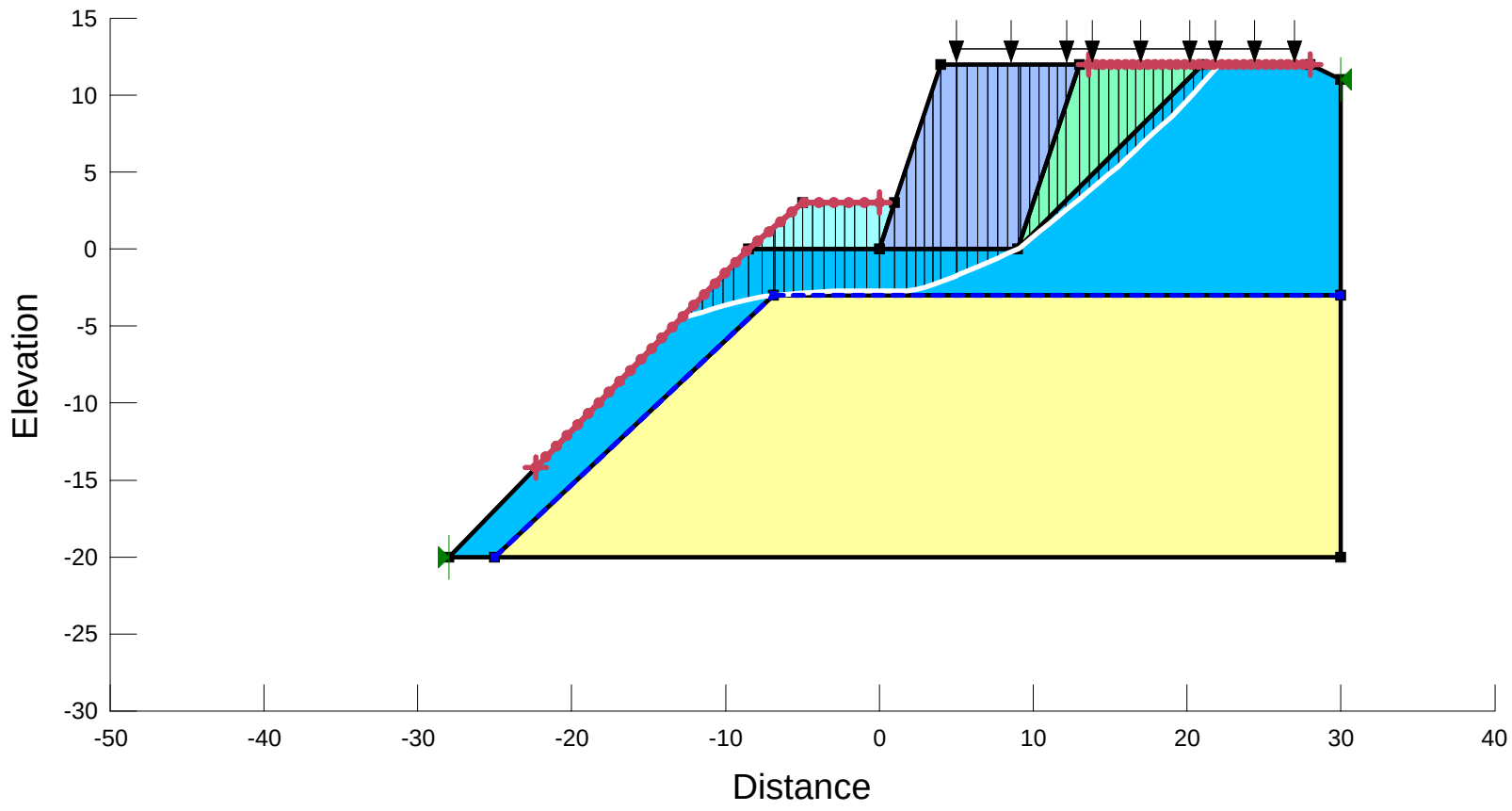
TN ERFO FS CHRKE804 2020-2(1)
MSE Wall-Global Stability
MP660-B

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Slope - 1.25H:1V
Undrained Conditions

1.56

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clayey Grav w/Sand	120	0	34
	Limestone Bedrock	160	4,000	40
	MSE Fill	120	2,000	34
	Retained Fill	120	0	30
	Toe Fill	120	0	30



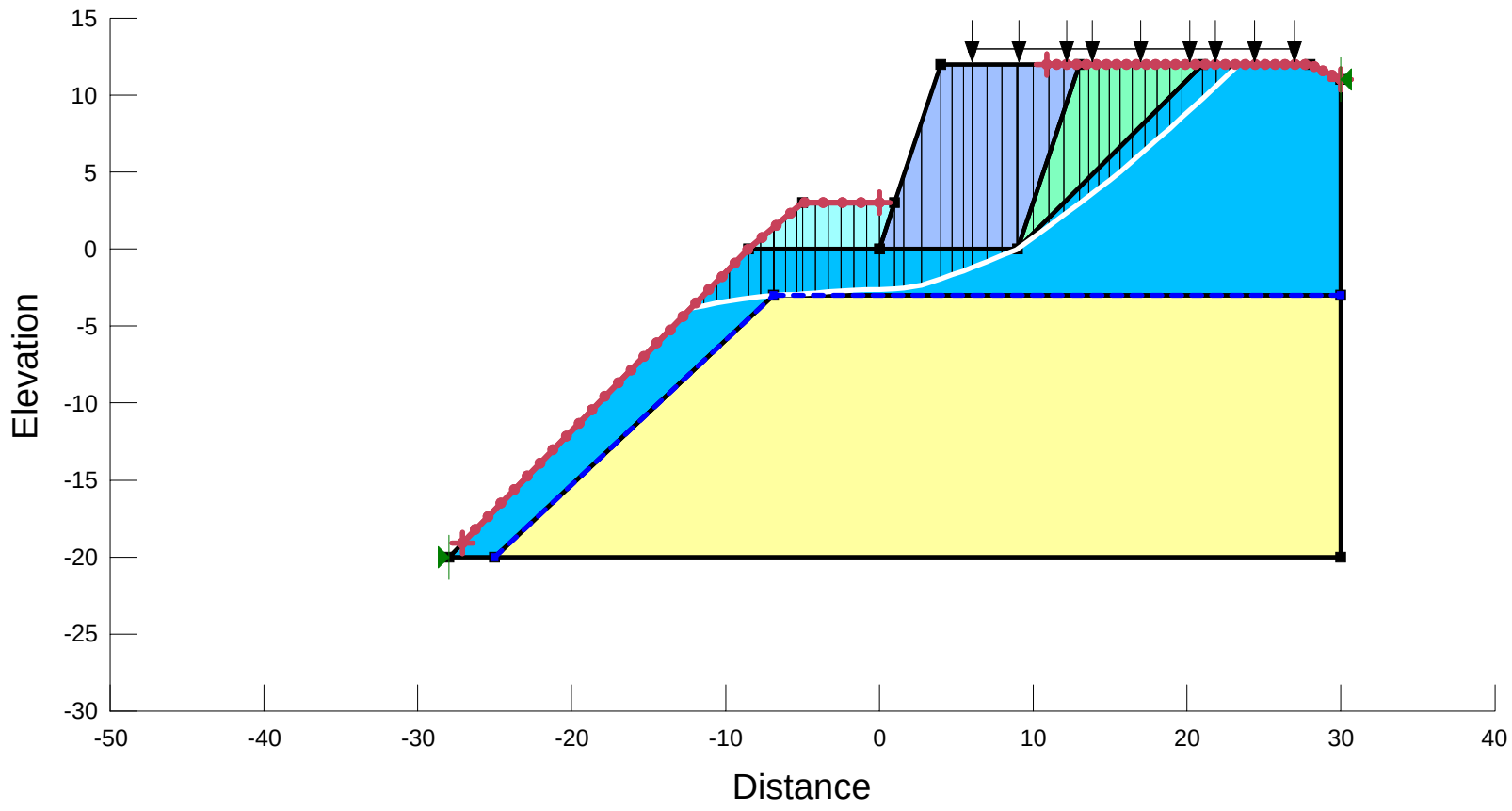
TN ERFO FS CHRKE804 2020-2(1)
MSE Wall-Global Stability
MP660-B

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Global Stability - Seismic Analysis

1.31

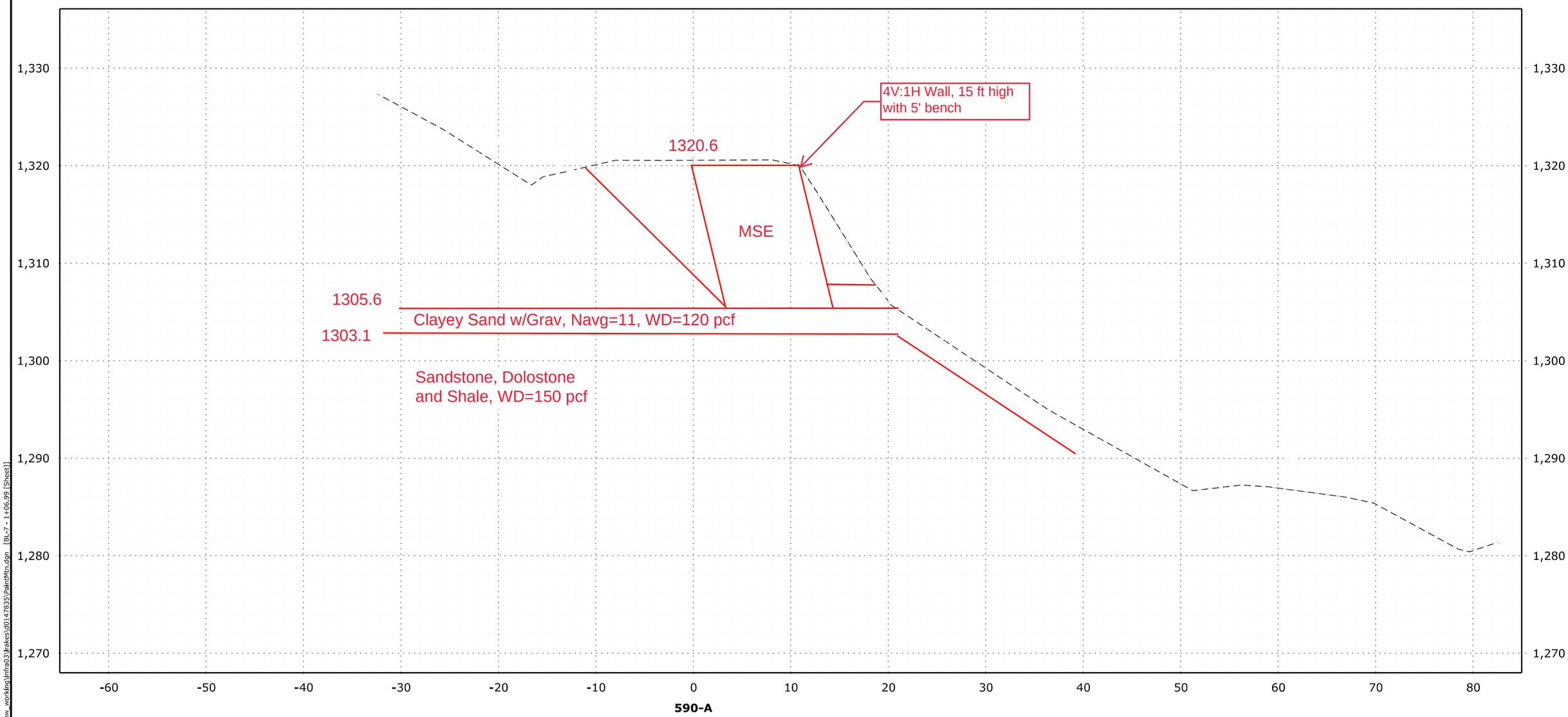
Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clayey Grav w/Sand	120	0	34
	Limestone Bedrock	160	4,000	40
	MSE Fill	120	2,000	34
	Retained Fill	120	0	30
	Toe Fill	120	0	30



MP 590

NPS PMIS No. xxxxxx NPS Drwg No. xxxxxx

PROJECT	SHEET NUMBER
	1+06.99



FHWA, Office of Federal Lands Highway

BOREHOLE 590-A

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25 June 2024 10:50 AM

AASHTO 2017-2020
TN ERFO FS CHRKE804 2020-2(1)

MSEW+: Update # 2023.21

PROJECT IDENTIFICATION

Title: TN ERFO FS CHRKE804 2020-2(1)
Project Number: MP 590
Client: FHWA
Designer: DRP
Station Number: MP590-A

Description:

MSE system to repair slope. Downslope at 1.5H:1V

Company's information:

Name: Stantec Consulting Services Inc.
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

File path and name: C:\Users\Dpleiman\OneDrive - Stantec\Documents\TN ERFO .....
.....int Mtn\MP590-A.BENp

Original date and time of creating this file: Wed Jun 26 15:14:35 2024

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

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SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	120.0 lb/ft ^{3}
Equivalent internal angle of friction, $\phi_{equiv.}$	32.0 °
Equivalent cohesion, $c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.1973 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 55.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.2973 (eq. 17 is utilized to calculate Ka for all batters)
(For external stability user specified δ = 20.00°)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 0.90 N γ= 0.77

SEISMICITY (using AASHTO 2017-2020)

Peak ground acceleration coeff., A = PGA = 0.135 and Site Factor, Fpga = 1.200. Maximum ground acceleration coeff., As = 0.162
Design acceleration coefficient in Internal Stability: Kh = Am = 0.162
Design acceleration coefficient in External Stability: Kh_d = 0.162 => Kh = Am = 0.162
Kh(ext.) = Fpga x PGA

Ka = 0.2973 Kae = 0.4177 In Coulomb equation for Ka, Omega was taken as ZERO and backslope inclined at angle I.
In M-O equation for Kae, Omega is always set to ZERO.
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd 15.00 [ft] { Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 12.00 ft }

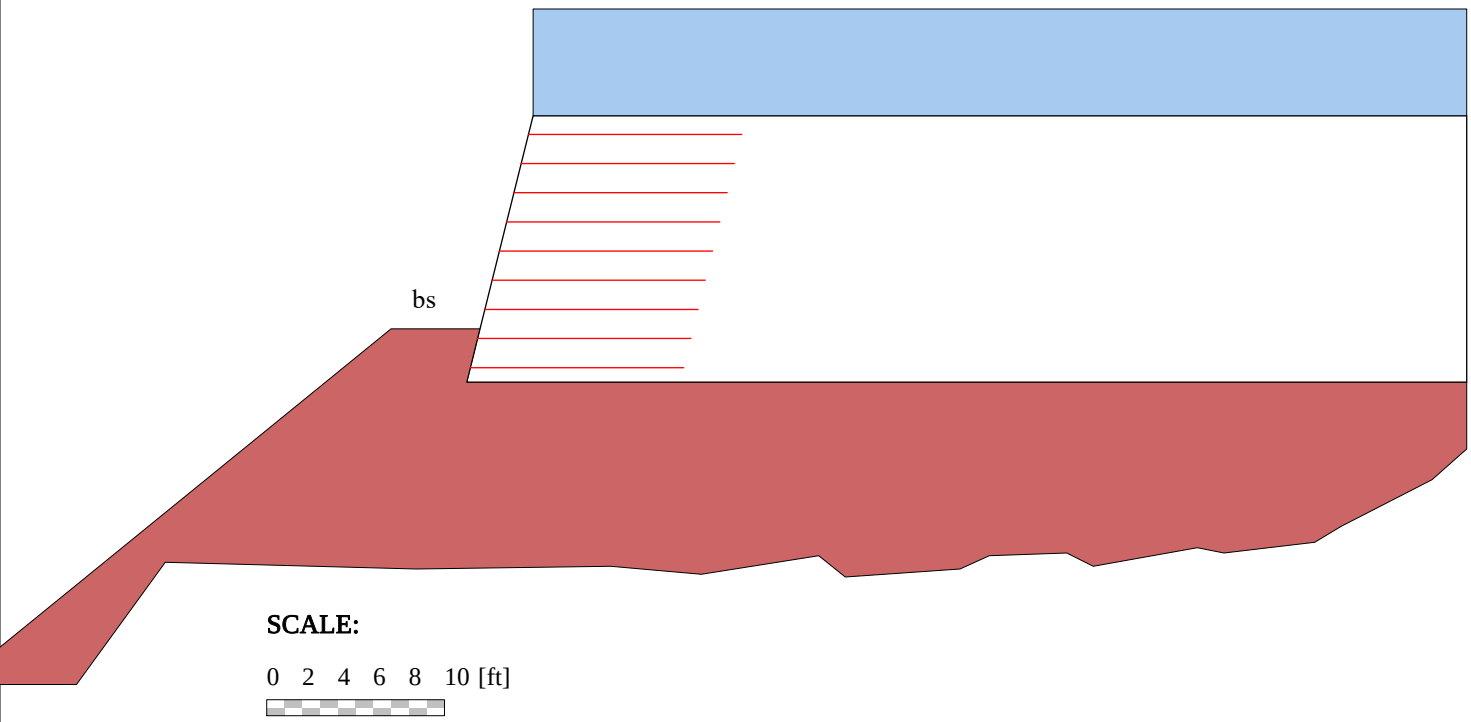
Soil in front of wall is inclined at 40.0°, Hs = 20.00 ft. and bs = 5.00 ft.

Batter, ω	14.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:



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AASHTO 2017-2020 – Load and Resisting Factors

INTERNAL STABILITY

Load factor for vertical earth pressure, EV:	$\gamma_{p\text{-}EV}$	1.35
Load factor for earthquake loads, EQ:	$\gamma_{p\text{-}EQ}$	1.00
Load factor for live load surcharge, LS: (Same as in External Stability).	$\gamma_{p\text{-}LS}$	1.75
Load factor for dead load surcharge, ES: (Same as in External Stability).	$\gamma_{p\text{-}ES}$	1.50

		Static	Combined static/seismic
Resistance factor for reinforcement tension	ϕ		
Geogrid:		0.90	1.20
Resistance factor for reinforcement tension in connectors	ϕ	Static	Combined static/seismic
Geogrid:		0.90	1.20
Resistance factor for geosynthetic pullout	ϕ	0.90	1.20

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV		Static	Combined Static/Seismic	
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH	$\gamma_{p\text{-}EH}$	1.50
Load factor for earthquake loads, EQ (multiplies P_{AE} and P_{IR}):	$\gamma_{p\text{-}EQ}$	1.00
Load factor for live load surcharge under seismic conditions:	$(\gamma_{p\text{-}LS})_{EQ}$	1.00
Load factor for dead load surcharge under seismic conditions:	$(\gamma_{p\text{-}ES})_{EQ}$	1.00

Resistance factor for shear resistance along common interfaces		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation	Static	Combined Static/Seismic
ϕ_b	0.65	0.90

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ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity - see limit equilibrium analysis, factored bearing load = 2617 lb/ft².
Foundation Interface: Direct sliding, CDR = 1.748, Eccentricity, e/L = 0.0385, CDR-overturning = 3.76

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION CDR [connection break]	Geogrid strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.82	12.00	1	N/A					
2	2.46	12.00	1	N/A					
3	4.10	12.00	1	N/A					
4	5.74	12.00	1	N/A					
5	7.38	12.00	1	N/A					
6	9.02	12.00	1	N/A					
7	10.66	12.00	1	N/A					
8	12.30	12.00	1	N/A					
9	13.94	12.00	1	N/A					

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity - see limit equilibrium analysis, factored bearing load = 2664 lb/ft².
Foundation Interface: Direct sliding, CDR = 1.434, Eccentricity, e/L = 0.1589, Fs-overturning = 2.55

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION CDR [connection break]	Geogrid strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.82	12.00	1	N/A					
2	2.46	12.00	1	N/A					
3	4.10	12.00	1	N/A					
4	5.74	12.00	1	N/A					
5	7.38	12.00	1	N/A					
6	9.02	12.00	1	N/A					
7	10.66	12.00	1	N/A					
8	12.30	12.00	1	N/A					
9	13.94	12.00	1	N/A					

Static Conditions: CDR for bearing resistance = 8450/2617 = 3.23

Seismic Conditions: CDR for bearing capacity = 10800/2664 = 4.05

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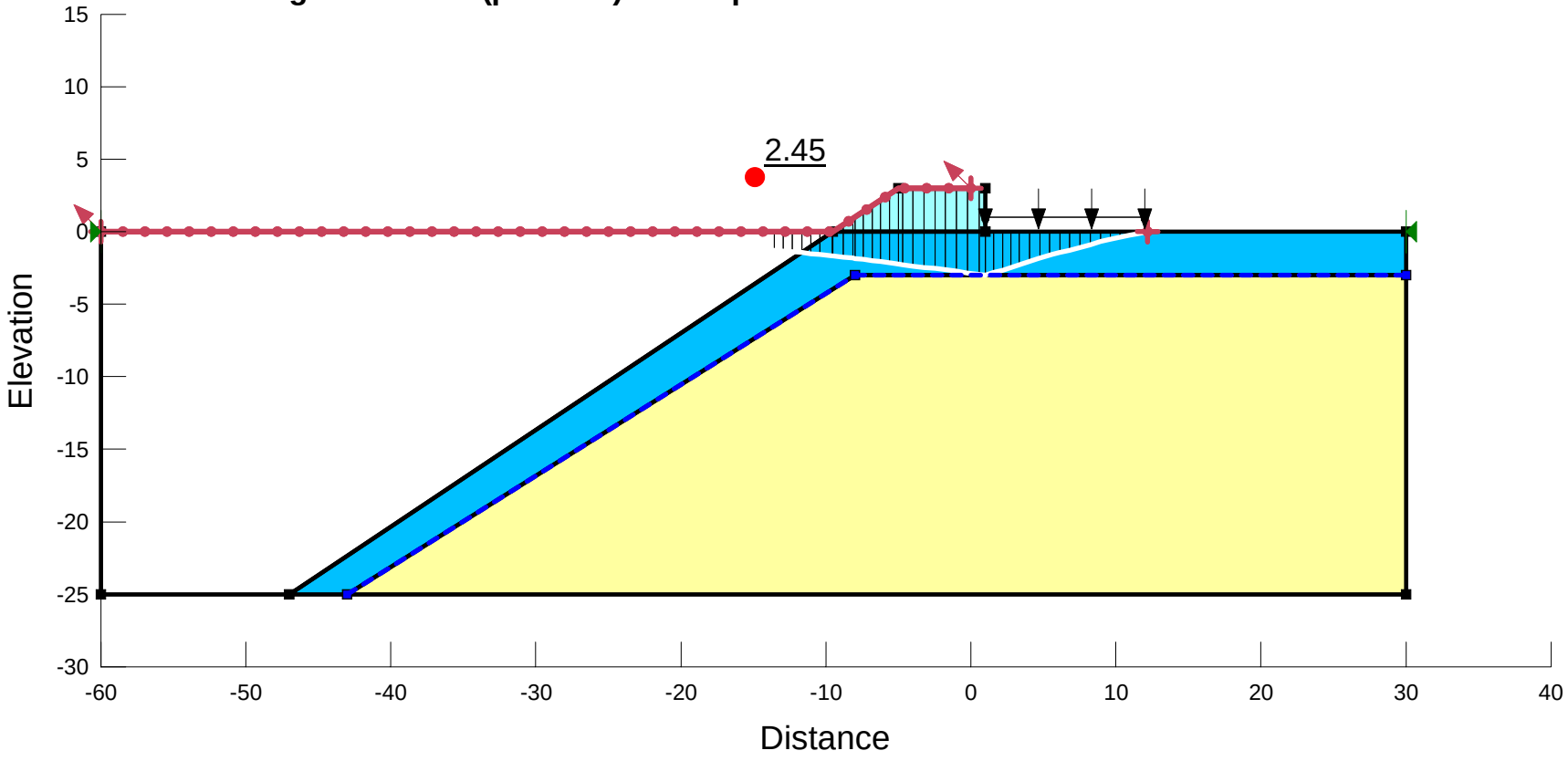
TN ERFO FS CHRKE804 2020-2(1)
MSE Wall Bearing Capacity
Limit Equilibrium Method
MP590-A

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Bearing Capacity on a 1.5H:1V Slope
Undrained Conditions

Applied Bearing Pressure = 13000+ psf
Factored Bearing Resistance (phi=0.65) = 8450 psf

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Air	0.1	0	0.1
	Sandstone, Siltstone Bedrock	160	4,000	40
	Silty Gravel w/Sand	120	0	32
	Toe Fill	120	0	30



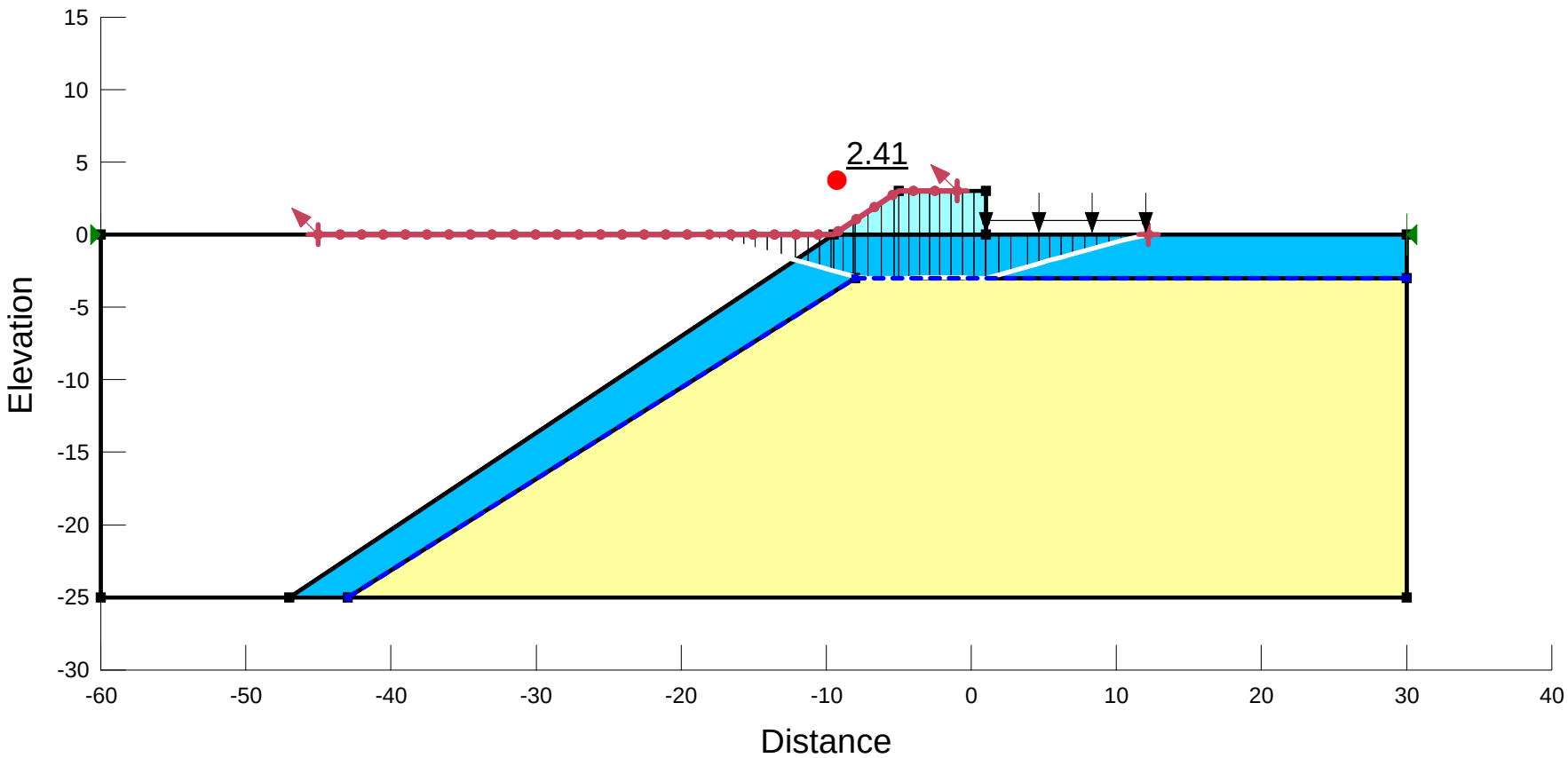
TN ERFO FS CHRKE804 2020-2(1)
MSE Wall Bearing Capacity
Limit Equilibrium Method
MP590-A

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Bearing Capacity on a 1.5H:1V Slope
Seismic Conditions

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Air	0.1	0	0.1
	Sandstone, Siltstone Bedrock	160	4,000	40
	Silty Gravel w/Sand	120	0	32
	Toe Fill	120	0	30

Applied Bearing Pressure = 12000+ psf
Factored Bearing Resistance (phi=0.9) = 10800 psf



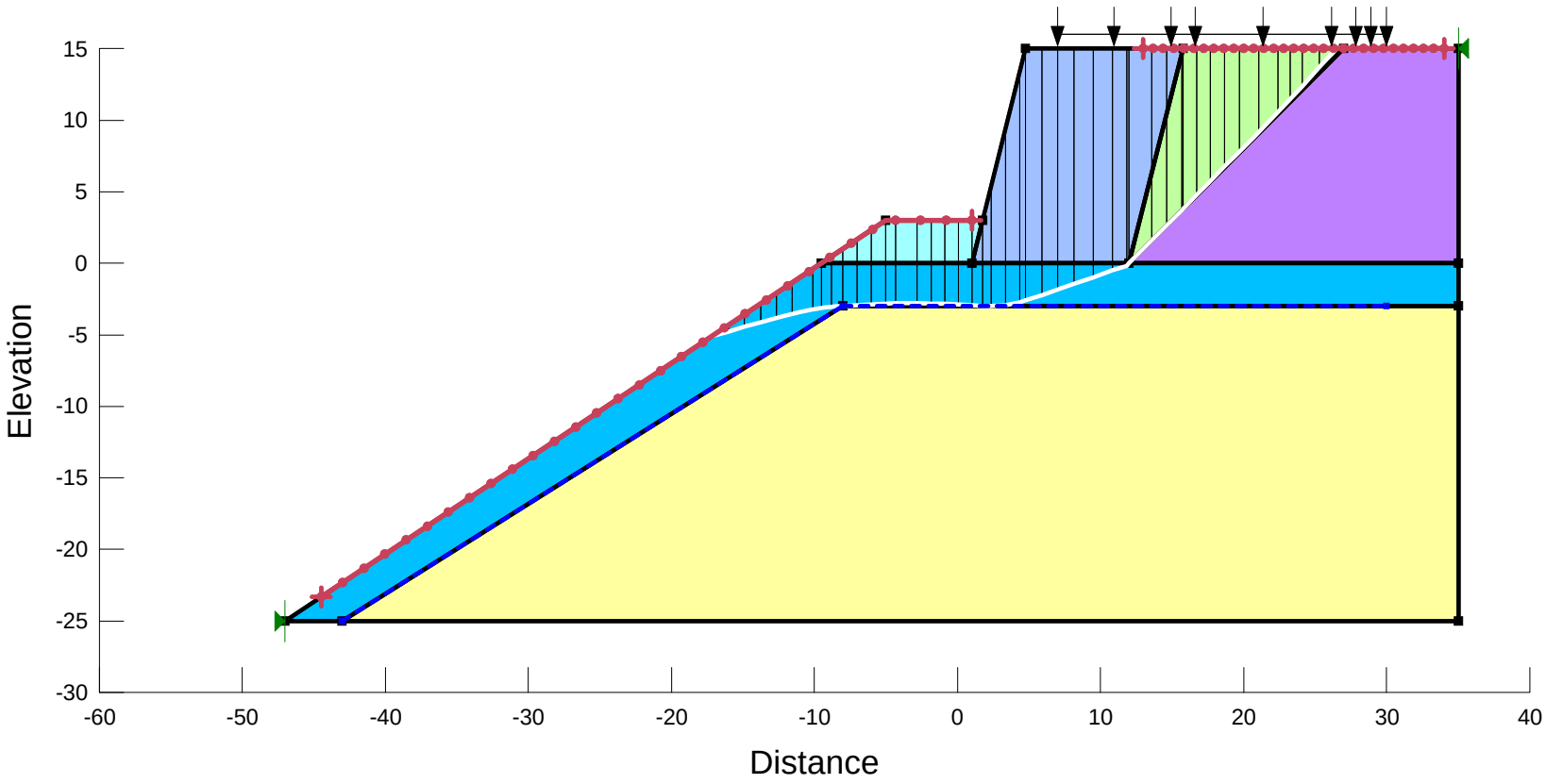
TN ERFO FS CHRKE804 2020-2(1)
MSE Wall
Global Stability Analysis
MP590-A

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Global Stability on a 1.5H:1V Slope
Undrained Conditions

1.47

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clayey Gravel w/Sand	120	0	35
	MSE Fill	120	2,000	34
	Retained Fill	120	0	30
	Sandstone, Siltstone Bedrock	160	4,000	40
	Silty Gravel w/Sand	120	0	32
	Toe Fill	120	0	30



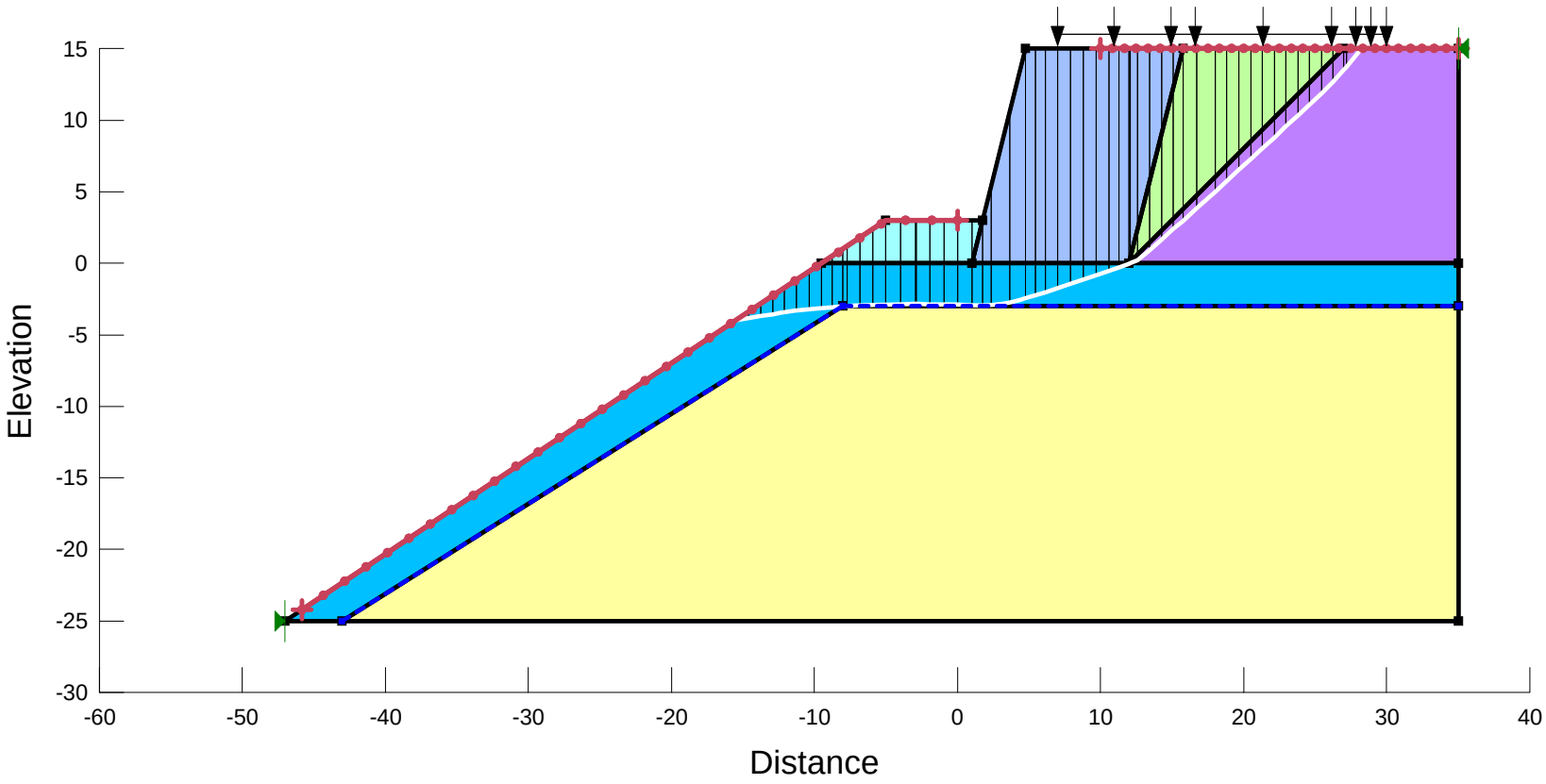
TN ERFO FS CHRKE804 2020-2(1)
MSE Wall
Global Stability Analysis
MP590-A

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Global Stability - Seismic Analysis

1.25

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clayey Gravel w/Sand	120	0	35
	MSE Fill	120	2,000	34
	Retained Fill	120	0	30
	Sandstone, Siltstone Bedrock	160	4,000	40
	Silty Gravel w/Sand	120	0	32
	Toe Fill	120	0	30



APPENDIX F
Geocell Information

BASELOK®
by Industrial Fabrics, Inc.

Date:	6/25/2024
Customer:	Ferguson Waterworks
Project Name:	Cincinatti Slope
Project Location:	Cincinnati, OH
Project Number:	EP0001678
Units	English

GeoCell Slope Protection Design

Inputs	Units	Amount
GeoCell Aperture Size		GC30
Width of GeoCell Panels		Wide
Width of GeoCell Panels	ft	17.85
Depth of GeoCells	inch	6
Length of Slope (Down Slope)	ft	65.00
Horizontal Component of Slope of Height = 1		1.00
Unit Weight of GeoCell Infill	lb/ft3	100.00
Additional Loads (Block / Snow)	lb/ft2	0.00
Lowest Angle of Internal Friction Soil (B/W Soil and Infill)	degrees	28
Factor of Safety, Sliding Force		1.4

GEOCELL

Net Sliding Force Calculations	Units	Amount
β = Longitudinal Slope Angle	degrees	45.0
Sliding Force	lb/ft	2298.10
Sliding Force with Factor of Safety, Sliding Force	lb/ft	3217.34
Sliding Resistance	lb/ft	1221.92
NSF = Net Sliding Force per foot of Width	lb/ft	1995.42
Net Sliding Force per Panel Width	lbs	35618.18
Factor of Safety (Shear Only)		**0.53**

Tendon Calculations	Units	Amount
Ultimate Strength of Tendon	lbs	5100
Factor of Safety, Tendons		1.83
Design Strength of Tendon	lbs	2786.69
N_t = OVERRIDE Number of tendons per Panel		
Req'd Number of Tendons per Panel, Nt	N_t =	**13**
Factor of Safety (Shear and Tendons)		**1.41**

Crest, Trench & Anchor Pipe Deadman Design Inputs	Units	Amount
Horizontal Crest Length	ft	1
Crest Depth to Bottom of GeoCell	inch	12
Key Trench Slope Angle	degrees	90
Depth of Geocell in Key Trench	inch	12
Unit Weight of Anchor Trench Backfill	lb/ft3	120
Lowest Angle of Internal Friction Soil Trench Backfill	degrees	36
Diameter of Anchor Pipe	inch	12
Depth of Anchor Trench	ft	4.5
Internal Friction Angle of Anchor Pipe and Backfill	degrees	5

GeoCell Crest and Trench Resistance Calculations	Units	Amount
Resisting Force from GeoCell on Crest and in Trench	lb/ft	174.37
Factor of Safety (Shear and Crest Anchorage)		**0.61**
Factor of Safety (Shear, Tendons, and Crest Anchorage)		**1.49**

Anchor Pipe Deadman Calculations	Units	Amount
Required Deadman Anchor Pipe Resistance (Actual Tendon Design Load)	lb/ft	1995.42
Required Deadman Anchor Pipe Resistance (Ultimate Strength of Tendons)	lb/ft	3714.29
Ultimate Deadman Anchor Pipe Resistance	lb/ft	**2352.30**
Factor of Safety (Deadman Only) (Actual Tendon Design Load)		**1.18**
Factor of Safety (Deadman Only) (Ultimate Strength of Tendons)		**0.63**

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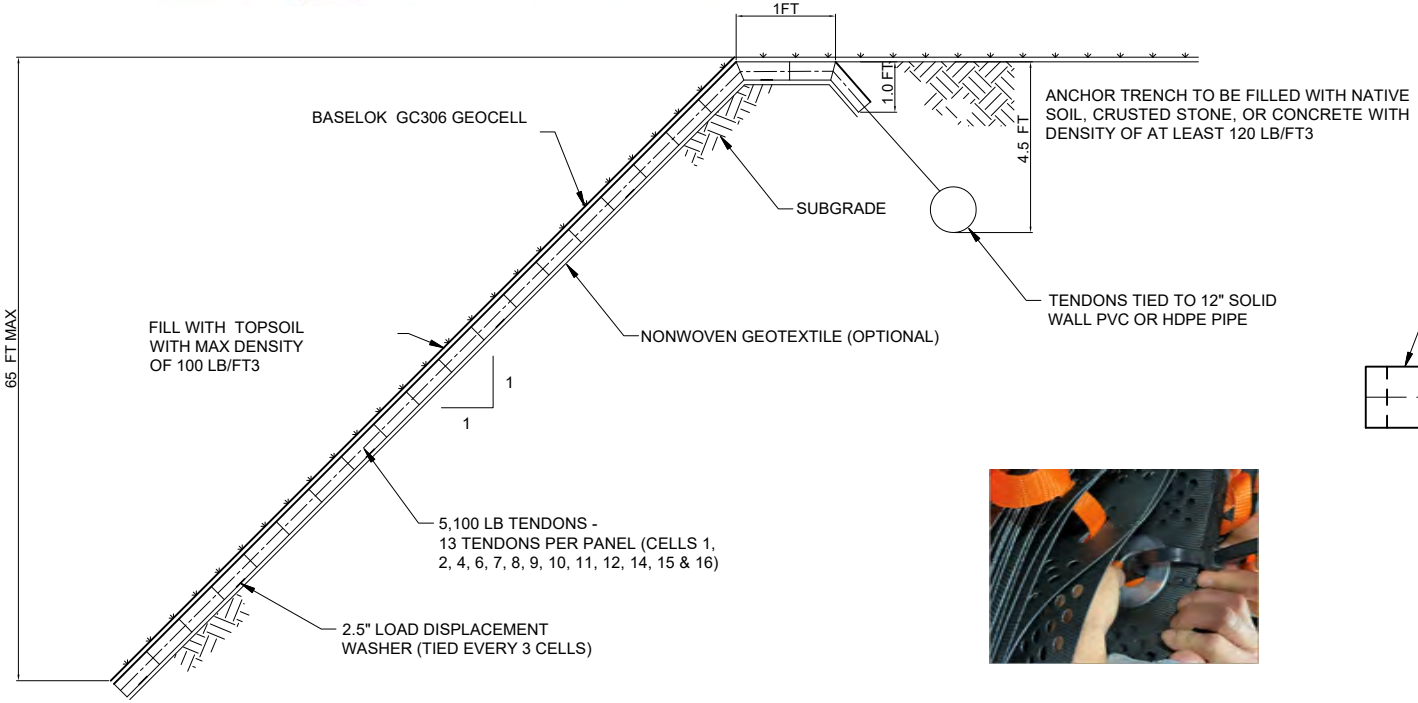
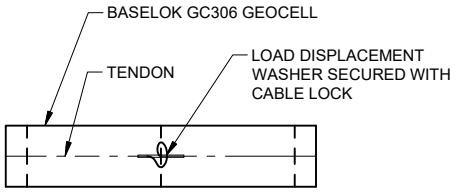
NOTES:

1. INSTALLATION SHALL BE PER PROJECT SPECIFICATIONS.
2. GEOTEXTILE SHALL BE PER ENGINEER OF RECORD AND PROJECT SPECIFICATIONS.
3. ANCHORING REQUIREMENTS SHALL BE PER ENGINEER OF RECORD AND PROJECT SPECIFICATIONS.



BASELOK GEOCELL SLOPE PROTECTION

(LOAD DISPLACEMENT WASHER)



DETAIL "1"

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510 O'Neal Ln Ext, Baton Rouge, LA 70819
fiberal.ok.com
1-800-949-3500

BASELOK GEOCELL SLOPE PROTECTION
TENDON WITH LOAD DISPLACEMENT WASHER SYSTEM

BASELOK GEOCELL SLOPE
DETAIL

SCALE: NONE	DRAWN BY:
DATE: JULY 2022	DESIGNED BY:
JOB NO.	SHEET NO. 31

BASELOK®
by Industrial Fabrics, Inc.

GEOCELL | GC30T

GC30T standard sections are manufactured from 58 strips of HDPE, resulting in a section length of 29 cells and 17 cells wide. Each strip is the appropriate width and 300 inches (7.62m) in length. Weld spacing is 17.5 in ± 0.12 in. (445 ± 3mm). Cell density is 21.7 cells per meter squared. Cell walls are textured and if perforations are required 13% ± 3% of the cell wall is removed. Polyethylene strip shall be textured and with a multitude of rhomboidal (diamond shape) indentations. The rhomboidal indentations shall have a surface density of 22 to 31 per cm^2 (140 to 200 per in^2).

Color: **Standard strips are black.** (*Tan, Green, other colors with no heavy metal content available upon request)*
Stabilizer: Hindered amine light stabilizer (HALS) 2.0% by weight of carrier

MATERIAL PROPERTIES

Description	Test Method	Units	Test Value
> Polymer Density	ASTM D1505	lb/ft^3 (g/cm^3)	**58.4-60.2** (0.935-0.965)
> Environmental Stress Crack Resistance	ASTM D5397	hours	>400
	ASTM D1693	hours	6,000
> Carbon Black Content	ASTM D1603	% by weight	1.5% - 2.0%
> Nominal Sheet Thickness before texturing	ASTM D5199	mil (mm)	**50** (1.27) -5%, +10%
> Nominal Sheet Thickness after texturing	ASTM D5199	mil (mm)	**60** (1.52) -5%, +10
> Resistance to Oxidation[2]	EN ISO 13438	years	≥50
> Resistance to Weathering[3]	EN 12224	%	100

PHYSICAL PROPERTIES

Description	Unit	Test Value
> Nominal - Expanded Cell Size (width x length)	in (mm)	**12.6** (320) x **11.3** (287)
> Nominal - Expanded Cell Area	in^2 (cm^2)	**71.3** (460)
> Nominal - Expanded Panel Size (width x length)	ft (m)	**17.85** (5.44) x **27.4** (8.35)
> Nominal - Expanded Panel Area	ft^2 (m^2)	**489** (45.4)
> Internal Junction Efficiency[1]	%	≥100
> Mechanical Junction Efficiency[1]	%	≥100
> Peak Friction Angle Ration (δ/Ø) granular material	unitless	0.95

> Cell Depth	in (mm)	**2** (50)	**3** (75)	**4** (100)	**6** (150)	**8** (200)
> Minimum Seam Peel Strength	lbf (N)	**160** (710)	**240** (1065)	**320** (1420)	**480** (2130)	**640** (2840)
> Minimum Seam Hang Strength	A 4 in (102mm) weld joint supporting a load of 160 lbs (72.5 kg) for 30 days minimum or a 4 in (102mm) weld joint supporting a load of 160 lbs (72.5 kg) for 7 days minimum while undergoing temperature change from 74˚F (23˚C) to 130˚F (54˚C) on a 1 hour cycle.					

Notes:
1) Value is a percentage of junction performance (EN ISO 13426-1) to perforated strip performance (EN ISO 10319).
2) Predicted to be durable for a minimum of 50 years in natural soil with a pH between 4 and 9 and at a soil temperature < 25˚C.
3) 100% of original tensile strength retained following exposure to intense UV radiation and accelerated weathering in accordance with EN 12224.

INDUSTRIAL FABRICS, INC.

Industrial Fabrics, Inc.
510 O'Neal Lane Ext
Baton Rouge LA 70819
800 848 4500
www.baselok.com

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BASELOK™

5,100 lbs. (23.2 kN) POLYESTER WOVEN TENDON SPEC SHEET

Physical Properties	Units	Min	Max.
Warp			
Breaking Strength	LBS.	5,100	N/A
Elongation at Break	%	9.0	15.0
Fill			
Breaking Strength	LBS.	240	N/A
Elongation at Break	%	9.0	15.0
General			
Weight	LBS./Ft.	.029	N/A
Width	Inches	.050	.070
Weave	Plain	N/A	N/A
Length	LF		835
Conditioning Treatment	CS Heat Set	N/A	N/A
Color Treatment	CS Orange	N/A	N/A

Description	Warp	Fill
Fiber	Filament	Filament
Type	Polyester	Polyester
Construction	Plain Weave	N/A

Customer should verify with the product manufacturer that customer has the most current BASELOK™ GEOCELL specifications for the product ordered or purchased. The BASELOK™ GEOCELL system can be used in the application described in our literature and on our website, provided proper installation and engineering principles are followed. Professional engineering should be consulted before installation of BASELOK™ GEOCELL units to assure appropriate design and use. ALL EXPRESSED OR IMPLIED WARRANTIES, INCLUDING THOSE OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. BASELOK™ is a trademark of Industrial Fabrics, Inc.

TND 5100 Rev. 08 29 2023

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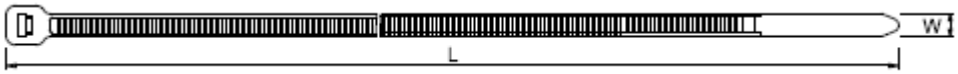
CONSTRUCTION PRODUCTS & ENGINEERING SOLUTIONS

BASELOK™

19’’ Cable Lock 310 lb Strength



General	
Description	19” Standard Nylon Cable Lock
Dimensional	
Length (in/mm)	18.90 (L) / 480 (L)
Width (in/mm)	0.50 (W) / 12.6 (W)
Approvals / Certifications	
UL 94V-2 Rated	Yes
ROHS Compatible	Compliant
UV Rated	Black Only
Physical	
Max. Bundle Dia. (in/mm)	4.72in / 120mm
Color	Black UV
Product Material	Polyamide Nylon 6/6
Mechanical	
Min. Tensile Strength (Lbs.)	310

OUTDOOR APPLICATIONS UV Stabilized Nylon 6/6 is used in continuous or extended exposure to outdoor use. The nylon cable tie is a weather resistant grade, enduring additional ultraviolet (UV) light. This grade is produced by incorporating stabilizers in the nylon resin. UV Stabilized Nylon cable ties are available only in black. Its working temperature range is from -40°F to 185°F.

MATERIAL	CONTINUOUS OPERATING TEMPERATURE		TENSILE STRENGTH AT 73° F DRY AS MOLDED ASTM-D-638 (psi)	UL FLAME RATING	OXYGEN INDEX %	GAMMA RADIATION RESISTANCE	UV RESISTANCE	MILITARY, FEDERAL AND ASTM SPECIFICATIONS
	MAX.	MIN.						
Nylon 6/6- UV Stabilized	185°F 85°C	-40°F -40°C	12,000	94V-2	NA	1 x 10'RADS	Very Good	ASTM-D4066 PA181

Customer should verify with the product manufacturer that customer has the most current **BASELOK™ GEOCELL** specifications for the product ordered or purchased. The **BASELOK™ GEOCELL** system can be used in the application described in our literature and on our website, provided proper installation and engineering principles are followed. Professional engineering should be consulted before installation of **BASELOK™ GEOCELL** units to assure appropriate design and use. ALL EXPRESSED OR IMPLIED WARRANTIES, INCLUDING THOSE OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. **BASELOK™** is a trademark of Industrial Fabrics, Inc.

CBL 310S Rev. 03 22 2021

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INSTALLATION PROCEDURES - SLOPE REINFORCEMENT

1| Consult with design engineer to determine specific anchoring method.

2| Stakes are typically used on slope less than or equal to 3H:1V. Tendon systems or twist anchors are usually used on slopes steeper than 3H:1V.

3| Installation can typically be carried out with five (5) laborers and one (1) supervisor.

4| Create a smooth and unvarying surface before application of the GeoCell. Some applications might require a non-woven fabric based on project parameters.

5| Panels are joined with a pneumatic stapler and galvanized staples or with our one-piece BaseLok™ Cable Locks.

6| Panels will need to be either precut or joined depending on the length of the slope. Prepare precut or pre-connect panels at the top of the slope.

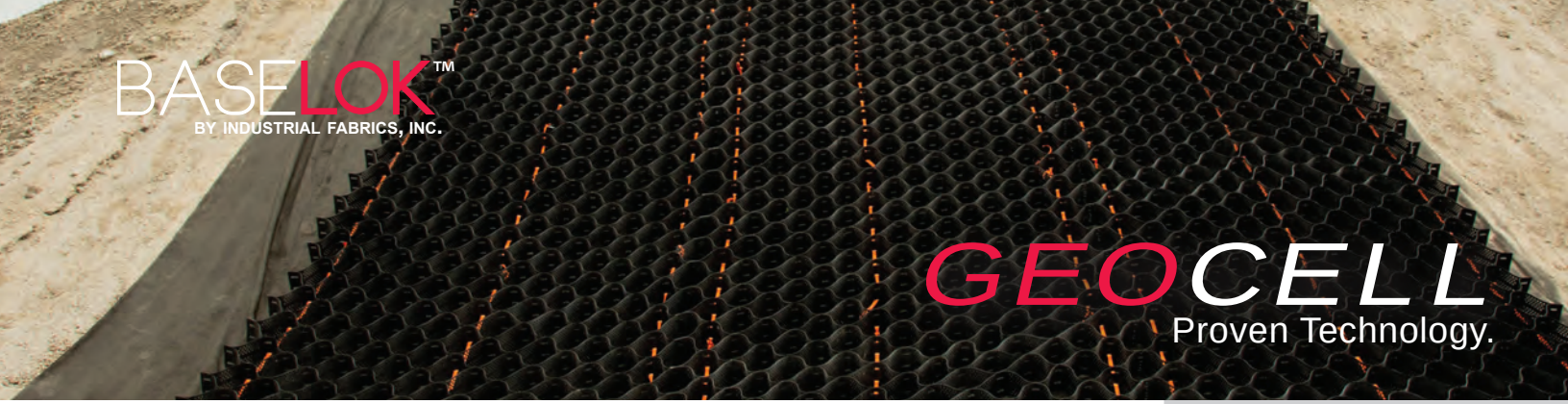
7| If the project design requires tendons, feed the tendons through the collapsed panel and attach one end to the dead man anchor in the anchor trench. Pull the tendons down the slope to the toe of the slope.

8| Place a minimum of one cell inside the anchor trench and stake every other cell inside the anchor trench. Stretch the panel(s) down the slope and stake every other cell at the bottom.

9| With the tendons through the panel, tie the tendon to the cell wall or to a load displacement washer every 3-6 cells depending on project requirement. Pre-threaded panels that are already tied to load displacement washers can also be purchased.

10| Proceed joining and expanding adjacent panels.

11| Backfill the anchor trench each day after the day's final panel is secured. Panels can be filled once the anchor trench is thoroughly backfilled. When filling the cells, work from the top down. Do not drop fill material more than 3' (1 m) from GeoCell panel.



Slope

INTRODUCTION

GeoCells were invented in the early 80's and patented by the United States Army Corps of Engineers to stabilized soft soils and construct roads for heavy load applications. Since their inception they are now used for various civil applications such as slope and channel protection and retaining walls.

On slope applications the BaseLok™ GeoCells can be filled with angular rock, concrete or with soil and vegetated, angular rock or concrete. The GeoCells confine the infill material creating a stable layer protecting the slope or channel from sheet flow. The GeoCells can be installed on slopes as steep as 60 degrees and on channels with flow velocities greater than 25 fps depending on infill material. BaseLok™ GeoCells is a flexible system that will contour to the sub-grade of a slope or channel reducing preparation time. When filled with soil and vegetated or rock the system is permeable reducing water runoff.

The BaseLok™ Geocell is the perfect system to protect impervious and fragile geomembrane liners. It can be installed directly over the liner without the use of stakes and filled with concrete for impact and puncture protection or filled with soil and APPLICATIONS vegetated to create a natural landscape.

APPLICATIONS

- **Slopes/ Embankments**
- **Pond Slopes**
- **Containment Berms**
- **Geomembrane Protection**
- **Shoreline Protection**
- **Landfill Caps**
- **Complete design review.**
- **On site installation assistance.**

KEYPOINTS

- **Complete design review.**
- **On site installation assistance.**
- **Value engineered designs that are project specific and reviewed by experienced professional geotechnical engineers.**
- **Construction possible on slopes greater than 1:1.**
- **On channel applications our GeoCells can be filled with rock for velocities up to 10 fps, vegetated soil up to 20 fps and concrete for velocities greater that 20 fps.**
- **For shore protection the GeoCell allows for the use of a smaller aggregate vs costly rip rap.**
- **On a concrete application the individual blocks become a flexible system that can conform to sub-grade settlement.**

TEAM SUPPORT

- 39 years as a leader in the Geosynthetic Industry
- 25 years of experience with geocells
- Design assistance
- Complete project evaluation
- Project specific value engineered designs reviewed by professional geotechnical engineers
- On site installation and site assessment assistance

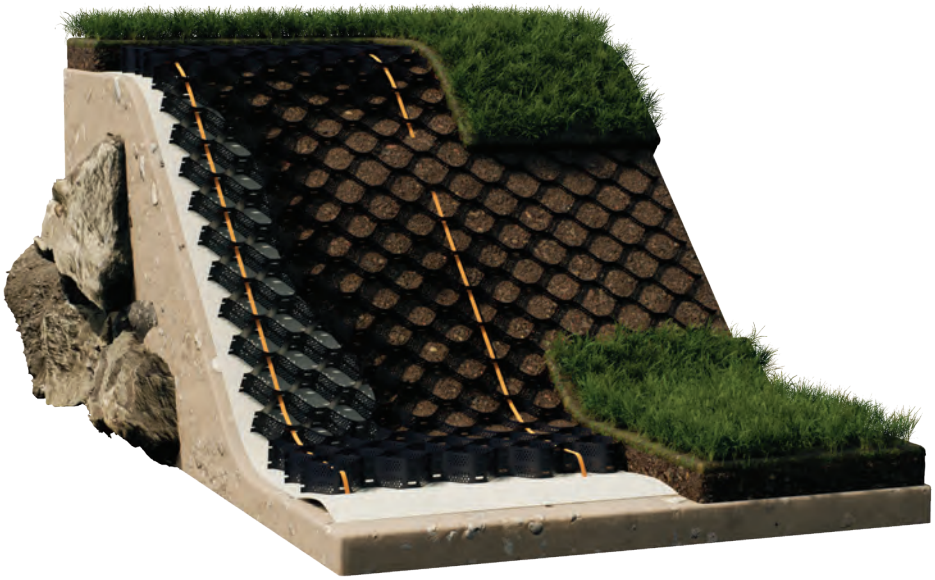
BENEFITS

- 100% manufactured in the USA
- Complete installation accessories
- Meets or exceeds industry standards

> **BaseLok™ GeoCell is a confinement system that can be used on slopes creating a stabilized and permeable layer. We offer an engineered system complete with anchoring components.**

CUSTOMIZATION

- BaseLok™ GeoCell panels can be manufactured to cover the length of the slope or width of the channel to be protected. Evaluation of the soil conditions and geometry of the slope or channel will determine appropriate cell depth for the application as well as anchoring requirements. BaseLok™ GeoCell can be manufactured with depths of 3", 4", 6", or 8" to meet specific project needs.



EXPERT TECHNICAL SUPPORT

- The superior effectiveness of GeoCell is made even better thanks to our BaseLok™ team's proficiency and technical support. We believe a solution is more than just a product we manufacture or sell; you deserve an attentive and knowledgeable team of professionals working alongside you every step of the way. Our experienced engineers and sales team are fully equipped to cater to your every need, no matter the project.

INDUSTRIAL FABRICS, INC.

Industrial Fabrics, Inc.
510 O'Neal Lane Ext
Baton Rouge LA 70819
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www.baselok.com

BASELOK™ GEOCELL may change product specifications without notice. The **BASELOK™ GEOCELL** system is suitable for use in the application described in our literature and on our website, provided proper installation and engineering principles are followed. Professional engineering should be consulted before installation of **BASELOK™ GEOCELL** units to assure proper design. ALL EXPRESSED OR IMPLIED WARRANTIES, INCLUDING THOSE OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. **BASELOK™** is a trademark of Industrial Fabrics, Inc.

INDUSTRIAL FABRICS, INC.

GeoCell

Limited Material Warranty

Industrial Fabrics, Inc. provides a limited warranty that each BaseLok™ GeoCell cellular section will be free from defects in materials and workmanship at the time of manufacture and for a period of ten years of normal use. This Limited Warranty does not include damages or defects to the GeoCell unrelated to the manufacturing process; caused by or resulting from misuse; misapplication; negligence; improper storage, installation, or application; Acts of God or force majeure; improper design; alteration of the products; or any other cause out of the control of Industrial Fabrics, Inc. Industrial Fabrics, Inc.'s exclusive liability under this warranty will be to furnish without charge at the original FOB point a replacement for any section that Industrial Fabrics, Inc. inspects and determines to be defective under normal use and service from a cause not excluded by this Limited Warranty during the 10-year period. If after inspection, Industrial Fabrics, Inc. determines that there is no defect in material or workmanship, customer shall pay the costs of inspection. The ten-year period for the purpose of this Limited Warranty begins on the date of shipment from Industrial Fabrics, Inc. This Limited Warranty is not assignable or transferrable and is not intended to be for the benefit of third parties.

INDUSTRIAL FABRICS, INC. MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, WRITTEN OR ORAL, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE, IN CONNECTION WITH THE GEOCELL SYSTEM. IN NO EVENT SHALL INDUSTRIAL FABRICS, INC. BE LIABLE FOR ANY DAMAGES TO PROPERTY, OR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR THE BREACH OF ANY EXPRESS OR IMPLIED WARRANTY OR FOR ANY OTHER REASONS, INCLUDING NEGLIGENCE, ARISING OUT OF THE USE OR IN CONNECTION WITH THE USE OF THE GEOCELL SYSTEM.

Any claim for breach of warranty must be made in writing by certified mail to the Authorized Agent of Industrial Fabrics, Inc. within (7) days of customer becoming aware of the alleged defect. Failure to provide written notification timely and within the 10-year warranty period shall be deemed to be a waiver of any rights to enforce any warranties and claims for defects against Industrial Fabrics, Inc. Industrial Fabrics, Inc. shall not be liable for costs and attorney's fees associated with any claims made against Industrial Fabrics, Inc. arising out of or related to this Limited Warranty, defects in GeoCell, or the sale, purchase, or use of GeoCell.

Industrial Fabrics, Inc.
510 O'Neal Lane Ext.
Baton Rouge, LA 70819

MANAGEMENT SYSTEM CERTIFICATE

Certificate no.:
C558800

Initial certification date:
11 October, 2022

Valid:
11 October, 2022 – 10 October, 2025

This is to certify that the management system of

Industrial Fabrics, Inc.

5102 Galveston Road, Houston, TX, 77017, USA

has been found to conform to the Quality Management System standard:

ISO 9001:2015

This certificate is valid for the following scope:

Manufacturing of erosion control, surface reinforcement, pipeline protection mesh products and cellular confinement systems for the civil and pipeline construction industries.

Place and date:
Katy, TX, 11 October, 2022

For the issuing office:
DNV - Business Assurance
1400 Ravello Drive, Katy, TX, 77449-5164, USA

Sherif Mekkawy
Management Representative

Lack of fulfilment of conditions as set out in the Certification Agreement may render this Certificate invalid.

ACCREDITED UNIT: DNV Business Assurance USA Inc., 1400 Ravello Drive, Katy, TX, 77449, USA - TEL: +1 281-396-1000. www.dnv.com

BASELOK® by Industrial Fabrics, Inc.

INDUSTRIAL FABRICS, INC.
CONSTRUCTION PRODUCTS & ENGINEERING SOLUTIONS

Official Build America Buy America Act Certificate

ATTENTION: All Interested Parties

SUBJECT: U.S.A. Manufacturing

All BaseLok® products are manufactured in the United States. The raw materials used to produce our products are manufactured and procured in the United States at various facilities. All BaseLok® products meet all provisions of the Build America Buy American Act enacted on November 15, 2021.

If you have any questions or need any further information please do not hesitate to contact me.

Thank you,

Robert Chalmers

Robert Chalmers, BEng, MBA
Chief Operating Officer
832 671 9659
rchalmers@ind-fab.com

Industrial Fabrics, Inc.
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**For an updated manufacturer compliance status throughout the audit cycle, SCAN the code with your mobile device.

AASHTO PRODUCT EVALUATION & AUDIT SOLUTIONS
DATAMINE
COMPLIANT

COMPLIANCE AUTHENTICATION

AASHTO

This authenticates:

Industrial Fabrics, Houston, TX, US

successfully complies with the AASHTO Product Evaluation & Audit Solutions

Subgrade Stabilization Geosynthetics

Work Plan

October 2023
Date of Administration

December 31, 2024
Date of Expiration

Jim Tymon
AASHTO Executive Director

CAT
CAT

APPENDIX G
Site and Rock Core Photographs

Photograph 1 – Briar Creek Rd: Boring Location 599-A

Photograph 2 – Photograph – Briar Creek: Boring Location 599-B

Photograph 3 – Briar Creek: Boring Location 633-A

Photograph 4 – Flatwoods: Boring Location 659-A

Photograph 5 – Flatwoods: Boring Location 659-B

Photograph 6 – Flatwoods: Boring Location 660-A

Photograph 7 – Flatwoods: Boring Location 660-B

Photograph 8 – Flatwoods: Boring Location 660-C

Photograph 9 – Paint Mtn: Boring Location 590-A

Photograph 9 – Paint Mtn: Boring Location 590-B

Photograph 1 – Briar Creek Rd: Boring Location 599-A

Photograph 2 – Photograph – Briar Creek: Boring Location 599-B

Photograph 3 – Briar Creek: Boring Location 633-A

Photograph 4 – Flatwoods: Boring Location 659-A

Photograph 5 – Flatwoods: Boring Location 659-B

Photograph 6 – Flatwoods: Boring Location 660-A

Photograph 7 – Flatwoods: Boring Location 660-B

Photograph 8 – Flatwoods: Boring Location 660-C

Photograph 9 – Paint Mtn: Boring Location 590-A

Photograph 9 – Paint Mtn: Boring Location 590-B