Retaining Wall
Subsurface Information

U-4756

Cumberland Co.

C201461

April 23, 2008

Mr. Kevin Austin, P.E.
Mulkey Engineers and Consultants
6750 Tryon Road
Cary, NC 27511

Re: Geotechnical Subsurface Exploration Report Addendum
Retaining Walls along Morganton Road
Cumberland County, NC
Tierra Project No.: 6211-07-018

Dear Mr. Austin:

As requested, Tierra North Carolina Inc. (Tierra) has performed additional geotechnical test borings for the proposed retaining walls at the above referenced site and prepared the following addendum to our original report (Tierra Project No. 6211-07-018, dated May 1, 2007). These additional services were performed in general accordance with our proposal (Tierra Proposal No. TR-07-017a, dated August 17, 2007). The following addendum presents field exploration and laboratory testing results, and the results of our analysis for the proposed retaining structures.

Project Description

Based upon our review of the plans provided by Mulkey Engineers and Consultants (Mulkey), dated April 2008, we understand the proposed project will consist of constructing 2:1 (horizontal to vertical) or flatter embankment slopes and three retaining walls associated with the roadway widening along Morganton Road between Glensford Drive and Sycamore Dairy Road in Fayetteville, North Carolina. Details of the project are provided below.

- Retaining Wall No. 1 (RW1): located between Stations 36+20 and 39+09 –L-, at offsets of approximately 75 to 100 feet left. The wall heights range from approximately 4 to 6 feet with 2:1 slopes above the wall, resulting in up to 18 feet of retained fill. A soldier pile and lagging wall system will be utilized for RW1.
- Retaining Wall No. 2 (RW2): located between Stations 49+59 and 54+45 -L-, at offsets of approximately 60 to 100 feet left. The wall heights range from approximately 4 to 8 feet with 2:1 slopes or flatter above the wall, resulting in up to 16 feet of retained fill. A soldier pile and lagging wall system will be utilized for RW2. The wall crosses over an elliptical 95-inch diameter RCP near Station 53+37 -L-.
- Retaining Wall No. 3 (RW3): located between Stations 50+60 and 54+65 -L-, at an offset of approximately 75 feet right. The wall heights range from approximately 3 feet to 10 feet with 2:1 slopes above the wall, resulting in up to 14 feet of retained fill. A soldier pile and lagging wall system will be utilized.
- Embankment Slopes: 2:1 or flatter slope construction is anticipated between Stations 34+50 and 55+50 -L-, on both sides of the roadway, except in the proposed retaining wall (RW1 through

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RW3) locations and the bridge structure. The slopes will tie into the existing embankment and have heights ranging from approximately 1 to 29 feet.

Subsurface Conditions

A total of fifteen (15) standard penetration test (SPT) borings (B-1 through B-15) were drilled near the proposed retaining structures and embankment slopes and extended to depths ranging from 15 to 50 feet below existing ground surface. The SPT Borings were advanced using a CME 45B track mounted drill rig with a manual hammer and mud rotary drilling techniques. Boring locations were established in the field by a qualified staff professional in accordance with the plans provided by Mulkey (refer to the attached Boring Location Plan). Ground surface elevations for the borings were estimated from the site topographic map provided by Mulkey.

In general, the soils beneath the proposed slopes and retaining structures consist of artificial fills underlain by coastal plain materials. Artificial fills were encountered at the ground surface and consist of approximately 3 to 12 feet of loose to very dense silty sand and medium stiff to hard sandy clay (A-2-4, A-6, and A-7-6). Coastal plain materials were encountered underneath artificial fills and extended to the boring termination depths, consisting of very loose to very dense sands and medium stiff to hard clays (A-2-4, A-2-6, A-3, A-6, and A-7).

The subsurface soil stratification is generalized to highlight major subsurface stratification features and material classifications. Specific details concerning subsurface conditions and materials encountered at each test location may be obtained from the soil test boring logs and cross sections in the attachments. The depths of strata indicated in the boring logs represent approximate boundaries between soil types of significantly different engineering properties; however, the actual transition may be gradual.

Groundwater Conditions

Groundwater measurements were obtained at the boring locations using a weighted 100-foot tape from a reference location at the top of each boring. Measurements were recorded immediately after boring completion and after a 24-hour waiting period at some locations. Groundwater was encountered at depths ranging from approximately 1 to 9 feet below ground surface immediately following boring completion and at some locations at depths of approximately 10 to 16 feet after a 24-hour period following drilling. However, it should be noted that due to mud rotary drilling techniques, during which water and bentonite are added to the borehole while drilling, the above water levels may not represent stabilized groundwater conditions.

Laboratory Testing

Representative split-spoon samples were selected from soil test borings to verify visual field classification and determine soil index properties. All testing was performed in general accordance with AASHTO, NCDOT and ASTM Standards. A total of seven (7) samples were analyzed in our laboratory for Atterberg limits, grain size analysis, and natural moisture content determination. The results of these tests are summarized in Table 1 in the Attachments. The test results indicate that the samples tested had AASHTO classifications ranging from A-2-6 to A-7-6, liquid limits ranging from non-plastic to 92 and plasticity indices ranging from non-plastic to 71. In addition, the samples had moisture contents ranging from 10 to 53 percent.

Embankment Slope Construction

Based upon the plans provided, it is our understanding that embankment slope construction is proposed with slopes of 2:1 or flatter. Based upon our field exploration, and our previous experience on similar projects we anticipate that 2:1 or flatter slope construction will be suitable for the project. Embankment construction shall be performed in accordance with NCDOT Specifications

In addition, construction of new fills on existing embankment slopes will need to include benching into the existing slopes in accordance with NCDOT Specifications to reduce the potential for creating a weak plane at the interface of the new fills and the existing soils. The proposed construction sequencing for the fill slope should include fill placement from the bottom to top of the existing slopes. Finished slopes shall be properly seeded or vegetated and maintained in accordance with NCDOT Specifications to reduce the potential for erosion.

A drainage system to improve the internal and external drainage of the new fill slope may also be installed. An underdrain may be constructed at the back of the lowest compaction bench and graded to remove water away from the new fill. The drain should consist of a 4-inch diameter perforated pipe and be construction in accordance with NCDOT Specifications. The drainage system should slope to allow for gravity drainage and tie into a collection system or outfall to direct water away from the slope.

Retaining Wall Analysis

As discussed above, three retaining structures (RW1, RW2 and RW3) will be constructed at the site using a soldier pile and lagging wall system. The retaining walls were analyzed using the following soil parameters:

TABLE 2: RETAINING WALL SOIL PARAMETERS

Soil Type	Approximate Soil Unit Weight (pcf)		Effective Soil Angle of Internal Friction (degrees)	Effective Cohesion (psf)	Equivalent Active Fluid Pressure (pcf)	
	γ_{sat}	$\gamma_{effective}$			Level Backfill	Sloping Backfill
Existing/Proposed Embankment Fill	120	57.6	30	0	43	58
Coastal Plain Soil	120	57.6	30	0	43	58

To account for groundwater fluctuations in the coastal plain, groundwater levels were assumed to be at the ground surface at the base of the retaining wall. However, the active fluid pressure values assume that the backfill behind the retained portion of the wall is fully drained and that hydrostatic pressure does not develop.

The intent of the soldier beam and lagging wall is to provide continuous support for the new embankment fill, as construction proceeds. The wall is constructed by drilling shafts and embedding steel piles in the shafts. Precast concrete lagging is inserted between the beams to retain the soil.

Presented below in Table 3 is a summary of the proposed wall locations and associated design criteria. The pile embedments and spacings provided below are based upon a factor of safety of 1.5 using AASHTO design procedures. Sample calculations for the design are provided in the Attachments.

TABLE 3: SOLDIER PILE AND LAGGING WALL SUMMARY

Wall No.	Station	Max. Exposed Wall Height (ft)	Preliminary Minimum Pile Size[1]	Drilled Pile Diameter (ft)	Pile Spacing (ft)	Drilled Pile Embedment Depth[2] (ft)	Deflection (in)	Max. Moment (kip-ft)
1	36+20 ~ 39+09 -L-	6	HP 12x53	2	10	22	0.3	125
2	49+60 ~ 54+45 -L-	8	HP 12x53	2	10	23	0.5	180
2	95" RCP (53+29 ~ 53+45 -L-)	10	W 30x99	3	16	35	0.4	360
3	50+60 ~ 53+50 -L-	10	HP 14x73	2	8	30	0.5	290
3	53+50 ~ 54+00 -L-	8	HP 12x53	2	10	23	0.5	180
3	54+00 ~ 54+65 -L-	6	HP 12x53	2	10	22	0.3	125

(1) Preliminary pile size estimated from Geotechnical Analysis. Final pile size to be determined by structural engineer.
(2) Depth is below the finished grade in front of the wall.

When drilling shafts, a temporary casing, which is removed when concrete is placed, should be utilized to prevent collapse of the overburden and infiltration of the groundwater in accordance with NCDOT Specifications. Drilled shaft construction techniques shall conform to NCDOT Specifications.

The soldier beam wall should be designed to provide drainage behind the wall, consisting of a minimum 1-foot wide free-draining granular backfill zone and weep holes through the wall. Alternatively, the installation of a prefabricated drainage composite behind the wall may be used. In addition, any voids between the wall and slope should be backfilled with gravel. Weep pipes should be placed through the wall at the lowest elevation that will allow gravity drainage.

General Retaining Wall Considerations

It is important that the retaining wall designs and construction conform to the specifications provided by NCDOT and AASHTO. The existing soils shall be cut back beyond the base of the foundation at a slope of 1H:1V or flatter as required by OSHA, and backfilled with compacted select material.

Hand guided compaction equipment should be used within 5 feet of the wall. In addition, the precast concrete panels should be monitored during backfilling to verify that the construction operations are not damaging the panels. Site grades should be designed to provide positive surface drainage away from the proposed structures.

Tierra should be provided the opportunity to review the parameters used in designing the retaining wall to ensure that they are consistent with our report. In addition, the wall foundations should be evaluated by NCDOT or a geotechnical engineer to confirm the design.

If you have any questions concerning the contents of this addendum or need additional information, please do not hesitate to contact our office.

Sincerely,
TIERRA

Pu (Paul) Zhang, Ph.D., P.E.
Geotechnical Engineer

Gabriel W. Lang, P.E.
Sr. Geotechnical Engineer/ Manager

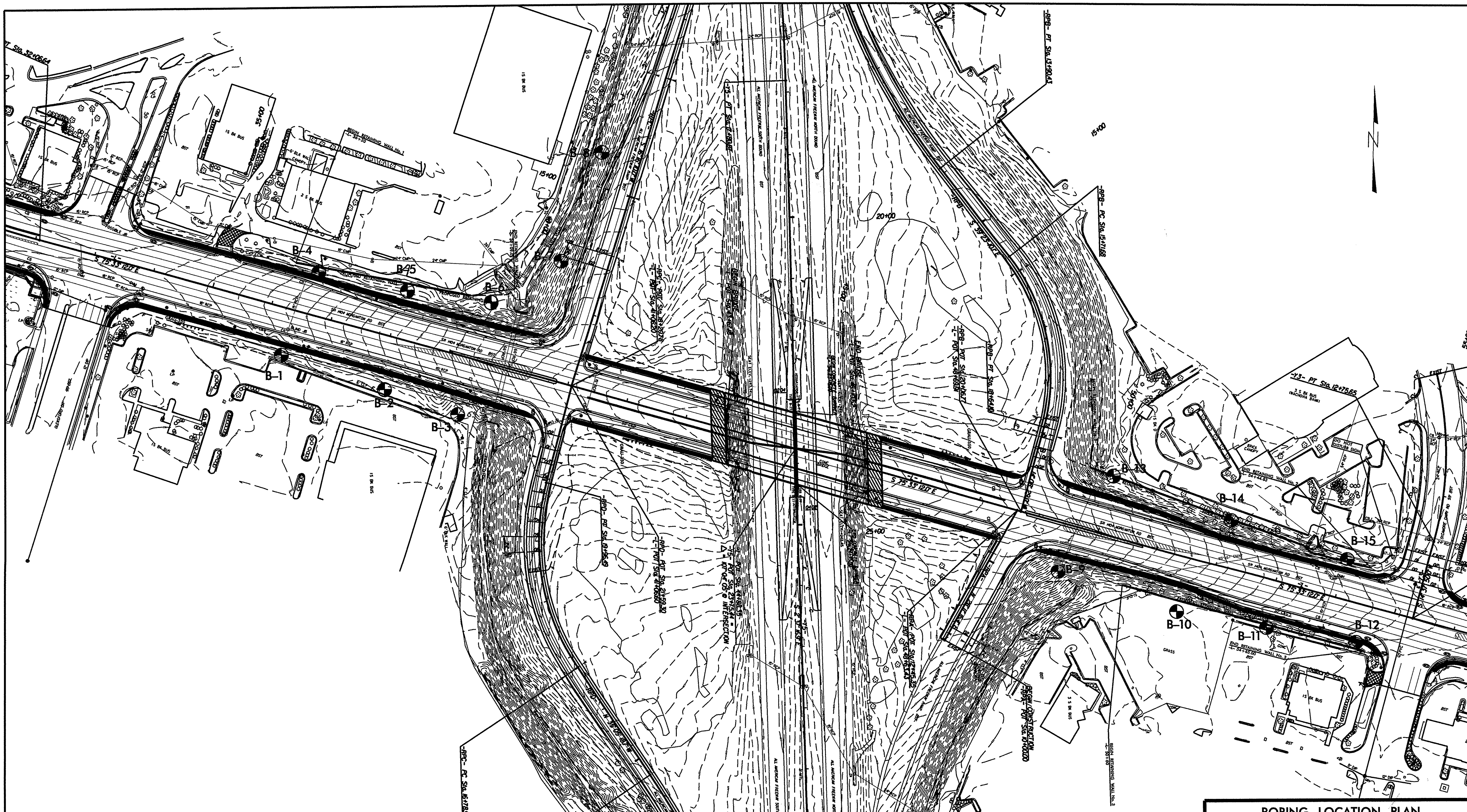
NORTH CAROLINA PROFESSIONAL SEAL 31421 ENGINEER GABRIEL W. LANG

4-23-08

Attachments: Boring Location Plan
Subsurface Cross Sections (Sheets 1 through 3)
Boring Logs (B-1 through B-15)
Legend
Table 1: Summary of Classification Test Results
Sample Retaining Wall Calculations

ATTACHMENTS

- **BORING LOCATION PLAN**
- **SUBSURFACE CROSS SECTIONS (SHEETS 1 THROUGH 3)**
- **BORING LOGS (B-1 THROUGH B-15)**
- **LEGEND**
- **TABLE 1: SUMMARY OF CLASSIFICATION TEST RESULTS**
- **SAMPLE RETAINING WALL CALCULATIONS**



NOTES:

- APPROXIMATE SPT BORING LOCATION
- PLANS ADOPTED FROM FILES RECEIVED FROM MULKEY ENGINEERS & CONSULTANTS, DATED APRIL 2008.

0 150 300 FEET

BORING LOCATION PLAN

RETAINING WALLS ALONG MORGANTON ROAD
CUMBERLAND COUNTY, NORTH CAROLINA
TIERRA PROJECT NO.: 6211-07-018

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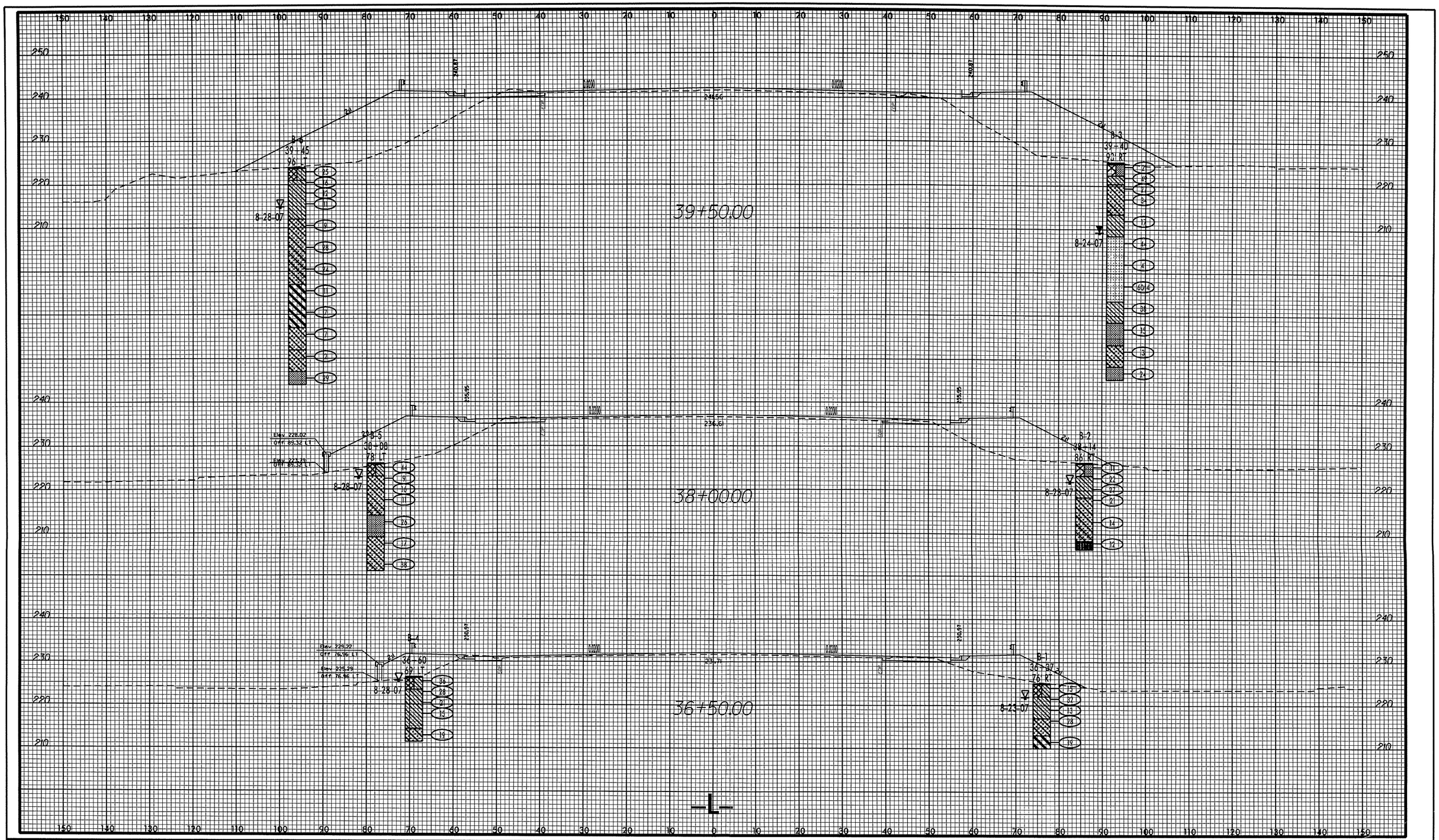

NOTES:

- PLANS ADOPTED FROM FILES RECEIVED FROM MULKEY ENGINEERS & CONSULTANTS, DATED APRIL 2008.

0 20 40

FEET

SUBSURFACE CROSS SECTION

SHEET 1 OF 3

RETAINING WALLS ALONG MORGANTON ROAD
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TIERRA PROJECT NO.: 6211-07-018

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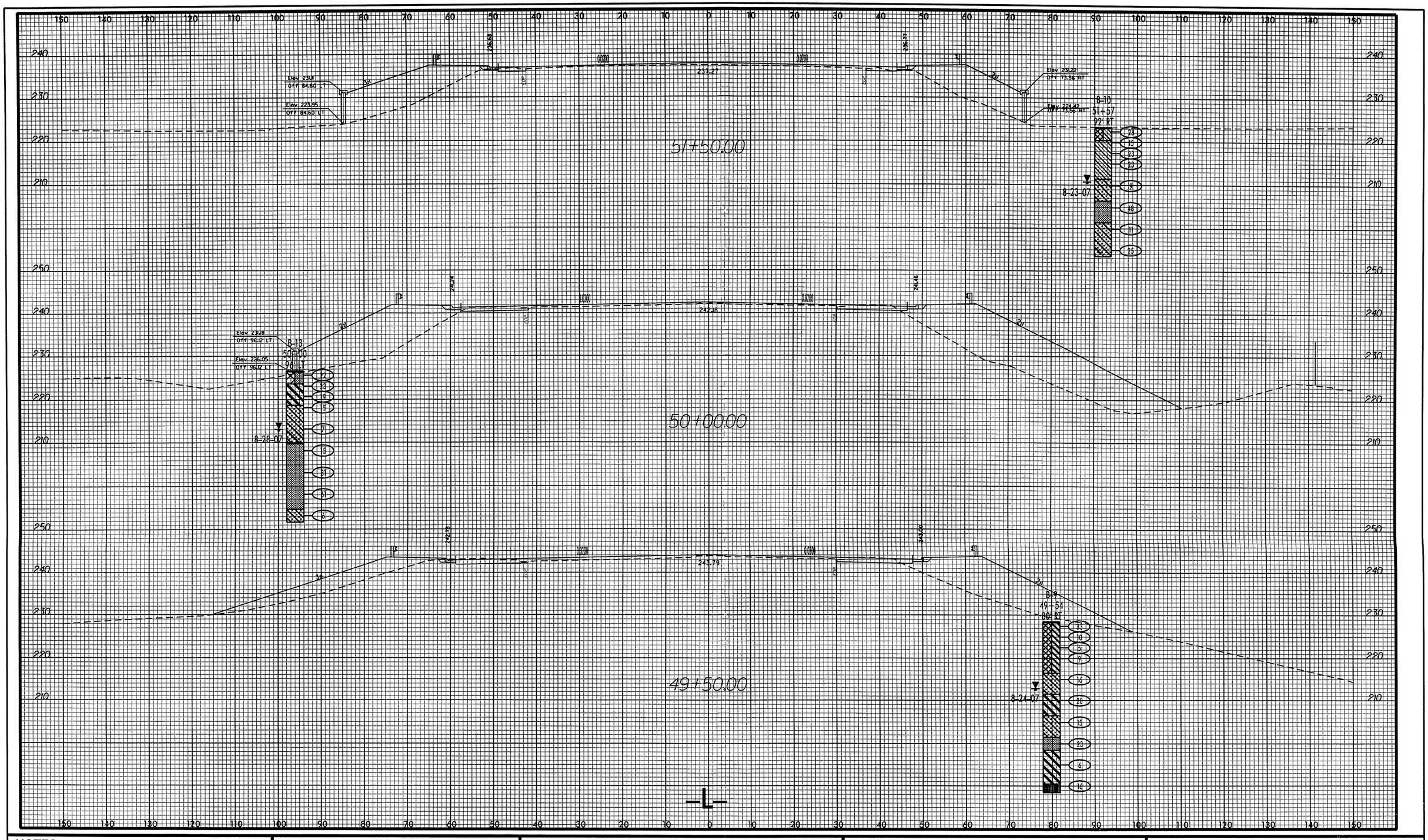

NOTES:

- PLANS ADOPTED FROM FILES RECEIVED FROM MULKEY ENGINEERS & CONSULTANTS, DATED APRIL 2008.

0 20 40

FEET

SUBSURFACE CROSS SECTION

SHEET 2 OF 3

RETAINING WALLS ALONG MORGANTON ROAD
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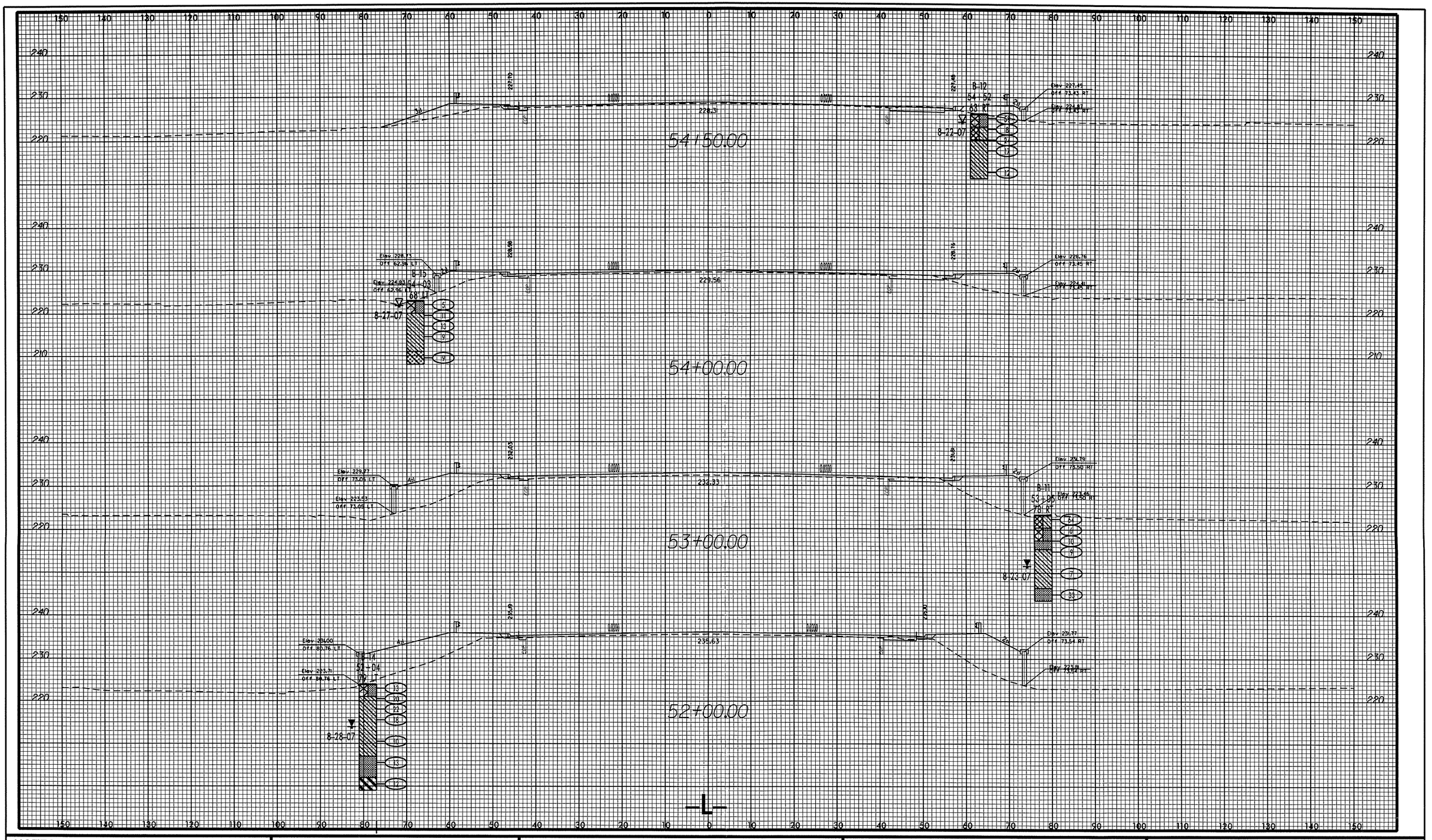

NOTES:

- PLANS ADOPTED FROM FILES RECEIVED FROM MULKEY ENGINEERS & CONSULTANTS, DATED APRIL 2008.

SUBSURFACE CROSS SECTION

SHEET 3 OF 3

RETAINING WALLS ALONG MORGANTON ROAD
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N.C.D.O.T. GEOTECHNICAL UNIT
BORING LOG

SHEET 1 OF 1

PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-1	**BORING LOCATION** 36+37	**OFFSET** 76' RT	**ALIGNMENT** -L-	**0 HR.** 3.2
COLLAR ELEV. 225 ft	**NORTHING** 479,948.5	**EASTING** 2,012,289.8		**24 HR.** CAVE @ 13.4
TOTAL DEPTH 15.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL	
DATE STARTED 8-23-07	**COMPLETED** 8-23-07	**SURFACE WATER DEPTH** N/A		

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
225.0					EXISTING GROUND				225.0 0.0
	1.0								224.8 ROOTMAT 0.2
		9	8	7	15	SS-1	10%		FILL: TAN, STIFF, SANDY CLAY (A-6)
	3.5								222.0 3.0
		9	13	19	32	SS-2	M		CP: TAN, GRAY AND REDDISH BROWN, V. STIFF TO STIFF, SANDY CLAY (A-6) WITH TRACE ORGANICS
220	6.0								
		5	11	2	13	SS-3	M		
	8.5								217.0 8.0
		9	14	14	28	SS-4	W		CP: TAN, MED. DENSE, CLAYEY SAND (A-2-6)
215									
	13.5								213.0 12.0
		6	6	13	19	SS-5	W		CP: GRAY AND PURPLE, V. STIFF, SANDY CLAY (A-7)
210									210.0 15.0
									BORING TERMINATED AT 15.0' BELOW EXISTING GROUND

NCDOT_BORE 07-018 RETAINING WALLS.GPJ NCDOT.GDT 9/9/07

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N.C.D.O.T. GEOTECHNICAL UNIT
BORING LOG

PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-2	**BORING LOCATION** 38+14	**OFFSET** 86' RT	**ALIGNMENT** -L-	**0 HR.** 4.4
COLLAR ELEV. 226.5 ft	**NORTHING** 479,894.6	**EASTING** 2,012,458.8		**24 HR.** CAVE @ 10
TOTAL DEPTH 20.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL	
DATE STARTED 8-23-07	**COMPLETED** 8-23-07	**SURFACE WATER DEPTH** N/A		

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
226.5					EXISTING GROUND				226.5 0.0
	1.0								226.3 ROOTMAT 0.2
225		8	4	7	11	SS-1	D		FILL: TAN AND GRAY, MED. DENSE, SILTY SAND (A-2-4)
	3.5								223.5 3.0
		9	10	12	22	SS-2	W		CP: TAN, GRAY AND REDDISH BROWN, V. STIFF, SANDY CLAY (A-6)
	6.0								
220		8	12	15	27	SS-3	M		
	8.5								218.5 8.0
		9	11	10	21	SS-4	M		CP: GRAY AND PURPLE, MED. DENSE, CLAYEY SAND (A-2-6)
215									
	13.5								
		5	6	8	14	SS-5	W		
210									
	18.5								208.5 18.0
		4	5	7	12	SS-6	W		CP: TAN AND WHITE, MED. DENSE, SLIGHTLY SILTY SAND (A-1-b)
									206.5 20.0
									BORING TERMINATED AT 20.0' BELOW EXISTING GROUND

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BORING LOG

SHEET 1 OF 1

PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-3	**BORING LOCATION** 39+40	**OFFSET** 93' RT	**ALIGNMENT** -L-	**0 HR.** 9.2
COLLAR ELEV. 225.5 ft	**NORTHING** 479,856.6	**EASTING** 2,012,578.7		**24 HR.** 16.2
TOTAL DEPTH 50.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL
DATE STARTED 8-23-07	**COMPLETED** 8-23-07	**SURFACE WATER DEPTH** N/A	

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
225.5					EXISTING GROUND				225.5 0.0
225	1.0								225.3 ROOTMAT 0.2
	3.5	6	7	14	21	SS-1	D		FILL: TAN AND GRAY, MED. DENSE, SILTY SAND (A-2-4)
		11	22	27	49	SS-2	W		222.5 3.0 CP: TAN AND REDDISH BROWN, HARD, SANDY CLAY (A-6) WITH ROOTS
220	6.0	9	11	16	27	SS-3	W		220.5 5.0 CP: TAN AND PURPLE, MED. DENSE TO DENSE, CLAYEY SAND (A-2-6)
	8.5	8	14	20	34	SS-4	W		
215									213.5 12.0 CP: GRAY AND PURPLE, V. STIFF, SANDY CLAY (A-6)
	13.5	7	8	9	17	SS-5	W		
210									208.5 17.0 CP: PURPLE, GRAY AND TAN, DENSE TO V. DENSE, SAND (A-3)
	18.5	17	19	25	44	SS-6	W		
205	23.5	28	24	17	41	SS-7	W		
200	28.5	60/.4			60/.4	SS-8	W		
195									193.5 32.0 CP: TAN, HARD, SANDY CLAY (A-6)
	33.5	18	23	15	38	SS-9	W		
190									188.5 37.0 CP: TAN AND GRAY, MED. DENSE, SILTY SAND (A-2-4)
	38.5	5	6	9	15	SS-10	W		
185									183.5 42.0 CP: DARK GRAY, V. LOOSE, CLAYEY SAND (A-2-6)
	43.5	2	1	2	3	SS-11	W		
180									178.5 47.0 CP: DARK GRAY, MED. DENSE, SILTY SAND (A-2-4)
	48.5	8	9	15	24	SS-12	W		175.5 50.0 BORING TERMINATED AT 50.0' BELOW EXISTING GROUND

NCDOT_BORE 07-018 RETAINING WALLS.GPJ NCDOT.GDT 9/9/07

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N.C.D.O.T. GEOTECHNICAL UNIT
BORING LOG

PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-4	**BORING LOCATION** 36+60	**OFFSET** 69' LT	**ALIGNMENT** -L-	**0 HR.** 0.9
COLLAR ELEV. 226.5 ft	**NORTHING** 480,083.8	**EASTING** 2,012,348.5		**24 HR.** BACKFILL
TOTAL DEPTH 15.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL	
DATE STARTED 8-28-07	**COMPLETED** 8-28-07	**SURFACE WATER DEPTH** N/A		

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
226.5					EXISTING GROUND				226.5 0.0
	1.0								226.3 ROOTMAT 0.2
225		15	17	19	36	SS-1	D		FILL: TAN, GRAY AND BROWN, HARD, SANDY CLAY (A-6) WITH ORGANICS
	3.5								223.5 3.0
		13	14	14	28	SS-2	M		CP: TAN AND GRAY, V. STIFF, SANDY CLAY (A-6)
	6.0								
220		8	9	12	21	SS-3	W		
	8.5								
		7	8	7	15	SS-4	W		
215									214.5 12.0
	13.5								CP: TAN AND GRAY, MED. DENSE, CLAYEY SAND (A-2-6)
		8	7	12	19	SS-5	W		211.5 15.0
									BORING TERMINATED AT 15.0' BELOW EXISTING GROUND

NCDOT_BORE 07-018 RETAINING WALLS.GPJ NCDOT.GDT 9/27/07

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N.C.D.O.T. GEOTECHNICAL UNIT
BORING LOG

SHEET 1 OF 1

PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-5	**BORING LOCATION** 38+08	**OFFSET** 78' LT **ALIGNMENT** -L-	**0 HR.** 3.2
COLLAR ELEV. 226 ft	**NORTHING** 480,055.6	**EASTING** 2,012,493.5	**24 HR.** BACKFILL
TOTAL DEPTH 25.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL
DATE STARTED 8-28-07	**COMPLETED** 8-28-07	**SURFACE WATER DEPTH** N/A	

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
226.0					EXISTING GROUND				226.0 0.0
225	1.0	14	19	25	44	SS-1	D		225.8 ROOTMAT 0.2 FILL: DARK GRAY, TAN AND RED, HARD, SANDY CLAY (A-6)
	3.5	3	3	6	9	SS-2	W		223.0 3.0 CP: TAN AND GRAY, LOOSE TO MED. DENSE, CLAYEY SAND (A-2-6)
220	6.0	5	7	9	16	SS-3	W		
	8.5	8	5	6	11	SS-4	W		
215	13.5	5	12	14	26	SS-5	W		214.0 12.0 CP: TAN AND GRAY, MED. DENSE, SILTY SAND (A-2-4)
210	18.5	8	12	5	17	SS-6	W		209.0 17.0 CP: PURPLE, TAN AND GRAY, MED. DENSE TO DENSE, CLAYEY SAND (A-2-6)
205	23.5	11	23	15	38	SS-7	W		201.0 25.0 BORING TERMINATED AT 25.0' BELOW EXISTING GROUND

NCDOT_BORE 07-018 RETAINING WALLS.GPJ NCDOT.GDT 9/27/07

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BORING LOG

SHEET 1 OF 1

PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-6	**BORING LOCATION** 39+45	**OFFSET** 96' LT	**ALIGNMENT** -L-	**0 HR.** 9.2
COLLAR ELEV. 224 ft	**NORTHING** 480,084.4	**EASTING** 2,012,642.3		**24 HR.** BACKFILL
TOTAL DEPTH 50.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL
DATE STARTED 8-28-07	**COMPLETED** 8-28-07	**SURFACE WATER DEPTH** N/A	

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
224.0					EXISTING GROUND				224.0 0.0
	1.0								223.8 ROOTMAT 0.2
		9	14	11	25	SS-1	D		FILL: DARK GRAY AND BROWN, V. STIFF, SANDY CLAY (A-6)
	3.5								221.0 3.0
220		6	7	9	16	SS-2	M		CP: BROWN AND TAN, V. STIFF TO STIFF, SANDY CLAY (A-6)
	6.0								
		3	4	8	12	SS-3	W		
	8.5								
215		5	4	7	11	SS-4	24%		
									212.0 12.0
	13.5								CP: LIGHT GRAY, LOOSE TO MED. DENSE, CLAYEY SAND (A-2-6)
210		4	4	5	9	SS-5	W		
	18.5								
205		4	10	18	28	SS-6	W		
	23.5								
200		8	12	12	24	SS-7	W		
	28.5								197.0 27.0
195		10	5	6	11	SS-8	W		CP: PURPLE, TAN AND GRAY, STIFF TO MED. STIFF, SANDY CLAY (A-7-6)
	33.5								
190		3	3	4	7	SS-9	53%		
									187.0 37.0
	38.5								CP: GRAY, LOOSE, CLAYEY SAND (A-2-6) WITH CLAY LENSES
185		3	3	4	7	SS-10	W		
	43.5								182.0 42.0
180		1	1	1	2	SS-11	W		CP: GRAY, V. LOOSE, CLAYEY SAND (A-2-6)
									177.0 47.0
	48.5								CP: DARK GRAY, MED. DENSE, SILTY SAND (A-2-4)
175		8	11	18	29	SS-12	W		174.0 50.0
									BORING TERMINATED AT 50.0' BELOW EXISTING GROUND

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PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-7	**BORING LOCATION** 16+32	**OFFSET** 76' RT	**ALIGNMENT** -RPC-	**0 HR.** 2.9
COLLAR ELEV. 227 ft	**NORTHING** 480,107.8	**EASTING** 2,012,742.8		**24 HR.** CAVE @ 6
TOTAL DEPTH 15.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL
DATE STARTED 8-27-07	**COMPLETED** 8-27-07	**SURFACE WATER DEPTH** N/A	

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
227.0					EXISTING GROUND				227.0 0.0
	1.0								226.8 ROOTMAT 0.2
225		8	13	13	26	SS-1	D		FILL: BROWN AND DARK GRAY, MED. DENSE, SILTY SAND (A-2-4)
	3.5								224.0 3.0
		8	9	13	22	SS-2	W		CP: GRAY AND TAN, MED. DENSE, CLAYEY SAND (A-2-6)
	6.0								222.0 5.0
220		5	5	5	10	SS-3	W		CP: TAN, GRAY AND REDDISH BROWN, STIFF, SANDY CLAY (A-6)
	8.5								219.0 8.0
		4	3	7	10	SS-4	W		CP: GRAY AND TAN, LOOSE TO MED. DENSE, CLAYEY SAND (A-2-6)
215									
	13.5								
		6	7	11	18	SS-5	W		212.0 15.0
									BORING TERMINATED AT 15.0' BELOW EXISTING GROUND

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BORING LOG

PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-8	**BORING LOCATION** 14+45	**OFFSET** 64' RT	**ALIGNMENT** -RPC-	**0 HR.** 2.2
COLLAR ELEV. 225.5 ft	**NORTHING** 480,284.3	**EASTING** 2,012,806.6	**24 HR.** CAVE @ 5.8
TOTAL DEPTH 15.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL
DATE STARTED 8-27-07	**COMPLETED** 8-27-07	**SURFACE WATER DEPTH** N/A	

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
225.5					EXISTING GROUND				225.5 0.0
225	1.0	8	12	10	22	SS-1	D		225.3 ROOTMAT 0.2 FILL: TAN AND REDDISH BROWN, MED. DENSE, SILTY SAND (A-2-4) WITH CLAY SEAMS AND ORGANICS
	3.5	10	10	10	20	SS-2	M		222.5 3.0 CP: TAN AND GRAY, MED. DENSE, CLAYEY SAND (A-2-6)
220	6.0	7	6	7	13	SS-3	M		220.5 5.0 CP: TAN AND REDDISH BROWN, MED. DENSE, SILTY SAND (A-2-4)
	8.5	3	3	3	6	SS-4	W		217.5 8.0 CP: TAN AND GRAY, MED. STIFF, SANDY CLAY (A-6)
215	13.5	4	7	15	22	SS-5	W		213.5 12.0 CP: TAN, MED. DENSE, CLAYEY SAND (A-2-6)
									210.5 15.0 BORING TERMINATED AT 15.0' BELOW EXISTING GROUND

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PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-9	**BORING LOCATION** 49+54	**OFFSET** 80' RT	**ALIGNMENT** -L-	**0 HR.** 5.2
COLLAR ELEV. 228.5 ft	**NORTHING** 479,616.1	**EASTING** 2,013,563.7		**24 HR.** 15.7
TOTAL DEPTH 40.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL	
DATE STARTED 8-23-07	**COMPLETED** 8-23-07	**SURFACE WATER DEPTH** N/A		

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
228.5					EXISTING GROUND				228.5 0.0
	1.0								228.3 ROOTMAT 0.2
	3.5	10	12	21	33	SS-1	D		FILL: RED, DARK GRAY, AND BROWN, HARD TO MED. STIFF TO STIFF, SANDY CLAY (A-7-6)
225		6	5	5	10	SS-2	W		
	6.0								
		2	2	3	5	SS-3	23%		
220	8.5								
		3	2	7	9	SS-4	W		
	13.5								216.5 12.0
215		6	8	8	16	SS-5	W		CP: TAN, GRAY AND PINK, MED. DENSE, CLAYEY SAND (A-2-6)
	18.5								211.5 17.0
210		5	16	12	28	SS-6	W		CP: PURPLE, TAN AND GRAY, V. STIFF, SANDY SILTY CLAY (A-7)
	23.5								206.5 22.0
205		10	6	9	15	SS-7	W		CP: TAN AND REDDISH BROWN, MED. DENSE, CLAYEY SAND (A-2-6)
	28.5								201.5 27.0
200		28	12	11	23	SS-8	W		CP: TAN AND GRAY, MED. DENSE, SILTY SAND (A-2-4)
	33.5								198.5 30.0
195		2	3	3	6	SS-9	W		CP: TAN AND PURPLE, MED. STIFF, SANDY SILTY CLAY (A-7)
	38.5								190.5 38.0
190		5	7	9	16	SS-10	W		CP: TAN AND GRAY, MED. DENSE, SAND (A-1-b)
									188.5 40.0
									BORING TERMINATED AT 40.0' BELOW EXISTING GROUND

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PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-10	**BORING LOCATION** 51+57	**OFFSET** 92' RT	**ALIGNMENT** -L-	**0 HR.** 4.7
COLLAR ELEV. 223 ft	**NORTHING** 479,554.3	**EASTING** 2,013,758.0		**24 HR.** 12.7
TOTAL DEPTH 30.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL	
DATE STARTED 8-22-07	**COMPLETED** 8-22-07	**SURFACE WATER DEPTH** N/A		

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
223.0					EXISTING GROUND				223.0 0.0
	1.0								222.8 ROOTMAT 0.2
220	3.5	9	16	12	28	SS-1	M		FILL: DARK BROWN, V. STIFF, SANDY CLAY (A-6)
		4	6	9	15	SS-2	W		220.0 3.0 CP: TAN, GRAY AND RED, STIFF TO V. STIFF, SANDY CLAY (A-6)
	6.0	8	11	12	23	SS-3	W		
215	8.5	9	11	12	23	SS-4	W		
									211.0 12.0
210	13.5	5	4	5	9	SS-5	W		CP: TAN, GRAY AND PURPLE, LOOSE, CLAYEY SAND (A-2-6)
									206.0 17.0
205	18.5	12	25	23	48	SS-6	W		CP: TAN AND GRAY, DENSE, SILTY SAND (A-2-4)
									201.0 22.0
200	23.5	5	6	5	11	SS-7	W		CP: PURPLE, TAN AND GRAY, MED. DENSE, CLAYEY SAND (A-2-6)
195	28.5	9	9	16	25	SS-8	W		193.0 30.0 BORING TERMINATED AT 30.0' BELOW EXISTING GROUND

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PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-11	**BORING LOCATION** 53+05	**OFFSET** 78' RT	**ALIGNMENT** -L-	**0 HR.** 2.4
COLLAR ELEV. 223.5 ft	**NORTHING** 479,530.5	**EASTING** 2,013,904.7		**24 HR.** 11.9
TOTAL DEPTH 20.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL	
DATE STARTED 8-22-07	**COMPLETED** 8-22-07	**SURFACE WATER DEPTH** N/A		

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
223.5					EXISTING GROUND				223.5 0.0
	1.0								223.3 ROOTMAT 0.2
		9	31	33	64	SS-1	D		FILL: DARK BROWN, TAN AND RED, HARD, SANDY CLAY (A-6)
220	3.5								220.5 3.0
		3	3	3	6	SS-2	M		FILL: DARK GRAY, LOOSE, SILTY SAND (A-2-4)
	6.0								217.5 6.0
		3	4	6	10	SS-3	M		CP: TAN AND GRAY, LOOSE, SILTY SAND (A-2-4)
215	8.5								215.5 8.0
		4	4	5	9	SS-4	W		CP: GRAY, TAN AND PURPLE, STIFF TO MED. STIFF, SANDY CLAY (A-6)
	13.5								
210		3	3	4	7	SS-5	W		
	18.5								206.5 17.0
205		6	15	18	33	SS-6	W		CP: TAN AND PINK, DENSE, SILTY SAND (A-2-4)
									203.5 20.0
									BORING TERMINATED AT 20.0' BELOW EXISTING GROUND

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PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-12	**BORING LOCATION** 54+52	**OFFSET** 63' RT	**ALIGNMENT** -L-	**0 HR.** 1.9
COLLAR ELEV. 226.5 ft	**NORTHING** 479,508.9	**EASTING** 2,014,050.3		**24 HR.** CAVE @ 12.9
TOTAL DEPTH 15.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL	
DATE STARTED 8-22-07	**COMPLETED** 8-22-07	**SURFACE WATER DEPTH** N/A		

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
226.5					EXISTING GROUND				226.5 0.0
	1.0								226.3 ROOTMAT 0.2
225		14	28	31	59	SS-1	▽		FILL: TAN AND BROWN, V. DENSE, SILTY SAND (A-2-4)
	3.5								223.5 3.0
		3	4	4	8	SS-2	W		FILL: TAN, MED. STIFF, SANDY CLAY (A-6)
	6.0								220.5 6.0
220		8	10	14	24	SS-3	W		CP: RED, TAN AND GRAY, V. STIFF TO STIFF, SANDY CLAY (A-6)
	8.5								
		6	8	9	17	SS-4	W		
215									
	13.5								
		6	5	7	12	SS-5	W		211.5 15.0
									BORING TERMINATED AT 15.0' BELOW EXISTING GROUND

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BORING LOG

SHEET 1 OF 1

PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-13	**BORING LOCATION** 50+00	**OFFSET** 96' LT	**ALIGNMENT** -L-	**0 HR.** 4.6
COLLAR ELEV. 226.5 ft	**NORTHING** 479,743.8	**EASTING** 2,013,735.5		**24 HR.** 13.6
TOTAL DEPTH 35.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL	
DATE STARTED 8-27-07	**COMPLETED** 8-27-07	**SURFACE WATER DEPTH** N/A		

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
226.5					EXISTING GROUND				226.5 0.0
	1.0								226.3 ROOTMAT 0.2
225		11	14	8	22	SS-1	D		FILL: TAN AND BROWN, MED. DENSE, SILTY SAND (A-2-4)
	3.5								223.5 3.0
		6	9	14	23	SS-2	W		CP: TAN, GRAY AND REDDISH BROWN, V. STIFF, SANDY CLAY (A-7-6)
	6.0								
220		7	8	11	19	SS-3	24%		
	8.5								218.5 8.0
		5	8	7	15	SS-4	W		CP: TAN AND GRAY, MED. DENSE TO LOOSE, CLAYEY SAND (A-2-6)
215									
	13.5								
		3	3	4	7	SS-5	W		
210									
	18.5								209.5 17.0
		12	8	7	15	SS-6	W		CP: TAN, GRAY AND PINK, MED. DENSE TO V. DENSE, SILTY SAND (A-2-4)
205									
	23.5								
		5	8	23	31	SS-7	W		
200									
	28.5								
		16	41	20	61	SS-8	W		
195									
	33.5								194.5 32.0
		4	3	3	6	SS-9	W		CP: TAN AND PURPLE, LOOSE, CLAYEY SAND (A-2-6)
									191.5 35.0
									BORING TERMINATED AT 35.0' BELOW EXISTING GROUND

NCDOT_BORE 07-018 RETAINING WALLS.GPJ NCDOT.GDT 9/9/07

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BORING LOG

SHEET 1 OF 1

PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-14	**BORING LOCATION** 52+04	**OFFSET** 79' LT	**ALIGNMENT** -L-	**0 HR.** 3.3
COLLAR ELEV. 224 ft	**NORTHING** 479,707.7	**EASTING** 2,013,846.3		**24 HR.** 10.1
TOTAL DEPTH 25.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL
DATE STARTED 8-27-07	**COMPLETED** 8-27-07	**SURFACE WATER DEPTH** N/A	

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
224.0					EXISTING GROUND				224.0 0.0
	1.0								223.8 ROOTMAT 0.2
		5	9	4	13	SS-1	M		FILL: TAN AND BROWN, MED. DENSE, SILTY SAND (A-2-4)
	3.5								221.0 3.0
220		9	7	13	20	SS-2	M		CP: RED, TAN AND GRAY, V. STIFF TO STIFF, SANDY CLAY (A-6)
	6.0								
		9	10	12	22	SS-3	M		
	8.5								
215		7	8	10	18	SS-4	W		
	13.5								
210		4	5	5	10	SS-5	W		
	18.5								207.0 17.0
205		4	5	8	13	SS-6	W		CP: TAN, GRAY AND PINK, MED. DENSE, SILTY SAND (A-2-4)
	23.5								202.0 22.0
200		5	5	7	12	SS-7	W		CP: TAN, GRAY AND PINK, STIFF, SANDY CLAY (A-7)
									199.0 25.0
									BORING TERMINATED AT 25.0' BELOW EXISTING GROUND

NCDOT_BORE 07-018 RETAINING WALLS.GPJ NCDOT.GDT 9/9/07

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BORING LOG

SHEET 1 OF 1

PROJECT NO. 6211-07-018	**ID.**	**COUNTY** CUMBERLAND	**GEOLOGIST** P. ZHANG
SITE DESCRIPTION MORGANTON ROAD RETAINING WALLS			**GROUND WATER (ft)**
BORING NO. B-15	**BORING LOCATION** 54+03	**OFFSET** 68' LT	**ALIGNMENT** -L-	**0 HR.** 1.2
COLLAR ELEV. 223 ft	**NORTHING** 479,647.5	**EASTING** 2,014,036.1		**24 HR.** CAVE @ 11.6
TOTAL DEPTH 15.0 ft	**DRILL MACHINE** CME 45B	**DRILL METHOD** MUD ROTARY	**HAMMER TYPE** MANUAL	
DATE STARTED 8-27-07	**COMPLETED** 8-27-07	**SURFACE WATER DEPTH** N/A		

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
223.0					EXISTING GROUND				223.0 0.0
	1.0						M		222.8 ROOTMAT 0.2
		3	1	4	5	SS-1			FILL: DARK BROWN, LOOSE, CLAYEY SILTY SAND (A-2-4)
220	3.5								220.0 3.0
		4	6	5	11	SS-2	W		CP: TAN, GRAY AND RED, STIFF, SANDY CLAY (A-6)
	6.0								
		5	5	8	13	SS-3	W		
215	8.5								
		4	5	4	9	SS-4	W		
									211.0 12.0
210	13.5								CP: TAN AND GRAY, LOOSE, CLAYEY SAND (A-2-6)
		3	5	4	9	SS-5	W		208.0 15.0

NCDOT_BORE 07-018 RETAINING WALLS.GPJ NCDOT.GDT 9/9/07

PROJECT REFERENCE NO.	SHEET NO.

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT
SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS

SOIL DESCRIPTION

SOIL IS CONSIDERED TO BE THE UNCONSOLIDATED, SEMI-CONSOLIDATED, OR WEATHERED EARTH MATERIALS THAT CAN BE PENETRATED WITH A CONTINUOUS FLIGHT POWER AUGER, AND YIELD LESS THAN 100 BLOWS PER FOOT ACCORDING TO STANDARD PENETRATION TEST (AASHTO T206, ASTM D-1586). SOIL CLASSIFICATION IS BASED ON THE AASHTO SYSTEM. BASIC DESCRIPTIONS GENERALLY SHALL INCLUDE: CONSISTENCY, COLOR, TEXTURE, MOISTURE, AASHTO CLASSIFICATION, AND OTHER PERTINENT FACTORS SUCH AS MINERALOGICAL COMPOSITION, ANGULARITY, STRUCTURE, PLASTICITY, ETC. EXAMPLE:

VERY STIFF, GRAY, SILTY CLAY, MOIST WITH INTERBEDDED FINE SAND LAYERS, HIGHLY PLASTIC, A-7-6

SOIL LEGEND AND AASHTO CLASSIFICATION

GENERAL CLASS.	GRANULAR MATERIALS (≤ 35% PASSING #200)							SILT-CLAY MATERIALS (> 35% PASSING #200)				ORGANIC MATERIALS		
GROUP CLASS.	A-1		A-3	A-2				A-4	A-5	A-6	A-7	A-1, A-2 A-3	A-4, A-5 A-6, A-7	
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6			
SYMBOL														
% PASSING #10 #40 #200	50 MX 30 MX 15 MX	50 MX 25 MX	51 MN 10 MX	35 MX	35 MX	35 MX	35 MX	36 MN	36 MN	36 MN	36 MN	GRANULAR SOILS	SILT-CLAY SOILS	MUCK, PEAT
LIQUID LIMIT	6 MX		NP	40 MX	41 MN	40 MX	41 MN	40 MX	41 MN	40 MX	41 MN	SOILS WITH LITTLE OR MODERATE AMOUNTS OF ORGANIC MATTER		HIGHLY ORGANIC SOILS
PLASTIC INDEX				10 MX	10 MX	11 MN	11 MN	10 MX	10 MX	11 MN	11 MN			
GROUP INDEX	0		0	0		4 MX		8 MX	12 MX	16 MX	No MX			
USUAL TYPES OF MAJOR MATERIALS	STONE FRAGS. GRAVEL, AND SAND		FINE SAND	SILTY OR CLAYEY GRAVEL AND SAND				SILTY SOILS		CLAYEY SOILS				
GEN. RATING AS A SUBGRADE	EXCELLENT TO GOOD							FAIR TO POOR				FAIR TO POOR	POOR	UNSUITABLE

PI OF A-7-5 SUBGROUP IS ≤ LL - 30 ; PI OF A-7-6 SUBGROUP IS > LL - 30

CONSISTENCY OR DENSENESS

PRIMARY SOIL TYPE	COMPACTNESS OR CONSISTENCY	RANGE OF STANDARD PENETRATION RESISTENCE (N-VALUE)	RANGE OF UNCONFINED COMPRESSIVE STRENGTH ($TONS/FT^2$)
GENERALLY GRANULAR MATERIAL (NON-COHESIVE)	VERY LOOSE	<4	
	LOOSE	4 TO 10	
	MEDIUM DENSE	10 TO 30	N/A
	DENSE	30 TO 50	
	VERY DENSE	>50	
GENERALLY SILT-CLAY MATERIAL (COHESIVE)	VERY SOFT	<2	<0.25
	SOFT	2 TO 4	0.25 TO 0.50
	MEDIUM STIFF	4 TO 8	0.5 TO 1.0
	STIFF	8 TO 15	1 TO 2
	VERY STIFF	15 TO 30	2 TO 4
	HARD	>30	>4

TEXTURE OR GRAIN SIZE

U.S. STD. SIEVE SIZE	4	10	40	60	200	270
OPENING (MM)	4.76	2.00	0.42	0.25	0.075	0.053

BOULDER (BLDR.)	COBBLE (COB.)	GRAVEL (GR.)	COARSE SAND (CSE. SD.)	FINE SAND (F SD.)	SILT (SL.)	CLAY (CL.)

GRAIN SIZE	MM	305	75	2.0	0.25	0.05	0.005
	IN.	12	3				

SOIL MOISTURE - CORRELATION OF TERMS

SOIL MOISTURE SCALE (ATTERBERG LIMITS)	FIELD MOISTURE DESCRIPTION	GUIDE FOR FIELD MOISTURE DESCRIPTION
	- SATURATED - (SAT.)	USUALLY LIQUID; VERY WET, USUALLY FROM BELOW THE GROUND WATER TABLE
LL — LIQUID LIMIT		
PLASTIC RANGE (PI)	- WET - (W)	SEMISOLID; REQUIRES DRYING TO ATTAIN OPTIMUM MOISTURE
PL — PLASTIC LIMIT		
OM — OPTIMUM MOISTURE	- MOIST - (M)	SOLID; AT OR NEAR OPTIMUM MOISTURE
SL — SHRINKAGE LIMIT		
	- DRY - (D)	REQUIRES ADDITIONAL WATER TO ATTAIN OPTIMUM MOISTURE

PLASTICITY

	PLASTICITY INDEX (PI)	DRY STRENGTH
NONPLASTIC	0-5	VERY LOW
LOW PLASTICITY	6-15	SLIGHT
MED. PLASTICITY	16-25	MEDIUM
HIGH PLASTICITY	26 OR MORE	HIGH

COLOR

DESCRIPTIONS MAY INCLUDE COLOR OR COLOR COMBINATIONS (TAN, RED, YELLOW-BROWN, BLUE-GRAY). MODIFIERS SUCH AS LIGHT, DARK, STREAKED, ETC. ARE USED TO DESCRIBE APPEARANCE.

GRADATION

WELL GRADED - INDICATES A GOOD REPRESENTATION OF PARTICLE SIZES FROM FINE TO COARSE.
UNIFORM - INDICATES THAT SOIL PARTICLES ARE ALL APPROXIMATELY THE SAME SIZE. (ALSO POORLY GRADED)
GAP-GRADED - INDICATES A MIXTURE OF UNIFORM PARTICLES OF TWO OR MORE SIZES.

ANGULARITY OF GRAINS

THE ANGULARITY OR ROUNDNESS OF SOIL GRAINS IS DESIGNATED BY THE TERMS ANGULAR, SUBANGULAR, SUBROUNDED, OR ROUNDED.

MINERALOGICAL COMPOSITION

MINERAL NAMES SUCH AS QUARTZ, FELDSPAR, MICA, TALC, KAOLIN, ETC. ARE USED IN DESCRIPTIONS WHENEVER THEY ARE CONSIDERED OF SIGNIFICANCE.

COMPRESSIBILITY

SLIGHTLY COMPRESSIBLE	LIQUID LIMIT LESS THAN 31
MODERATELY COMPRESSIBLE	LIQUID LIMIT EQUAL TO 31-50
HIGHLY COMPRESSIBLE	LIQUID LIMIT GREATER THAN 50

PERCENTAGE OF MATERIAL

ORGANIC MATERIAL	GRANULAR SOILS	SILT - CLAY SOILS	OTHER MATERIAL	
TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%	TRACE	1 - 10%
LITTLE ORGANIC MATTER	3 - 5%	5 - 12%	LITTLE	10 - 20%
MODERATELY ORGANIC	5 - 10%	12 - 20%	SOME	20 - 35%
HIGHLY ORGANIC	>10%	>20%	HIGHLY	35% AND ABOVE

GROUND WATER

- WATER LEVEL IN BORE HOLE IMMEDIATELY AFTER DRILLING
- STATIC WATER LEVEL AFTER 24 HOURS
- PW — PERCHED WATER, SATURATED ZONE, OR WATER BEARING STRATA
- SPRING OR SEEP

MISCELLANEOUS SYMBOLS

- ROADWAY EMBANKMENT (RE) WITH SOIL DESCRIPTION
- SOIL SYMBOL
- ARTIFICIAL FILL (AF) OTHER THAN ROADWAY EMBANKMENT
- INFERRED SOIL BOUNDARY
- INFERRED ROCK LINE
- ALLUVIAL SOIL BOUNDARY
- 25/025 — DIP & DIP DIRECTION OF ROCK STRUCTURES
- SOUNDING ROD
- SPT CPT DPT DMT VST PMT — TEST BORING
- AUGER BORING
- CORE BORING
- MW — MONITORING WELL
- PIEZOMETER INSTALLATION
- SLOPE INDICATOR INSTALLATION
- SPT N-VALUE
- REF — SPT REFUSAL

SAMPLE DESIGNATIONS
S - BULK SAMPLE
SS - SPLIT SPOON SAMPLE
ST - SHELBY TUBE SAMPLE
RS - ROCK SAMPLE
RT - RECOMPACTED TRIAXIAL SAMPLE
CBR - CALIFORNIA BEARING RATIO SAMPLE

ABBREVIATIONS

AR - AUGER REFUSAL
BT - BORING TERMINATED
CL. - CLAY
CPT - CONE PENETRATION TEST
CSE. - COARSE
DMT - DILATOMETER TEST
DPT - DYNAMIC PENETRATION TEST
e - VOID RATIO
F - FINE
FOSS. - FOSSILIFEROUS
FRAC. - FRACTURED, FRACTURES
FRAGS. - FRAGMENTS
HI. - HIGHLY
MED. - MEDIUM
MICA. - MICACEOUS
MOD. - MODERATELY
NP - NON PLASTIC
ORG. - ORGANIC
PMT - PRESSUREMETER TEST
SAP. - SAPROLITIC
SD. - SAND, SANDY
SL. - SILT, SILTY
SLI. - SLIGHTLY
TCR - TRICONE REFUSAL
w - MOISTURE CONTENT
V - VERY
VST - VANE SHEAR TEST
WEA. - WEATHERED
γ - UNIT WEIGHT
γ_d - DRY UNIT WEIGHT

EQUIPMENT USED ON SUBJECT PROJECT

DRILL UNITS:
- [ ] MOBILE B-___
- [ ] BK-51
- [ ] CME-45C
- [ ] CME-550
- [ ] PORTABLE HOIST
- [X] CME-45B
- [ ] _____

ADVANCING TOOLS:
- [ ] CLAY BITS
- [ ] 6" CONTINUOUS FLIGHT AUGER
- [ ] 8" HOLLOW AUGERS
- [ ] HARD FACED FINGER BITS
- [ ] TUNG.-CARBIDE INSERTS
- [ ] CASING [ ] W/ ADVANCER
- [X] TRICONE 3" * STEEL TEETH
- [ ] TRICONE _____ * TUNG.-CARB.
- [ ] CORE BIT
- [X] MUD ROTARY

HAMMER TYPE:
- [ ] AUTOMATIC
- [X] MANUAL

CORE SIZE:
- [ ] -B_____
- [ ] -N_____
- [ ] -H_____

HAND TOOLS:
- [ ] POST HOLE DIGGER
- [ ] HAND AUGER
- [ ] SOUNDING ROD
- [ ] VANE SHEAR TEST
- [ ] _____

PROJECT REFERENCE NO.	SHEET NO.

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
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SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS

ROCK DESCRIPTION

HARD ROCK IS NON-COASTAL PLAIN MATERIAL THAT IF TESTED, WOULD YIELD SPT REFUSAL. AN INFERRED ROCK LINE INDICATES THE LEVEL AT WHICH NON-COASTAL PLAIN MATERIAL WOULD YIELD SPT REFUSAL. SPT REFUSAL IS PENETRATION BY A SPLIT SPOON SAMPLER EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS. IN NON-COASTAL PLAIN MATERIAL, THE TRANSITION BETWEEN SOIL AND ROCK IS OFTEN REPRESENTED BY A ZONE OF WEATHERED ROCK.
ROCK MATERIALS ARE TYPICALLY DIVIDED AS FOLLOWS:

WEATHERED ROCK (WR)		NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT N VALUES > 100 BLOWS PER FOOT IF TESTED.
CRYSTALLINE ROCK (CR)		FINE TO COARSE GRAIN IGNEOUS AND METAMORPHIC ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES GRANITE, GNEISS, GABBRO, SCHIST, ETC.
NON-CRYSTALLINE ROCK (NCR)		FINE TO COARSE GRAIN METAMORPHIC AND NON-COASTAL PLAIN SEDIMENTARY ROCK THAT WOULD YEILD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES PHYLLITE, SLATE, SANDSTONE, ETC.
COASTAL PLAIN SEDIMENTARY ROCK (CP)		COASTAL PLAIN SEDIMENTS CEMENTED INTO ROCK, BUT MAY NOT YIELD SPT REFUSAL. ROCK TYPE INCLUDES LIMESTONE, SANDSTONE, CEMENTED SHELL BEDS, ETC.

WEATHERING

FRESH	ROCK FRESH, CRYSTALS BRIGHT, FEW JOINTS MAY SHOW SLIGHT STAINING. ROCK RINGS UNDER HAMMER IF CRYSTALLINE.
VERY SLIGHT (V SLI.)	ROCK GENERALLY FRESH, JOINTS STAINED, SOME JOINTS MAY SHOW THIN CLAY COATINGS IF OPEN, CRYSTALS ON A BROKEN SPECIMEN FACE SHINE BRIGHTLY. ROCK RINGS UNDER HAMMER BLOWS IF OF A CRYSTALLINE NATURE.
SLIGHT (SLI.)	ROCK GENERALLY FRESH, JOINTS STAINED AND DISCOLORATION EXTENDS INTO ROCK UP TO 1 INCH. OPEN JOINTS MAY CONTAIN CLAY. IN GRANITOID ROCKS SOME OCCASIONAL FELDSPAR CRYSTALS ARE DULL AND DISCOLORED. CRYSTALLINE ROCKS RING UNDER HAMMER BLOWS.
MODERATE (MOD.)	SIGNIFICANT PORTIONS OF ROCK SHOW DISCOLORATION AND WEATHERING EFFECTS. IN GRANITOID ROCKS, MOST FELDSPARS ARE DULL AND DISCOLORED, SOME SHOW CLAY. ROCK HAS DULL SOUND UNDER HAMMER BLOWS AND SHOWS SIGNIFICANT LOSS OF STRENGTH AS COMPARED WITH FRESH ROCK.
MODERATELY SEVERE (MOD. SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. IN GRANITOID ROCKS, ALL FELDSPARS DULL AND DISCOLORED AND A MAJORITY SHOW KAOLINIZATION. ROCK SHOWS SEVERE LOSS OF STRENGTH AND CAN BE EXCAVATED WITH A GEOLOGIST'S PICK. ROCK GIVES "CLUNK" SOUND WHEN STRUCK. *IF TESTED, WOULD YIELD SPT REFUSAL*
SEVERE (SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC CLEAR AND EVIDENT BUT REDUCED IN STRENGTH TO STRONG SOIL. IN GRANITOID ROCKS ALL FELDSPARS ARE KAOLINIZED TO SOME EXTENT. SOME FRAGMENTS OF STRONG ROCK USUALLY REMAIN. *IF TESTED, YIELDS SPT N VALUES > 100 BPF*
VERY SEVERE (V SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC ELEMENTS ARE DISCERNIBLE BUT THE MASS IS EFFECTIVELY REDUCED TO SOIL STATUS, WITH ONLY FRAGMENTS OF STRONG ROCK REMAINING. SAPROLITE IS AN EXAMPLE OF ROCK WEATHERED TO A DEGREE SUCH THAT ONLY MINOR VESTIGES OF THE ORIGINAL ROCK FABRIC REMAIN. *IF TESTED, YIELDS SPT N VALUES < 100 BPF*
COMPLETE	ROCK REDUCED TO SOIL. ROCK FABRIC NOT DISCERNIBLE, OR DISCERNIBLE ONLY IN SMALL AND SCATTERED CONCENTRATIONS. QUARTZ MAY BE PRESENT AS DIKES OR STRINGERS. SAPROLITE IS ALSO AN EXAMPLE.

ROCK HARDNESS

VERY HARD	CANNOT BE SCRATCHED BY KNIFE OR SHARP PICK. BREAKING OF HAND SPECIMENS REQUIRES SEVERAL HARD BLOWS OF THE GEOLOGIST'S PICK.
HARD	CAN BE SCRATCHED BY KNIFE OR PICK ONLY WITH DIFFICULTY. HARD HAMMER BLOWS REQUIRED TO DETACH HAND SPECIMEN.
MODERATELY HARD	CAN BE SCRATCHED BY KNIFE OR PICK. GOUGES OR GROOVES TO 0.25 INCHES DEEP CAN BE EXCAVATED BY HARD BLOW OF A GEOLOGIST'S PICK. HAND SPECIMENS CAN BE DETACHED BY MODERATE BLOWS.
MEDIUM HARD	CAN BE GROOVED OR GOUGED 0.05 INCHES DEEP BY FIRM PRESSURE OF KNIFE OR PICK POINT. CAN BE EXCAVATED IN SMALL CHIPS TO PEICES 1 INCH MAXIMUM SIZE BY HARD BLOWS OF THE POINT OF A GEOLOGIST'S PICK.
SOFT	CAN BE GROVED OR GOUGED READILY BY KNIFE OR PICK. CAN BE EXCAVATED IN FRAGMENTS FROM CHIPS TO SEVERAL INCHES IN SIZE BY MODERATE BLOWS OF A PICK POINT. SMALL, THIN PIECES CAN BE BROKEN BY FINGER PRESSURE.
VERY SOFT	CAN BE CARVED WITH KNIFE. CAN BE EXCAVATED READILY WITH POINT OF PICK. PIECES 1 INCH OR MORE IN THICKNESS CAN BE BROKEN BY FINGER PRESSURE. CAN BE SCRATCHED READILY BY FINGERNAIL.

FRACTURE SPACING

TERM	SPACING
VERY WIDE	MORE THAN 10 FEET
WIDE	3 TO 10 FEET
MODERATELY CLOSE	1 TO 3 FEET
CLOSE	0.16 TO 1 FEET
VERY CLOSE	LESS THAN 0.16 FEET

BEDDING

TERM	THICKNESS
VERY THICKLY BEDDED	> 4 FEET
THICKLY BEDDED	1.5 - 4 FEET
THINLY BEDDED	0.16 - 1.5 FEET
VERY THINLY BEDDED	0.03 - 0.16 FEET
THICKLY LAMINATED	0.008 - 0.03 FEET
THINLY LAMINATED	< 0.008 FEET

INDURATION

FOR SEDIMENTARY ROCKS, INDURATION IS THE HARDENING OF THE MATERIAL BY CEMENTING, HEAT, PRESSURE, ETC.

FRIABLE	RUBBING WITH FINGER FREES NUMEROUS GRAINS; GENTLE BLOW BY HAMMER DISINTEGRATES SAMPLE.
MODERATELY INDURATED	GRAINS CAN BE SEPARATED FROM SAMPLE WITH STEEL PROBE; BREAKS EASILY WHEN HIT WITH HAMMER.
INDURATED	GRAINS ARE DIFFICULT TO SEPARATE WITH STEEL PROBE; DIFFICULT TO BREAK WITH HAMMER.
EXTREMELY INDURATED	SHARP HAMMER BLOWS REQUIRED TO BREAK SAMPLE: SAMPLE BREAKS ACROSS GRAINS.

TERMS AND DEFINITIONS

ALLUVIUM (ALLUV.) - SOILS THAT HAVE BEEN TRANSPORTED BY WATER.

AQUIFER - A WATER BEARING FORMATION OR STRATA.

ARENACEOUS - APPLIED TO ROCKS THAT HAVE BEEN DERIVED FROM SAND OR THAT CONTAIN SAND.

ARGILLACEOUS - APPLIED TO ALL ROCKS OR SUBSTANCES COMPOSED OF CLAY MINERALS, OR HAVING A NOTABLE PROPORTION OF CLAY IN THEIR COMPOSITION, AS SHALE, SLATE, ETC.

ARTESIAN - GROUND WATER THAT IS UNDER SUFFICIENT PRESSURE TO RISE ABOVE THE LEVEL AT WHICH IT IS ENCOUNTERED, BUT WHICH DOES NOT NECESSARILY RISE TO OR ABOVE THE GROUND SURFACE.

CALCAREOUS (CALC.) - SOILS THAT CONTAIN APPRECIABLE AMOUNTS OF CALCIUM CARBONATE.

COLLUVIUM - ROCK FRAGMENTS MIXED WITH SOIL DEPOSITED BY GRAVITY ON SLOPE OR AT BOTTOM OF SLOPE.

CORE RECOVERY (REC.) - TOTAL LENGTH OF ALL MATERIAL RECOVERED IN THE CORE BARREL DIVIDED BY TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE.

DIKE - A TABULAR BODY OF IGNEOUS ROCK THAT CUTS ACROSS THE STRUCTURE OF ADJACENT ROCKS OR CUTS MASSIVE ROCK.

DIP - THE ANGLE AT WHICH A STRATUM OR ANY PLANAR FEATURE IS INCLINED FROM THE HORIZONTAL.

DIP DIRECTION (DIP AZIMUTH) - THE DIRECTION OR BEARING OF THE HORIZONTAL TRACE OF THE LINE OF DIP, MEASURED CLOCKWISE FROM NORTH.

FAULT - A FRACTURE OR FRACTURE ZONE ALONG WHICH THERE HAS BEEN DISPLACEMENT OF THE SIDES RELATIVE TO ONE ANOTHER PARALLEL TO THE FRACTURE.

FISSILE - A PROPERTY OF SPLITTING ALONG CLOSELY SPACED PARALLEL PLANES.

FLOAT - ROCK FRAGMENTS ON SURFACE NEAR THEIR ORIGINAL POSITION AND DISLODGED FROM PARENT MATERIAL.

FLOOD PLAIN (FP) - LAND BORDERING A STREAM, BUILT OF SEDIMENTS DEPOSITED BY THE STREAM.

FORMATION (FM.) - A MAPPABLE GEOLOGIC UNIT THAT CAN BE RECOGNIZED AND TRACED IN THE FIELD.

JOINT - FRACTURE IN ROCK ALONG WHICH NO APPRECIABLE MOVEMENT HAS OCCURRED.

LEDGE - A SHELF-LIKE RIDGE OR PROJECTION OF ROCK WHOSE THICKNESS IS SMALL COMPARED TO ITS LATERAL EXTENT.

LENS - A BODY OF SOIL OR ROCK THAT THINS OUT IN ONE OR MORE DIRECTIONS.

MOTTLED (MOT.) - IRREGULARLY MARKED WITH SPOTS OF DIFFERENT COLORS. MOTTLING IN SOILS USUALLY INDICATES POOR AERATION AND LACK OF GOOD DRAINAGE.

PERCHED WATER - WATER MAINTAINED ABOVE THE NORMAL GROUND WATER LEVEL BY THE PRESENCE OF AN INTERVENING IMPERVIOUS STRATUM.

RESIDUAL (RES.) SOIL - SOIL FORMED IN PLACE BY THE WEATHERING OF ROCK.

ROCK QUALITY DESIGNATION (RQD) - A MEASURE OF ROCK QUALITY DESCRIBED BY TOTAL LENGTH OF ROCK SEGMENTS EQUAL TO OR GREATER THAN 4 INCHES DIVIDED BY THE TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE.

SAPROLITE (SAP.) - RESIDUAL SOIL THAT RETAINS THE RELIC STRUCTURE OR FABRIC OF THE PARENT ROCK.

SILL - AN INTRUSIVE BODY OF IGNEOUS ROCK OF APPROXIMATELY UNIFORM THICKNESS AND RELATIVELY THIN COMPARED WITH ITS LATERAL EXTENT, THAT HAS BEEN EMPLACED PARALLEL TO THE BEDDING OR SCHISTOSITY OF THE INTRUDED ROCKS.

SLICKENSIDE - POLISHED AND STRIATED SURFACE THAT RESULTS FROM FRICTION ALONG A FAULT OR SLIP PLANE.

STANDARD PENETRATION TEST (PENETRATION RESISTANCE) (SPT) - NUMBER OF BLOWS (N OR BPF) OF A 140 LB. HAMMER FALLING 30 INCHES REQUIRED TO PRODUCE A PENETRATION OF 1 FOOT INTO SOIL WITH A 2 INCH OUTSIDE DIAMETER SPLIT SPOON SAMPLER. SPT REFUSAL IS PENETRATION EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS.

STRATA CORE RECOVERY (SREC.) - TOTAL LENGTH OF STRATA MATERIAL RECOVERED DIVIDED BY TOTAL LENGTH OF STRATUM AND EXPRESSED AS A PERCENTAGE.

STRATA ROCK QUALITY DESIGNATION (SRQD) - A MEASURE OF ROCK QUALITY DESCRIBED BY TOTAL LENGTH OF ROCK SEGMENTS WITHIN A STRATUM EQUAL TO OR GREATER THAN 4 INCHES DIVIDED BY THE TOTAL LENGTH OF STRATA AND EXPRESSED AS A PERCENTAGE.

TOPSOIL (TS.) - SURFACE SOILS USUALLY CONTAINING ORGANIC MATTER.

BENCH MARK:

ELEVATION: FT.

NOTES:

GROUND SURFACE ELEVATIONS FOR THE TEST BORINGS ARE ESTIMATED FROM SITE TOPOGRAPHIC MAPS PREPARED BY OTHERS.

TIERRA 2736 ROWLAND ROAD RALEIGH NC 27615

RETAINING WALLS ALONG MORGANTON ROAD

CUMBERLAND COUNTY, NORTH CAROLINA

TIERRA PROJECT NO. 6211-07-018

TABLE 1: SUMMARY OF CLASSIFICATION TEST RESULTS

BORING #		SAMPLE #	NATURAL MOISTURE CONTENT	TOTAL SAMPLE PERCENT PASSING			ATTERBERG LIMIT		
AASHTO Classification									
STATION #	OFFSET (FEET)	DEPTH (FEET)		#10	#40	#200	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX
B-1		SS-1	9.8%	100	87	54	28	13	15
A-6									
36+37 -L-	76' RT	1.0-2.5							
B-3		SS-7	N/A	100	76	7	NP	NP	NP
A-3									
39+40 -L-	93' RT	23.5-25.0							
B-5		SS-4	N/A	100	80	35	37	17	20
A-2-6									
38+08 -L-	78' LT	8.5-10.0							
B-6		SS-4	24.2%	100	97	67	37	21	16
A-6									
39+45 -L-	96' LT	8.5-10.0							
B-6		SS-9	53.0%	100	99	94	92	21	71
A-7-6									
39+45 -L-	96' LT	33.5-35.0							
B-9		SS-3	22.6%	99	82	48	43	18	25
A-7-6									
49+54 -L-	80' RT	6.0-7.5							
B-13		SS-3	23.6%	98	81	51	47	25	22
A-7-6									
50+00 -L-	96' LT	6.0-7.5							

Developed by Dr. Pu Zhang, Tierra, Inc.

Soldier Pile Lagging Wall (per AASHTO 5.6)

Project ID: Morganton Road RW # 3 Station 50+60 ~ 53+50

Input — Wall Dimensions

Wall Height H=	10	ft
Soldier Pile Spacing L=	8	ft
Effective Pile Width b=	2	ft
Soil Arching Factor N=	3	* AASHTO N=3, Caltrans N=0.08*Φ for granular, N=1~2 for cohesive.
Embedment Depth D=	21.7219583	ft
Backfill angle Beta=	26.6	degree
Consider Soil Disturbance @ Excavation	yes	

Retaining Soil Parameters

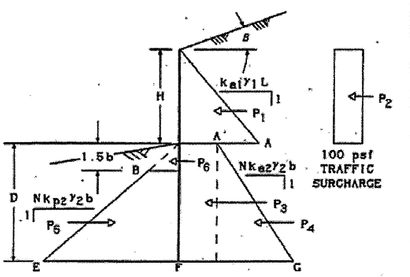
Cohesion c=	0	lb/ft^2
Friction angle Φ=	30	deg
Unit weight Gamma=	120	lb/ft^3

Base Soil Parameters

Cohesion c=	0	lb/ft^2
Friction angle Phi=	30	deg
Unit weight Gamma=	120	lb/ft^3

Surcharge

Uniform surcharge q=		lb/ft^2



Run — *Solver under Tools menu*

0.00	=0	Moments about F.
-102438.04	=0	Zero Shear Plan.

Steel Yield Strength Fy=	50	ksi	
Allowable Bending Stress Fb=	30	ksi	=0.6Fy
Section Modulus S=	0.00	in^3	
Required Embedment Depth D_0=	21.7	ft	
Design Embedment Depth D=	30	ft	$=1.4D_0$

Gamma water	62.4	lb/ft^3
Total H'	10.00	ft

Active Earth Pressure

Ka1=	0.538	
PA=	5162.95	
P1h=	23082.36	
P1v=	11558.79	
Surcharge P2=	0.00	
Ka2=	0.538	
PA'=	3872.21	*: Assume Groundwater is
PG=	4037.38	at the bottom of excavation.
P3h=	75209.11	
P3v=	37661.92	
P4h=	39208.54	
P4v=	19634.18	

Passive Earth Pressure

Kp2=	3.00	
PB=	3110.4	
PE=	22521.33	
P6=	4665.60	
P5=	244603.66	

Moments about F:

Active Source	Force	Arm	Moment
P1	23082.36	25.06	578335.30
P2	0.00	26.72	0.00
P3	75209.11	10.86	816844.63
P4	39208.54	7.24	283895.44
P6	4665.60	19.72	92014.77
Sum	142165.62		1771090.14
Resistance Source			
P5	244603.66	7.24	1771090.14

LPILE+ 4.0 INPUT SHEET:

UNIT : 2

Designer: PZ Checker: GL

Project Title

Proj. #:	6211-07-018	Station:	RW3 51+00
County	Cumberland		

Pile Properties

Total Pile Length	444.0	(in)
Increments (recommend 50 to 100)	100	
Distance from Top of Pile to Ground	120.0	(in)
Combined Ground Slope & Batter Angles	0	(degrees)

Pile Sections

Section #	Depth (in)	Diameter (in)	Mom. of Inertia (in4)	Area (in2)	Modulus (psi)
1	0	14	729	21.46	30000000
2	120.0	14	729	21.46	30000000
3	120.0	24	16286	452	3800000
4 (Tip)	444	24	16286	452	3800000

Distributed Lateral Load Intensity

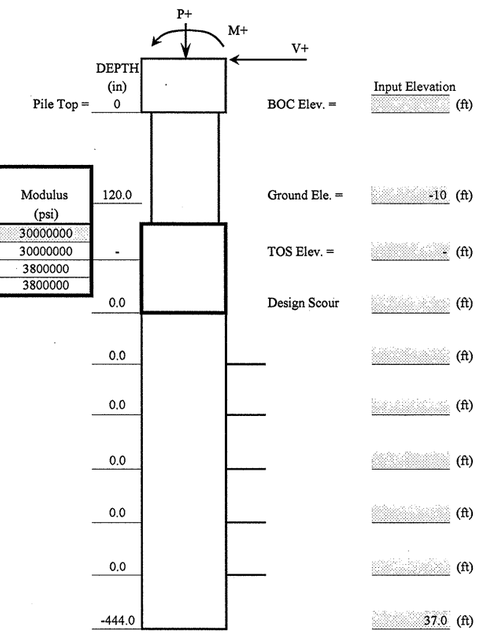
Point No.	Depth (in)	Distr. Load lbs/in
1	0	0
2	108	346

Pile-Head Boundary Conditions & Loading

Pile-Head B.C.	V (Shear) (lbs)	M (Moment) (lbs-in)	P (Axial) (lbs)
Shear & Moment	0	0	0
Shear & Slope			

Soil Layers

Layer #	Internal Soil Type	x-top (in)	x-bottom (in)
1	4	120.0	444.0
2		444	0.0
3		0	0.0
4		0	0.0
5		0	0.0
6			



DEFLECTION @ PILE TOP = Δ_{TOP}

Δ_{TOP}	Max. Neg.	Pile Length
0.54	373	444.0
(in)	(in)	(in)

#1 = Soft Clay Criteria (Matlock)
#2 = Stiff Clay with Free Water
#3 = Stiff Clay without Free Water
#4 = Sand (Reese, 1974)
#5 = Linear Interp. p-y curves
#6 = Strong Rock (Vuggy Limestone)
#7 = Silt (Cemented c-phi soil)
#8 = API Sand (O'Neill)
#9 = Weak Rock (Reese, 1977)

COMMENTS:

SOIL and ROCK PROPERTIES

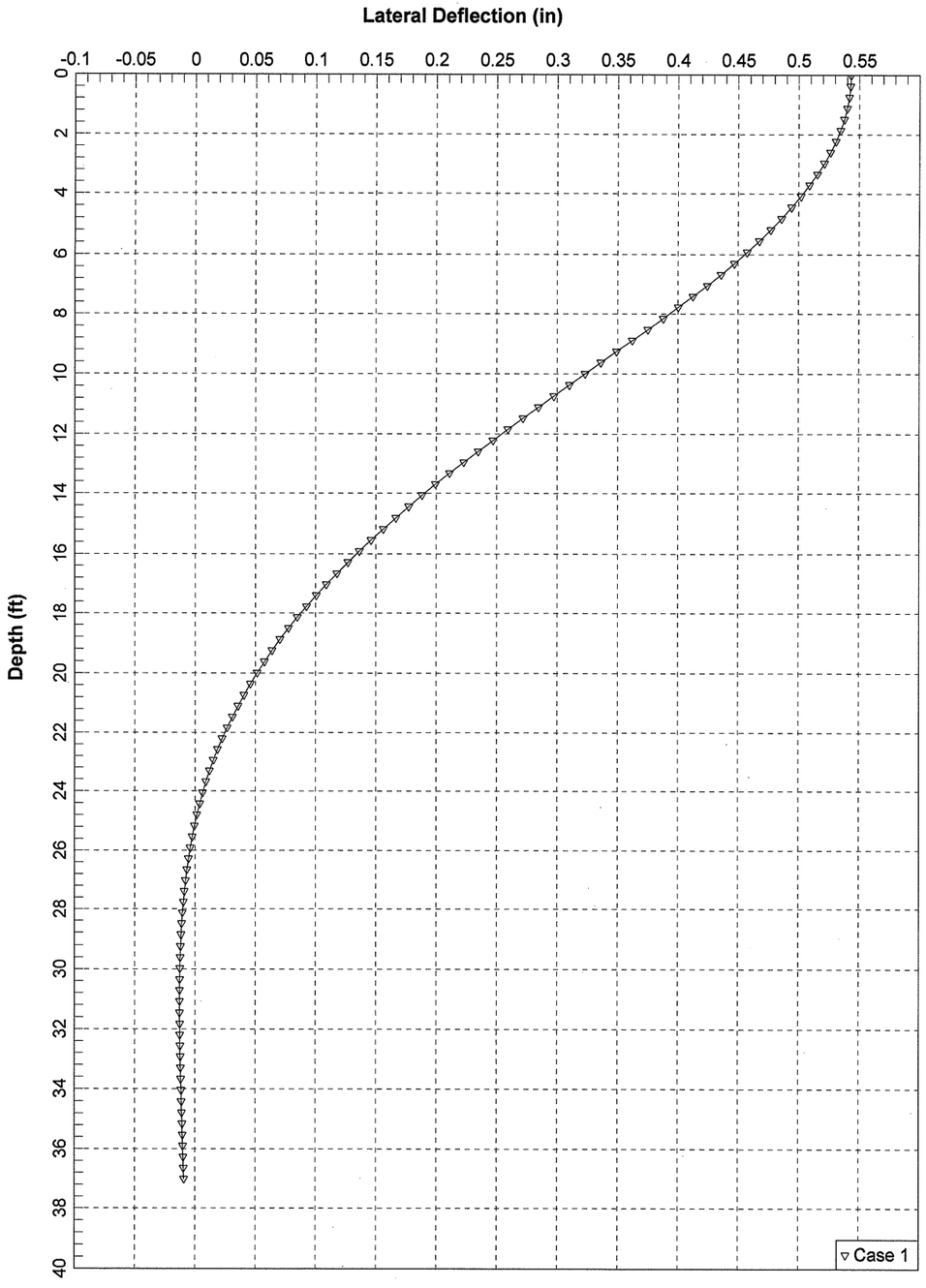
Non-rock Soil Types	Eff. Unit Wt. (pci)	p-y Modulus (pci)	Cohesive Str. (psi)	Friction Angle ϕ (degrees)	Soil Strain ε_{50}
4	0.033	20		30	

Weak Rock	Eff. Unit Wt. (pci)	Young's Mod.* (psi)	Uniax. Comp. Str. (psi)	RQD (%)	k rm (.0005 to .00005)

Strong Rock Properties (Vuggy Limestone)	Eff. Unit Wt. (pci)	Uniax. Comp. Str. (psi)

* Young's Modulus of Rock = 200 to 500 X Comp. Strength of Rock (RULE OF THUMB)

	(ft)
POINT OF FIXITY EL. =	
TIP NO HIGHER THAN =	


Lateral Deflection (in)
-0.1
-0.05
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
Case 1