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COMMONWEALTH of VIRGINIA
DEPARTMENT OF TRANSPORTATION
DIVISION: MATERIALS

REPORT COVER SHEET

Geotechnical Engineering Report
Slope and Roadway Embankments
March 3, 2017
AECOM Technical Services, Inc.
Germantown, Maryland

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Project Description: **I-264/Witchduck Road Interchange & Ramp Extension (C-D Road)**
From: **0.383 Mile East of WBL I-64**
To: **0.472 Mile East of Witchduck Road**
Project UPC No.: **UPC 17630**

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I-264 WITCHDUCK ROAD INTERCHANGE AND RAMP EXTENSION

CITY OF VIRGINIA BEACH, VIRGINIA

1.0 INTRODUCTION

This report presents the results of our geotechnical evaluation of the proposed embankment slopes within the I-64/I-264 Witchduck Road interchange improvement project (Project UPC No.: UPC 17630) located in the city of Virginia Beach, Virginia. The extent of embankment slopes analyzed in this study is included in Section 4.0 of this report. A general description of the subsurface conditions and summary of analyses and recommendations regarding the embankment slopes are included herein. This report also provides a brief discussion of the design and construction of earthworks associated with the project.

2.0 SCOPE OF WORK

The scope of work for this report includes the following:

a. Review the proposed embankment slopes and perform global slope stability analyses.

b. Perform settlement analyses for the proposed roadway embankments.

c. Evaluate the expected roadway embankment settlement and the impacts of settlement on adjacent existing structures and roadways, including the need for soil improvement to reduce the embankment settlements to meet the Virginia Department of Transportation (VDOT) maximum settlement requirements.

As per VDOT Manual of the Structure and Bridge Division, Part 11, Chapter 10, post-construction settlement criteria is one-inch in 20 years within 100 feet of bridge abutments and two inches in 20 years beyond 100 feet.

3.0 BACKGROUND

HDR, Inc. (HDR) was retained by VDOT to perform the subsurface investigation for the I-64/I-264 Witchduck Road interchange improvement project. HDR performed various subsurface explorations along the project site including soil borings with standard penetration testing (SPT with automatic hammer), Cone Penetration Testing (CPT), and soil laboratory testing of disturbed and undisturbed samples. A geotechnical engineering report (GER) was prepared for each specific sub-project within the project area. The GERs were provided to AECOM with the Request for Proposal (RFP) by VDOT. The

GERs relevant to this report are the GERs prepared for Greenwich, Newtown, Witchduck and I-264 subprojects.

4.0 PROPOSED ROADWAY EMBANKMENTS

As part of the proposed I-64/I-264 Witchduck Road interchange improvement project, new roadway embankments will be constructed at different areas of the project. The roadway embankment locations, grading and geotechnical subsurface information were obtained from available design drawings and cross sections provided by Kimley Horn, dated August 5, 2016, and the GERs prepared by HDR dated September 20, 2013 and January 11, 2013. A summary of the embankment slopes that were reviewed/analyzed in detailed is included in Table 1 below. All the proposed embankment slopes were reviewed and design embankment sections were taken at 10 locations.

Table 1 - Summary of Roadway Embankments Analyzed

General Area Reviewed	Starting Station	Ending Station	Final Fill Height (ft)	Reference Project Area
Slopes	50+00	54+50	18 to 30	Newtown/PSA I264 CD
Slopes	58+00	66+00	4 to 30	Newtown/PSA I264 CD
Slopes	155+00	171+00	6 to 10	PSA I264 CD/Greenwich
Slopes	172+00	182+50	5 to 15	PSA I264 CD/Greenwich
Slopes	185+50	208+00	14 to 29	PSA I264 CD/Witchduck
Newtown Loop B	11+83.84	16+50	11 to 18	Newtown
Ramp C	11+00	12+50	4 to 15	Newtown
Temporary Ramp A	202+00	205+00	3 to 9	Witchduck
Witchduck Loop B	10+00	22+00	5 to 23	Witchduck
Temporary Ramp B	400+55	406+00	1 to 6	Witchduck

5.0 SITE GEOLOGY

The site lies in the Coastal Plain of Virginia, which encompasses the eastern portion of the state, beginning at the “Fall Line,” roughly approximated by Interstate I-95, where the bedrock-derived Piedmont materials transition to the coastal sediments. Published geologic information covering the Virginia Coastal Plain indicates that the site is underlain by several geologically-recent (Quaternary age) formations, and a more ancient (Tertiary age) formation of the Chesapeake Group at depth. Recent Holocene age alluvium and recent fill material are also present at the site.

The alluvial materials consist of gravel, sand, silt, and clay of highly variable composition and sorting. Recent fill materials were also encountered in the borings. The fill materials are believed to have been placed for the present approach fills along the right of way.

The Pleistocene formations present below the alluvial and recent fill materials extend to as deep as approximately El. -86 feet. These formations include the Sedgefield Member of the Tabb formation (Upper Pleistocene) in about the top 20 feet, underlain by the Shirley formation (Middle Pleistocene) that extends from about El -16 feet to approximately El. -45 feet. These sediments consist primarily of silty and clayey sands, which are very loose to loose nearer the surface, transitioning to medium dense to dense at the bottom. The Shirley formation sediments are underlain by the Charles City formation (Lower Pleistocene) that generally extend to the top of the Yorktown formation, which is between about El. -58 and -86 feet. The Charles City formation includes very stiff to hard fat clays, high-plasticity silts and medium dense to dense clayey sands and silty sands.

The deepest borings extended into the Yorktown formation of the Chesapeake Group. This unit consists of gray silty sand interbedded with clay and silt layers. The Yorktown formation contains marine shell fragments, which are typical with many sub-units of the Chesapeake Group. This stratum is generally medium dense to very dense.

6.0 SUBSURFACE EXPLORATION

HDR performed various subsurface explorations including soil borings with standard penetration testing (SPT with automatic hammer), Cone Penetration Testing (CPT), and soil laboratory testing. HDR performed various engineering evaluations along the I-264 Witchduck Road Interchange project site and prepared a GER for each specific sub-project within the project area. The four GERs that have relevant geotechnical data for the embankment areas analyzed are the GERs prepared for Greenwich, Newtown, Witchduck, and I-264 subprojects, dated January 11, 2013 and September 20, 2013.

7.0 SUBSURFACE CONDITIONS

The subsurface conditions indicated by the soil borings performed by HDR are discussed in detail in the GERs. Much of the near-surface zones consist of highly variable recent fill material. This fill likely represents materials placed during construction of the existing highways or earlier development that has occurred over the years.

Below the recent fill, layers of clays and sands of the Tabb and Shirley Formations are present at the sites. These layers are generally interbedded and were classified as upper sands, lower sands, upper clays and lower clays. It is noted that the upper clays were observed to not to be interbedded with the upper sands and the lower clays were observed to not to be interbedded with the lowers sands in some areas of the project site.

The upper sand and upper clays were characterized by loose to medium dense and soft to medium stiff consistencies, respectively. The upper sand stratum typically varied in elevation between about El. +15 feet and El. -30 feet. We have further divided the upper clay strata as Upper Clay 1 material and Upper Clay 2 material. The Upper Clay 1 was typically encountered as high as El +15 feet and as deep as El -33 feet. Near the existing ground surface, there is a clay layer from about El. +15 to +10 feet, which appears to be a desiccated Upper Clay 1 layer that was generally stiff based on CPT data. Upper Clay 2 stratum was encountered as high as El -30 feet to -47 feet.

The lower sand and lower clay are generally interbedded and are typically medium dense, or medium stiff to stiff, with sporadic stronger and weaker layers. The lower sand was encountered as shallow as about El. -11 feet and as deep as about El -63 feet, varying in thickness between about 8 feet and 30 feet. The lower clay was encountered as shallow as about El. -33 feet and as deep as El. -74 feet, varying in thickness between about 7 feet and 27 feet.

The deepest borings penetrated into the Yorktown formation. This stratum consists of medium dense to very dense silty or clayey sands, with occasional shell fragments. Standard Penetration Tests (SPTs) indicate that the field N-values for these materials range from about 10 blows per foot (bpf) to approximately 50 bpf, with an average of about 25. These soils are known to be over-consolidated with relatively higher strength and lower permeability than the Upper Clay 1 and Upper Clay 2 soils at the site and are widely used for end bearing for driven piles or drilled shaft support.

8.0 SEISMIC SITE CLASSIFICATION

The site classification for seismic design was determined using Table C3.10.3.1.1 of AASHTO LRFD Bridge Design Manual (ALBDM), 2012. AASHTO allows the use of SPT field N-values, undrained shear strength (Su) and shear wave velocity (Vs) measurements to define the soil profile at the site. We used the SPT field N-value method for classification based on the upper 100 feet of the site soil profile. Based on the field N-values obtained in the soil borings drilled at the site, the soil profile at the site is predominantly composed of silty and sandy soils. The weighted N-value for the profile is 6.

According to ALBDM (2012), Table 3.10.3.1-1, the site can be classified as Site Class E. AASHTO recommends using seismic design parameters for earthquakes that have a 7-percent probability of exceedance in 75 years of projected useful life of the structure. Hence, peak ground acceleration (PGA) values and mapped spectral accelerations for short periods (Ss) and long periods (S1) used in evaluating the site coefficients were based on Figure 3.10.2.1-1, Figure 3.10.2.1-2, and Figure 3.10-2.1-3 of the ALBDM, respectively.

PGA for the project area was determined to be 0.03g. Ss and S1values were determined to be 0.08g and 0.03g, respectively. The site factor for short periods (Fa) may be taken as 2.5 and the site coefficient for long periods (Fv) may be taken as 3.5 based on Tables 3.10.3.2-2 and 3.10.3.2-3, respectively. The value of SDS and SD1 obtained are 0.2g and 0.105 g, respectively, where:

S_{DS} = The maximum considered earthquake spectral response acceleration for a short period

S_{D1} = The maximum considered earthquake spectral response acceleration for a 1-second period

9.0 SLOPE STABILITY AND SETTLEMENT ANALYSES

9.1 Design Soil Parameters

HDR provided a set of recommended soil parameters in the GERs for this project. We have reviewed the soil laboratory test results, the CPT data and the soil boring logs presented in the GERs. We used our engineering judgement in revising some of the soil parameters. A summary of various soil laboratory results versus elevation are presented in Appendix A, Soil Laboratory Summary.

Over the entire site, results of Atterberg limit tests indicate that the Upper Clay 1 and Upper Clay 2 materials are typically classified as CL and CH. Liquid limit values typically ranged from 30 to 50 percent (and occasionally as high as 70 to 90), with plasticity indices generally ranging from 10 to 25 percent. Moisture contents typically ranged from 23 to 40 percent (and occasionally as high as 60 percent). No organic content and dual liquid limit testing was performed.

Over the entire site for the Upper Clay 1 and Upper Clay 2 materials, consolidation tests performed on relatively undisturbed tube samples in these strata indicate OCRs in the 1.3 to 2.0 range, indicative of slight over-consolidation. Compression ratios (CR) typically ranged from 0.10 to 0.20. Recompression ratios (RR) typically ranged from 0.008 to 0.017. Both CR and RR are strain-based ratios. The coefficient of consolidation typically ranged from 0.10 to 0.25 square feet per day (sfd). Secondary compression ratios generally ranged from 0.002 and 0.006 for the stress ranges of interest (consolidation loadings of 1 to 2 tons per square foot (tsf) and 2 to 4 tsf. Unit weights of the two upper clay strata typically ranged from approximately 105 to 125 pounds per cubic foot (pcf).

HDR recommended that the undrained shear strength for the upper clay soils be calculated as 800 pounds per square foot (psf) + 30 psf/foot and 1,000 psf + 25 psf/foot of layer thickness (depending on the location within the project site). The undrained shear strength of the Upper Clay 1 and Upper Clay 2 materials obtained from the unconsolidated-undrained (UU) triaxial shear test results presented in the GERs range from about 560 to 1,620 psf. A review of the soil boring logs drilled in the vicinity of the proposed roadway embankments indicate that the field SPT blow counts in the Upper Clay 1 and Upper Clay 2 soils range from 0 to 5 blows per foot, with an average value of 2 blows per foot. A review of the CPT data and soil laboratory test results presented in HDR's report indicated that the shear strength of the upper clays varies between about 400 psf and 1,500 psf. The high values obtained in UU test results may be due to the fact that higher strength samples may have been tested, while the soils in the softer portion of the layer may have been difficult to collect and may not have been tested. Therefore, after review of the CPT data and the UU triaxial shear test results, we generally considered an undrained shear strength profile ranging from 500 psf near the top of the Upper Clay 1 stratum to 1,200 psf near the bottom of the Upper Clay 2 stratum in our analyses.

HDR recommended effective friction angles between 28 degrees and 30 degrees for the Upper Clay 1 and Upper Clay 2 materials in the GERs. In our opinion, these values seemed high for slightly over-consolidated soft to stiff clays. Based on the available CPT data and laboratory test data presented in the GERs, we judged that an effective friction angle of 23 degrees was appropriate for the Upper Clay 1 and Upper Clay 2 strata.

A deeper generally medium stiff to stiff lower clay layer is also present across the site ranging between about El -33 feet to El -74 feet. HDR recommended an undrained shear strength for the lower clay of 3,000 psf and an effective friction angle between 28 degrees and 32 degrees for the material. For the same reasons stated in the previous paragraph, we judged that an effective friction angle of 25 degrees for the lower clay is a more appropriate value for this material.

Available soil borings indicate that generally medium dense upper and lower sand layers are present at the site. Based on the SPT field N-values, the upper sands and lower sands generally have medium dense consistency. Therefore, a Young's soil modulus of 250 tsf was used for the elastic settlement analysis for the upper and lower sand layers as recommended in Table D-3 of the US Army Corp of Engineers manual EM-1110-1-1904 "Settlement Analysis." The above reference is included in Appendix C.

Additional details of the soil parameters used in our slope stability analyses and settlement calculations are included in the slope stability analyses and the settlement calculation packages included in Appendices B and C, respectively.

9.2 Groundwater Conditions

HDR's soil borings typically indicate groundwater readings between about El. 0 and El. +13. It is possible that stabilized groundwater levels are higher than those encountered during drilling. Fluctuations in groundwater levels may occur due to seasonal variations in rainfall, evaporation, construction activity in the vicinity of the site, surface runoff, and other site-specific factors.

9.3 Selection of Design Sections for Slope Stability

The most critical slopes along the reviewed embankment slope areas were identified and analyzed for short-term global stability and long-term global stability. The specific sections were selected based on proposed embankment heights and subsurface conditions along the project area. The soil parameters used in our slope stability analyses are summarized in Table 2. The soil parameters used in our analyses were utilized based upon our review of the CPT data, soil laboratory test results and soil borings provided in the GDRs.

Table 2 - Summary of Design Soil Parameters

Stratum Description	Unit Weight, γ_m (pcf)	Long-Term Analyses: Effective Friction Angle, Ø (deg)	Long-Term Analyses: Cohesion (psf)	Short-Term Analyses: Effective Friction Angle, Ø (deg)	Short-Term Analyses: Undrained Shear Strength, Su (psf)
Proposed Normal Weight Fill	130	34	0	34	0
Existing Fill	125	32	0	32	0
Upper Sands	115	30 to 32	0	30 to 32	0
Upper Clay 1 and 2	112 to 120	23	0	0	500 to 1,200
Lower Sands	125	32	0	32	0
Lower Clays	115 to 120	25	0	0	3,000

Soil parameters for the Upper Clay 2, Lower Sands and Lower Clays were estimated and included in the table above. However, they were not used in the slope stability analyses because they do not impact the analyses. Parameters were not estimated for the Yorktown formation, because they also do not impact the analyses.

9.4 Design and Surcharge Loads

A design live load for traffic of 300 psf was applied on the roadway embankments. In order to meet the established maximum settlement criteria (see Section 9.8 of this report), substantial completion of primary settlement and dissipation of excess pore water pressures will be required and an over-load, or surcharge, will be required to reduce post-construction secondary compression to acceptable levels. Analyses indicate that surcharges above final height of 3 to 5 feet will be required to meet this criteria where prefabricated vertical drains (PVD) are utilized. A surcharge load of 780 psf to 1,170 psf, which corresponds to a 6-foot to 9-foot high soil surcharge, was considered for the short-term global slope stability analysis. PVD and surcharge details are presented in Section 9.9 of this report.

9.5 Embankment Stability and Settlement Analyses/Calculations

GeoStudio 2007 -SLOPE/W software was utilized to evaluate the global stability of the embankments. The SLOPE/W computer program generates potential failure surfaces through a user selected range of entry and exit areas or center and tangent grids using the Spencer method that considers both force and moment equilibrium. The entry and exit areas method of defining the slip surface was used to evaluate global stability of the embankments.

A software program “FoSSA” Version 2.0 licensed by ADAMA Engineering was utilized to perform 2-D settlement analyses. FoSSA calculates stress distribution based on numerical integration of the basic Boussinesq equation. Elastic settlement is calculated using numerical integration of Hooke's equations. Consolidation settlement (1-D) is calculated utilizing Terzaghi's differential equation using a finite difference scheme. Prefabricated Vertical Drain (PVD's) design follows: Prefabricated Vertical Drains, Vol. I: Engineering Guidelines, by Rixner, Kraemer, and Smith, Haley & Aldrich, FHWA report FHWA/RD-86/168, September 1986, Contract No. DTFH61-83-C-00101. The undrained shear strength calculations during consolidation are calculated using Stability Evaluation during Staged Construction, by Ladd, Journal of Geotechnical Engineering, ASCE, 1991, Vol. 117, No. 4, pp. 540-615.

9.6 Factor of Safety Requirements

VDOT’s Materials Division, Manual Instructions, Section 305.03 recommends the following minimum factors of safety (FOS) for global slope stability analysis.

Table 3 - VDOT Recommended Factors of Safety

Stratum Description	Short Term	Long Term
Non-Critical Slopes (exposed height < 25 ft)	1.3	1.3
Critical Slopes (exposed height > 25 ft)	1.5	1.5

We considered all slopes greater than 25 feet high as critical slopes and all slopes less than 25 feet high as non-critical slopes. A discussion regarding the slopes analyzed and the analysis results is included in the next section of this report. It is noted that a minimum FOS of 1.3 was considered for the short-term condition during construction.

9.7 Global Slope Stability of Embankments

The short- and long-term global stability of the embankments was evaluated at specific locations selected by AECOM. The specific locations were selected based on proposed embankment heights and subsurface conditions along project area. Available design drawings indicate that the new roadway embankments will have a slope of 2H:1V.

Based on VDOT's Materials Division, Manual Instructions, Section 305.03, a minimum global stability FOS of 1.5 is required for embankment slopes with height of 25 feet or greater and a FOS of 1.3 for embankment slopes less than 25 feet high. The slope stability analyses indicated that the slopes analyzed meet the global slope stability FOS criteria. Table 4 shows a summary of our global slope stability analyses. The slope stability calculations are included in Appendix B of this report.

Table 4 - Embankment Slope Stability Analysis Results

Station		Earth Surcharge for Short Term Analysis (psf)	Traffic Surcharge for Long Term Analysis (psf)	Slope Height (ft)	Critical/ Non-Critical	Factor of Safety				Ground Improvement	
						Circular Failure Surface		Wedge Failure Surface		Circular	Wedge
						Short Term	Long Term	Short Term	Long Term	Short Term	Long Term
45+00	LEFT	780	300	13	Non-Critical	1.7	1.9	1.6	2.2	-	-
	RIGHT	780	300	13.5	Non-Critical	1.4	1.4	1.5	1.5	-	-
47+50	LEFT	780	300	6.6	Non-Critical	1.6	1.9	4.0	4.0	-	-
	RIGHT	780	300	6	Non-Critical	1.6	2.1	2.0	3.1	-	-
53+00	LEFT	780	300	8	Non-Critical	2.3	2.5	2.8	4.3	-	-
	RIGHT	780	300	21	Non-Critical	1.5	1.6	1.7	1.8	-	-
58+00	LEFT	780	300	6	Non-Critical	2.5	2.4	4.9	5.3	-	-
	RIGHT-1	780	300	24.5	Non-Critical	1.4	1.5	-	-	-	
	RIGHT-2	780	300	8.5	Non-Critical	2.0	1.8	-	-	-	-
	RIGHT-3	780	300	24.5	Non-Critical	1.5	1.7	1.5	1.8	-	-
61+00	RIGHT	780	300	18.5	Non-Critical	1.6	1.5	1.5	1.6	-	-
61+50	LEFT	780	300	4	Non-Critical	2.7	2.8	3.0	3.7	-	-
	RIGHT	780	300	17.25	Non-Critical	1.7	1.4	1.6	1.7	-	-
	CENTER	780	300	11	Non-Critical	1.7	1.9	2.6	2.6	-	-
66+00	LEFT	780	300	5	Non-Critical	2.3	2.3	2.5	3.0	-	-
	RIGHT	780	300	4.6	Non-Critical	1.8	1.5	2.0	2.0	-	-
	CENTER	780	300	11.4	Non-Critical	1.6	1.8	1.6	2.2	-	-
85+00	RIGHT	780	300	26.5	Critical	1.5	1.5	1.5	1.9	-	-
171+00	RIGHT	780	300	8.75	Non-Critical	1.3	1.4	1.7	2.1	-	-
177+00	RIGHT	780	300	9.3	Non-Critical	1.5	1.4	1.5	1.7	-	-
179+00	RIGHT	780	300	13.5	Non-Critical	1.4	1.5	1.6	1.7	-	-
182+50	RIGHT	780	300	22.6	Non-Critical	1.5	1.6	1.4	2.1	-	-
203+50	LEFT	780	300	20	Non-Critical	1.7	1.5	2.0	1.6		
208+00	RIGHT	780	300	8.5	Non-Critical	1.9	2.0	1.9	2.2	-	-
407+66	RIGHT	780	300	12.5	Non-Critical	1.5	1.7	1.6	2.1	-	-
14+00	LEFT	780	300	7	Non-Critical	2.3	2.0	3.5	2.8	-	-
	RIGHT	780	300	7	Non-Critical	2.4	1.8	2.8	2.0	-	-
17+50	LEFT	780	300	11	Non-Critical	1.8	1.5	1.7	2.0	-	-
	RIGHT	780	300	6.5	Non-Critical	1.6	1.8	6.4	1.9	-	-

9.8 Embankment Settlement Analyses

Maximum roadway settlement criteria per VDOT's Manual of the Structure and Bridge Division, Part 11, Chapter 10 is that settlements shall not exceed 2 inches over a 20-year period after roadways are constructed. During a meeting on January 4, 2017 that was attended by VDOT, Kimley Horn and AECOM, it was decided that this settlement criteria could be relaxed in roadway slope areas provided that VDOT maintenance groups were informed about areas that will likely need greater than normal maintenance and more pavement overlays than normal. AECOM discussed at the meeting that settlement calculations were indicating as much as about 1 to 3 inches of additional settlement along the edges of existing I-264 due to placement of new grading fill and additional settlement of as much as about 3 to 4 inches at the edges of existing shoulders, due to placement of new grading fill. VDOT indicated at this meeting that these magnitudes of settlement would be acceptable for this project, due to the significant cost savings. As a result, VDOT recognized that additional maintenance and pavement overlays may be required by relaxing the maximum settlement criteria. Widening of existing I-264 will require various amounts of new fill material to reach the proposed grades. The soil borings drilled by HDR and included in the GERs indicate various thicknesses of compressible Upper Clay 1 and Upper Clay 2 strata. The weight of the new fill material will induce additional stresses onto the Upper Clay 1 and Upper Clay 2 strata, which will cause the clay materials to consolidate and settle. The settlement analyses indicated that up to about 20 inches of embankment settlement is anticipated in some areas of the proposed project. A summary of the anticipated embankment settlements is shown on Table 5. The settlement calculations are included in Appendix C of this report.

Table 5 - Estimated Embankment Settlement Results

General Area Reviewed	Starting Station	Ending Station	Approximate Final Fill Height (ft)	Estimated Maximum Settlement (inches)
Embankment	CD 50+00	CD 54+50	18 to 30	10 to 20
Embankment	CD 58+00	CD 66+00	4 to 30	8 to 18
Embankment	I-264 155+50	I-264 171+00	6 to 10	3 to 6
Embankment	I-264 176+50	I-264 182+50	5 to 15	4 to 10
Embankment	I-264 185+50	I-264 191+50	14 to 29	10 to 20
Embankment	I-264 193+50	I-264 194+00	11 to 18	6 to 14
Newtown Loop B	11+83.84	16+50	4 to 15	7 to 12
Ramp C	11+00	12+50	3 to 9	3 to 8
Temporary On Ramp A	202+00	205+00	5 to 23	8 to 16
Witchduck Loop B	11+00	22+00	1 to 20	5 to 14
Temporary On Ramp B	400+55	406+00	1 to 6	2 to 4

The anticipated embankment settlements are large and would take years to dissipate due to the consolidation of the Upper Clay 1 and Upper Clay 2 strata present below the proposed embankments. Additionally, the calculated embankment settlements exceed the project maximum settlement criteria. Therefore, various ground improvement methods (primarily PV drains) were considered and are recommended. Details of our recommendations are included in the next section of this report.

9.9 Ground Improvement Options Considered for Roadway Embankments

As mentioned in the previous section of this report, due to the anticipated large settlements expected, various ground improvement methods were considered along with their impacts to the project. Consideration was provided to project impacts such as technical feasibility, project costs, schedules, and constructability (some ground improvements involve specialized materials and/or construction). The selected ground improvement methods for this project considered not only the geotechnical issues, but the other aspects of the project as well. Slope stability was also evaluated based on applicable criteria to determine the need for ground improvements.

The following alternatives were considered for the proposed project embankments:

1. Normal weight fill (130 pcf) with surcharge and without ground improvements;
2. Normal weight fill (130 pcf) with surcharge and with PVD;
3. Expanded shale lightweight fill (60 to 70 pcf), with surcharge and without ground improvements;
4. Expanded shale lightweight fill (60 to 70 pcf), with surcharge and with PVD;
5. Geofoam lightweight fill (2 pcf) without ground improvements;
6. Low-density cementitious fill (30 pcf) without ground improvements.
7. Densified-aggregate-piers (DAPs), Stone Columns and / or cemented aggregate piers (CAPs)
8. Pile supported embankment with various deep foundation elements including precast concrete piles, steel H-piles, micropiles, and auger-cast piles.
9. Soil-cement mixing
10. Compaction grouting
11. Jet grouting
12. Drilled Shafts

Based on the alternative considerations noted below, only alternatives 1, 2, 3, 4 and 8 were considered in detail for the proposed embankments.

Alternative 1, Normal weight fill (with surcharge) without ground improvements:

Use of normal weight fill (130 pcf) without ground improvements is generally the simplest and least expensive alternative. However, the waiting period for the primary consolidation of the upper clay soils to dissipate can be excessive (i.e., many years) depending on the amount of fill, amount of settlement anticipated, and the soil conditions. This approach may also require multiple construction stages in some areas, which could impact the construction schedule.

Alternative 2, Normal weight fill (with surcharge) with PVD:

Use of normal weight fill (130 pcf) with PVD is generally the second least expensive alternative. In comparison to Alternative 1, the use of PVD can significantly reduce the wait period until primary consolidation is achieved. Staged construction to mitigate shear/bearing capacity failures in the underlying soft upper clay soils may be required depending upon height of fill. Potentially, more than one waiting period may also be required. The settlement waiting period(s) may not be acceptable to the project from a construction schedule standpoint.

Alternative 3, Lightweight fill (with surcharge) without ground improvements:

Expanded shale lightweight fill (60–70 pcf) significantly reduces the load on the soils from the embankment. This reduced load reduces the amount of settlement, but generally not the settlement waiting period when compared to normal weight fill. Thus, the waiting period until primary consolidation is achieved can be excessive depending on the amount of fill, amount of settlement anticipated, and the soil conditions. Since the cost of expanded shale lightweight fill is significantly more than the cost of normal weight fill, but have similar installation times and settlement waiting periods, this alternative was only considered viable for locations where lightweight fill would reduce the total settlement such that the settlement waiting period would essentially be eliminated (or significantly reduced if the lightweight fills do not exceed the maximum past pressure).

Alternative 4, Lightweight fill (with surcharge) with PVD:

This alternative is nearly identical to Alternative 3 described above, except that the use of PVD can significantly reduce the total primary consolidation waiting period. However, the reduced settlement waiting period with PVD would generally be the same as the waiting period with normal weight fill and PVD. This alternative has the benefit of reducing the number of stages of construction for high embankments. Similar to Alternative 3, this alternative was only considered viable for locations where lightweight fill would reduce the total settlement, allowing the settlement waiting period to be essentially eliminated (or significantly reduced if the lightweight fills do not exceed the maximum past pressure).

Alternative 5, Geofoam Lightweight materials:

This alternative utilizes EPS GeoFoam, expanded polystyrene, which weighs on the order of 2 pcf. Geofoam essentially reduces settlements significantly compared to other fill alternatives. However, there are several concerns with this material including: the material is very expensive, buoyancy (floating), material degradation from hydrocarbons, and maintenance issues. GeoFoam is many times more expensive than regular weight fill. As the material is less dense than water consideration must be given for ground water and flood conditions to avoid buoyancy issues. The GeoFoam material can be degraded by hydrocarbons such as diesel fuel and is mitigated by encapsulating with a geomembrane. The installation of the GeoFoam materials is generally expected to be as expensive as pile-supported embankments. Therefore, GeoFoam was primarily evaluated for placement over existing utilities (including drainage pipes) to minimize the total settlement and to minimize risks of damaging the utilities.

Alternative 6, Lightweight Low-Density Cementitious Fill Materials:

This alternative utilizes Low-Density Cementitious Fill, which weighs on the order of 30 pcf. This material also reduces settlements significantly compared to other fill alternatives. However, the cost of this material is much more than the cost of regular weight fill. This material also has a constructability concern that silos of cement are required on site, and it is generally a slow process. As the material is less dense than water consideration must be given for ground water and flood conditions to avoid buoyancy issues. It is a good solution for placement of this material over existing utilities, and frequently is used in combination with over-excavation to reduce net loadings. Due to the high costs this alternative was not considered in detail for the embankments on the project.

Alternative 7, Densified Aggregate Piers and/or Cemented Aggregate Piers:

This alternative utilizes densified aggregate piers (DAPs) or cemented aggregate piers (CAPs) to improve the soil conditions under the proposed embankments, reduce the total settlement, and improve slope stability factors of safety. Given the soil profile in the project area, in order to penetrate the underlying Upper Clay 1 and Upper Clay 2 strata the aggregate piers would need to be installed to a depth of up to 85 feet below the proposed embankments. Installation of aggregate piers to such depths would present installation difficulties, as equipment is generally not available to install piers to these depths. AECOM contacted DAP contractors and they concurred that there could be constructability issues during installation of DAPs due to the thickness and soft nature of the Upper Clay 1 and Upper Clay 2 materials. Given the depth required the cost of aggregate piers would be equal to or greater than pile-supported embankments with more risks. Therefore, this option was not recommended for this project.

Alternative 8, Pile Supported Embankments:

This alternative utilizes a grid of piles with pile caps covered by a load transfer platform (LTP) to support the embankment fill. Pile supported embankments have significant costs, require time to install the piles (and pile caps), and can generate noise and vibration from driven piles. The noise and vibration from driven piles can impact nearby properties. Drilled piles, such as auger-cast piles, can mitigate the noise issues. Also, driven piles can be pre-drilled to reduce ground vibrations. Pile supported embankments essentially eliminate primary settlement and concerns about differential settlement near pile supported structures, such as bridge abutments.

The pile size, spacing, and depth are determined based on the design load and soil conditions. We believe that the use of square precast concrete piles is the most cost-effective type of pile for this application. Steel H-piles and micropiles were also considered but are more expensive. The piles generally need to extend down into the Yorktown formation soils to achieve required bearing capacity for the design loads, which results in pile lengths of approximately 85 to 95 feet.

Due to cost and vibration considerations, pile supported embankments were only considered preferable where primary consolidation wait periods for other alternatives were expected to have unacceptable construction schedule impacts, or the VDOT settlement criteria could not otherwise be met. Additionally, pile-supported embankments were also considered adjacent to existing or proposed bridges to mitigate the possible impact of large settlement onto the bridge piles.

Alternatives 9 – 12:

Alternatives 9 – 12 were not considered in detail as they are expected to cost significantly more (50 – 300 percent) than the pile supported alternative.

The various ground improvement options considered for the embankments were discussed with VDOT, Kimley Horn and AECOM personnel during a meeting on January 4, 2017 and ground improvement methods were selected for the various project areas during this meeting. A matrix with ground improvement recommendations and associated waiting periods and relative costs is shown in Table 6. The embankments with recommended ground improvement methods are illustrated on Figures 1, 2 and 3 included in this report. Details of the geotechnical recommendations for the embankments are presented below.

Table 6 – Ground Improvement Options Matrix for Roadway Embankments

Ground Improvement Options Matrix for Embankments												
Embankment	PV-Drains and Surcharge			Expanded Shale Light Weight Fill with PV-Drains		Pile-Supported Embankment			Geofoam			Recommendations
	Estimated Waiting Period (calendar days)	Approx. Max. Settlement After Ground Improvement in 20 years (inch)	Estimated Cost in Plan View (ft2)	Estimated Waiting Period (calendar days)	Aprox. Max. Settlement After Ground Improvement in 20 years (inch)	Estimated Waiting Period (calendar days)	Approx. Max. Settlement After Ground Improvement in 20 years (inch)	Estimated Cost in Plan View (ft2)	Estimated Waiting Period (calendar days)	Aprox. Max. Settlement After Ground Improvement in 20 years (inch)	Estimated Cost in Plan View (ft2)	
CD STA 50+00 to 54+50	90-120	2"	$30-50	Regular weight fill works for one stage, lightweight fill not required		0	2"	$100-120	0	2"	$120-170	PVD/Surcharge option with regular weight fill is recommended. Piled embankment will be installed within 80 ft of bridge abutments.
CD STA 58+00 to 66+00	90-120	2"	$30-50	Regular weight fill works for one stage, lightweight fill not required		0	2"	$100-120	0	2"	$120-170	PVD/Surcharge option with regular weight fill is recommended. Piled embankment will be installed within 80 ft of bridge abutments.
I-264 STA 155+50 to 171+00	90-120	2"	$10-25	30-60	2"	0	2"	$80-100	0	2"	$40-70	PVD/Surcharge option with expanded shale lightweight fill is recommended. Geofoam is reccommended over proposed and existing utilites.
I-264 STA 176+50 to 182+50	90-120	2"	$20-35	Regular weight fill works for one stage, lightweight fill not required		0	2"	$90-110	0	2"	$70-100	PVD/Surcharge option with regular fill is recommended. Piled embankment will be installed within 80 ft of bridge abutment.
I-264 STA 185+50 to 191+50	90-120	2"	$30-50	Regular weight fill works for one stage, lightweight fill not required		0	2"	$100-120	0	2"	$120-170	PVD/Surcharge with piled embankments adjacent to the CSX bridge abutment is recommended.
I-264 STA 193+50 to 194+00	90-120	2"	$30-50			0	2"	$90-110	0	2"	$80-120	PV-Drains/Surcharge option with normal fill recommended.
Temporary On Ramp B to Witchduck Rd (STA 400+00 to 406)	90-120	2"	$10-25	Regular weight fill works for one stage, lightweight fill not required		0	2"	$60-80	0	2"	$40-70	Regular weight fill. No ground improvement is recommended.
Newtown Road Loop B (STA 11+83.84 to 16+50)	90-120	2"	$20-35	Geofoam or expanded shale lightweight fill recommeded over utility pipes.		0	2"	$90-110	0	2"	$70-100	PVD/Surcharge option with regular weight fill is recommended. Geofoam is reccommended over proposed and existing utilites.
Newtown Road Ramp C (STA 11+00 to STA 12+50)	90-120	2"	$10-25	Regular weight fill works for one stage, lightweight fill not required		0	2"	$60-80	0	2"	$40-70	PVD/Surcharge option with regular weight fill is recommended. Geofoam is reccommended over proposed and existing utilites.
Temporary On Ramp A from Witchduck Rd (STA 203+00 to 205+00)	90-120	2"	$10-25	Regular weight fill works for one stage, lightweight fill not required		0	2"	$90-120	0	2"	$90-130	PV-Drains/Surcharge option with normal fill recommended.
Witchduck Rd Loop B (16+50 to 21+00)	90-120	2"	$30-50	Regular weight fill works for one stage, lightweight fill not required		0	2"	$90-110	0	2"	$80-120	PV-Drains/Surcharge option with normal fill is recommended. Special utility installation considerations are discussed in the report.
Witchduck Rd Ramp A	90-120	2"	$30-50	Regular weight fill works for one stage, lightweight fill not required		0	2"	$90-120	0	2"	$90-130	

T- Estimated Waiting Period (calendar days)

S- Approximate Maximum Settlement After Ground Improvement in 20 years (inch)

9.9.1 CD Station 50+00 to 54+50 and CD Station 58+00 to Station 66+00

These sections of roadway improvements will require up to 30 feet of new fill to reach the proposed final embankment heights. Settlement calculations indicated 10 to 20 inches of total settlement during construction and for 20-years after construction completion. These settlements are considered excessive and the use of PVD/surcharge as ground improvement is recommended between CD Station 50+00 to Station 54+50 and CD Station 58+00 to Station 66+00 to accelerate the primary settlement of the embankment areas due to the new fill. A waiting period of 90 and 120 days is recommended after construction of the embankment and surcharge to allow primary consolidation to dissipate and to limit the secondary compression to acceptable limits prior to roadway paving. Settlement calculations are included in Appendix C. We calculated that a surcharge requirement of 5 feet above finished grade will be required to dissipate the primary consolidation and to limit the secondary compression to acceptable limits.

Surcharging above final grade should be constructed at a 2H:1V slope. It is noted that short-term factors of safety were at least 1.3 for the start of the surcharging period prior to soil strength gain. PVDs should generally be installed below the bottom of the Upper Clay 2 stratum. This corresponds to approximately El. -45 ft in most areas. PVDs should be placed in a triangular pattern at a 5-foot center-to-center spacing. PVDs should be placed from the proposed toe-of-slope to midway up the existing roadway slopes. A drainage blanket should be placed after subgrade preparation and prior to PVD installation. The drainage material should consist of a minimum of 18 inches of material with less than 5 percent passing the No. 200 sieve.

Settlement calculations indicate as much as about 1 to 3 inches of additional settlement along the edges of existing I-264 due to placement of new grading fill and additional settlement of as much as about 3 to 4 inches at the edges of existing shoulders, due to placement of new fill after surcharging is complete. It was decided by VDOT at the January 4th meeting that these magnitudes of settlement would be acceptable for this project, due to the significant cost savings with the PVD/surcharge approach. Additional maintenance and pavement milling and overlays may be needed in areas of existing pavement when using the PVD/surcharge approach.

A proposed Newtown Bridge overpass (Bridge B601) will be constructed and will be supported on piles. The settlement of the new fill adjacent to the piles will induce lateral stresses and downdrag loads onto the new piles, which could damage the piles. Therefore, it is recommended that the roadway embankment on each side of Bridge B601 be supported on piles. The pile-supported embankment should be a minimum of 80 feet in length on each side of the bridge. Sixty-foot long zones (transition zones) to transition from piles to PVD/surcharge should be constructed adjacent to pile supported embankments. A detail of the pile-supported embankment and transition zone is provided as Figure 4. The piles for the pile-supported embankment zone should bear into the Yorktown formation. Pile embedment into the Yorktown formation soils varies from about 10 to 12 feet to obtain the required pile capacity. The piles should be placed where new fill will be placed and up the existing roadway embankment slopes. Piles can be designed for nominal (ultimate) pile resistances provided in Table 7. A resistance factor (Φ) of 0.65, per the LRFD Code, must be applied to calculate the factored pile resistance.

Table 7 - Piles for Pile Supported Embankment

Pile Type	**Pile Size (in)**	**Nominal (ultimate) Pile Resistance (kips)**	**Estimated Pile Tip Elevation (ft)**
Square Precast Concrete	12	410	-72

It is noted that the piles were not designed for downdrag loads because settlement adjacent to piles were expected to be small enough that negative drag loads would not develop on the piles. Piles shall be spaced at a center-to-center spacing of 7 feet. A concrete pile cap 3.5 feet square shall be constructed at the top of each pile. The pile supported embankment calculations are included in Appendix E. Additional pile recommendations are included in the “Pile Installation Consideration” Section 10.2 of this report.

A three-foot thick Load Transfer Platform (LTP) system should be installed over the piles and should extend 5 feet beyond the last row of piles. The LTP should extend below the entire width of the embankment and up the existing roadway slopes where piles are installed. The LTP fill material shall be crushed stone such as VDOT CBR No. 30 Coarse Aggregate. The LTP shall consist of three “doubled” layers of High Strength GeoSynthetic reinforcement (HSGS). Each “doubled” HSGS layer shall consist of two layers of HSGS placed such that the strong direction is perpendicular to the alignment for one layer and parallel to the alignment for the second layer. The first “doubled” HSGS layer shall be placed over a 6-inch lift of crushed stone above the tops of the pile caps. The second “doubled” HSGS layer shall be placed above the first “doubled” geosynthetic layer, separated by a 6 in lift of crushed stone. The third “doubled” layer of geosynethetic shall be placed above the second “doubled” geosynthetic layer, separated by a 6 in lift of crushed stone. Eighteen inches of crushed stone shall be placed over the top “doubled” layer if HSGS. The HSGS material should have a minimum long-term allowable tensile strength of 800 pounds per linear foot and a minimum long-term stiffness of 16,000 pounds per linear foot.

After the LTP is installed, the new fill can be constructed over the LTP. The piles should be embedded a minimum of 6 inches into the pile caps for structural purposes. The structural engineer should verify the minimum pile embedment into the pile cap.

The design of the pile-supported embankment including the LTP was based on the Strategic Highway Research Program Design Guidance for Column-Supported Embankments based on "Ground Improvement Methods Reference Manual Vol. II", FHWA NHI-06-020. The above mentioned design guidance recommends a minimum LTP thickness of 3 feet with one to three layers of geosynthetic reinforcement.

9.9.2 Newtown Loop B Station 11+83.84 to Station 16+50

This area will require up to 15 feet of new fill to reach the proposed grades between about Station 11+83.84 and Station 16+50. Settlement calculations indicated 7 to 12 inches of settlement during construction and for 20-years after construction completion. These settlement values are considered excessive and the use of PVD/surcharge as ground improvement is recommend in this area to accelerate the primary consolidation of the compressible Upper Clay 1 and Upper Clay 2 strata under the proposed embankment. A waiting period of 90 and 120 days is recommended after placement of the new fill material and surcharge to allow the primary consolidation to dissipate prior to roadway paving. The settlement calculations are included in Appendix C. We calculated that a surcharge requirement of 3 feet above finished grade will be required to dissipate the primary consolidation and to limit the secondary compression to acceptable limits. Surcharging above final grade should be constructed at a 2H:1V slope. It is noted that short-term factors of safety were at least 1.3 for the start of the surcharging period prior to soil strength gain. PVDs should generally be installed below the bottom of the upper clay strata. This corresponds to approximately El. -45 ft in most areas. PVDs should be placed in a triangular pattern at a 5-foot center-to-center spacing. PVDs should be placed from toe-of-slope to midway up the existing slope. A drainage blanket should be placed after subgrade preparation and prior to wick drain installation. The drainage material should consist of a minimum of 18 inches of material with less than 5 percent passing the No. 200 sieve.

9.9.3 Newtown Road Ramp C Station 11+00 to Station 12+50

The proposed Newtown Road Ramp C will require up to 9 feet of new fill to reach the proposed grades between about Station 11+00 and Station 12+50. Settlement calculations indicated 3 to 8 inches of settlement during construction and for 20-years after construction completion. This settlement is considered excessive because it will occur adjacent to a structure (Wall B). Therefore, the use of PVD/surcharge as ground improvement is recommend between Station 11+00 and Station 12+50 to accelerate the settlement of the new fill material under the embankment. A waiting period of 90 and

120 days is recommended after placement of the new fill material and surcharge to allow the primary consolidation to dissipate prior to roadway paving. The settlement calculations are included in Appendix C. We calculated that a surcharge requirement of 3 feet above finished grade will be required to dissipate the primary consolidation and to limit the secondary compression to acceptable limits.

Surcharging above final grade should be constructed at a 2H:1V slope. It is noted that short-term factors of safety were at least 1.3 for the start of the surcharging period prior to soil strength gain. PVDs should generally be installed below the bottom of the Upper Clay 2 stratum. This corresponds to approximately El. -45 feet in most areas. PVDs should be placed in a triangular pattern at a 5-foot center-to-center spacing. PVDs should be placed from toe-of-slope to midway up the existing slope. A drainage blanket should be placed after subgrade preparation and prior to PVD installation. The drainage material should consist of a minimum of 18 inches of material with less than 5 percent passing the No. 200 sieve.

This area of Newtown Road Ramp C is adjacent to proposed Wall B. The proposed Wall B will also need the use of PVD/surcharge as ground modification. The recommendations for Wall B are included in the I-264/Witchduck Road Interchange & Ramp Extension (C-D Road) MSE Wall Geotechnical Report dated February 7, 2017 prepared by AECOM. The construction of Wall B and the Newtown Road Ramp C embankment between about Station 11+00 and Station 12+50 should be coordinated during construction.

9.9.4 I-264 Station 155+50 to I-264 Station 171+00

This section of roadway embankment along I-264 will require up to 10 feet of new fill to reach the proposed grades between about Station 155+50 and Station 171+00. Settlement calculations using lightweight fill consisting of expanded shale indicate about 2 inches of settlement over the design life, including about one inch of secondary compression. This magnitude of settlement is considered acceptable and it is recommended that lightweight fill material consisting of expanded shale be used in this area. A waiting period of 30 to 60 days should be considered to allow settlement to occur in this area. PVDs and surcharge will not be needed in this area. The settlement calculations are included in Appendix C. Settlement calculations indicate as much as about 1 inch of additional settlement along the edges of existing shoulders, due to placement of new lightweight fill.

9.9.5 I-264 Station 176+50 to I-264 Station 182+50

This section of roadway improvements will require up to 15 feet of new fill to reach the proposed top of the embankments. We calculated 6 to 10 inches of settlement during construction and for 20-years after construction is complete. These settlement values are considered excessive. Therefore, the use of PVD/surcharge as ground improvement is recommend between Station 176+00 to Station 182+50 to accelerate the dissipation of the primary consolidation due to the new fill material. A waiting period between 90 and 120 days is recommended after construction of the embankment and surcharge to allow primary consolidation to dissipate prior to roadway paving. The settlement calculations are included in Appendix C. We calculated that a surcharge requirement of 3 feet above finished grade will be required to dissipate the primary consolidation and to limit the secondary compression to acceptable limits.

Surcharging above final grade should be constructed at a 2H:1V slope. It is noted that short-term factors of safety were at least 1.3 for the start of the surcharging period prior to soil strength gain. PVDs should generally be installed below the bottom of the Upper Clay 2 Stratum. This corresponds to approximately El. -45 ft in most areas. PVDs should be placed in a triangular pattern at a 5-foot center-to-center spacing. PVDs should be placed from the proposed toe-of-slope to midway up the existing slope. A drainage blanket should be placed after subgrade preparation and prior to PVD installation. The drainage material should consist of a minimum of 18 inches of material with less than 5 percent passing the No. 200 sieve.

Settlement calculations indicate as much as about 1 to 3 inches of additional settlement along the edges of existing I-264 due to placement of new grading fill and additional settlement of as much as about 3 to 4 inches at the edges of existing shoulders, due to placement of new fill. It was decided by VDOT at the January 4th meeting that these magnitudes of settlement would be acceptable for this project, due to the significant cost savings with the PVD/surcharge approach. Additional maintenance and pavement milling and overlays may be needed in areas of existing pavement when using the PVD/surcharge approach..

An existing CSX Railroad Bridge overpass is located at about Station 182+50. It is understood that the CSX Bridge is supported on piles. The settlement of the new fill adjacent to the bridge piles will induce lateral stresses and downdrag forces onto the new piles, which could damage the piles. It is considered that the risk of damage to the existing piles is not acceptable and it is recommended that the roadway embankment adjacent to the CSX Bridge be supported on piles. The pile-supported embankment should extend a minimum of 80 feet from the bridge. A 60-foot long transition zone to transition from piles to PVD/surcharge should be constructed adjacent to pile supported embankment. A detail of the pile supported embankment and transition zone is provided as Figure 4. The piles for the pile-supported embankment at the toe of the existing slope should be founded into the Yorktown formation soils. Piles should extend where new fill will be placed and up to the top of the existing roadway embankment slopes. It is noted that piles placed within the existing roadway embankment slopes can be designed for a lower nominal (ultimate) pile resistance values because of lower fill heights in these areas. Estimated pile tip elevations were raised in existing embankment slope areas to reduce pile lengths. It is our understanding that transportation of piles longer than 110 feet is problematic. Piles can be designed for nominal (ultimate) pile resistances provided in Table 8. A resistance factor (Φ) of 0.65, per the LRFD Code, must be applied to calculate the factored pile resistance

Table 8 - Piles for Pile Supported Embankments

Proposed Fill Height (feet)	Pile Type	Pile Size (in)	Nominal (ultimate) Pile Resistance (kips)	Estimated Pile Tip Elevation (ft)
5 or less	Square Precast Concrete	12	90	-49
5 to 10			143	-64
10 to 15			215	-69
15 to 20			350	-75
20 to 30			447	-79

It is noted that the piles were not designed for downdrag loads because settlements adjacent to piles were expected to be small enough that downdrag loads would not develop on the piles. Piles should be spaced at a center-to-center spacing of 7 feet. A concrete pile cap 3.5 feet square should be constructed at the top of each pile. The pile supported embankment calculations are included in Appendix E. Additional pile recommendations are included in the "Pile Installation Consideration" Section 10.2 of this report.

A three-foot thick Load Transfer Platform (LTP) system shall be installed over the piles and should extend 5 feet beyond the last row of piles. The LTP should extend below the embankment fill and on top of the pile caps. The LTP fill material shall be crushed stone such as VDOT CBR No. 30 Coarse Aggregate. The LTP shall consist of three "doubled" layers of High Strength GeoSynthetic reinforcement (HSGS). Each "doubled" HSGS layer shall consist of two layers of HSGS placed such that the strong direction is perpendicular to the alignment for one layer and parallel to the alignment for the second layer. The first "doubled" HSGS layer shall be placed over a 6-inch lift of crushed stone above the tops of the pile caps. The second "doubled" HSGS layer shall be placed above the first "doubled" geosynthetic layer, separated by a 6 in lift of crushed stone. The third "doubled" layer of geosynethetic shall be placed above the second "doubled" geosynthetic layer, separated by a 6 in lift of crushed stone. Eighteen inches of crushed stone shall be placed over the top "doubled" layer if HSGS. The HSGS material should have a minimum long-term allowable tensile strength of 800 pounds per linear foot and a minimum long-term stiffness of 16,000 pounds per linear foot.

9.9.6 I-264 Station 185+50 to 191+50, Station 193+00 to 194+00 and Witchduck Permanent Road Loop B from Station 16+50 to 21+00

These roadway improvement areas will require new fill heights of up to 29 feet to reach the proposed grades. We calculated 5 to 20 inches of settlement during construction and for 20-years after construction is complete. Therefore, ground improvement is recommended for these embankment areas. It is our understanding that sufficient time is available in the construction schedule to use PVD/surcharge in these areas. Therefore, PVD/surcharge is recommended in these areas.

The use of PVDs as ground improvement is recommended to accelerate the dissipation of the primary consolidation due to the new fill material. A waiting period of 90 and 120 days is recommended after construction of the embankments and surcharges to allow primary consolidation to dissipate prior to roadway paving. The settlement calculations are included in Appendix C. We calculated that a surcharge requirement of 3 to 5 feet above finished grade will be required to limit the secondary compression to acceptable limits.

Surcharging above final grade should be constructed at a 2H:1V slope. It is noted that short-term factors of safety were at least 1.3 for the start of the surcharging period prior to soil strength gain. PVDs should generally be installed below the bottom of the Upper Clay 2 Stratum. This corresponds to approximately El. -45 ft in most areas. PVDs should be placed in a triangular pattern at a 5-foot center-to-center spacing. PVDs should be placed from the proposed toe-of-slopes to midway up the existing slopes. Drainage blankets should be placed after subgrade preparation and prior to PVD installation. The drainage material should consist of a minimum of 18 inches of material with less than 5 percent passing the No. 200 sieve.

Settlement calculations indicate as much as about 1 to 3 inches of additional settlement along the edges of existing I-264 due to placement of new grading fill and additional settlement of as much as about 3 to 4 inches at the edges of existing shoulders, due to placement of new fill. It was decided by VDOT at the January 4th meeting that these magnitudes of settlement would be acceptable for this project, due to the significant cost savings with the PVD/surcharge approach. Additional maintenance and pavement milling and overlays may be needed in areas of existing pavement when using the PVD/surcharge approach.

Minor fills and cuts will be required to reach the proposed grades for Witchduck Permanent Loop B between Station 10+00 and Station 16+50 and minor settlements, which are less than VDOT’s maximum settlement criteria, are expected in this area. Therefore, ground improvement is not considered necessary for Loop B between Station 10+00 and Station 16+50.

An existing CSX Railroad Bridge overpass is located at about Station 185+50. It is understood that the CSX Bridge is supported on piles. The settlement of the new fill adjacent to the bridge piles will induce lateral stresses and downdrag forces onto the new piles, which could damage the piles. It is considered that the risk of damage to the existing piles is not acceptable and it is recommended that the roadway embankment adjacent to the CSX Bridge be supported on piles. The pile-supported embankment should extend a minimum of 80 feet from the bridge. A 60-foot long transition zone to transition from piles to PVD/surcharge should be constructed adjacent to pile supported embankment. A detail of the pile supported embankment and transition zone is provided as Figure 4. The piles for the pile-supported embankment at the toe of the existing slope should be founded into the Yorktown formation soils. Piles should extend where new fill will be placed and up to the top of the existing roadway embankment slopes. It is noted that piles placed within the existing roadway embankment slopes can be designed for a lower nominal (ultimate) pile resistance values because of lower fill heights in these areas. Estimated pile tip elevations were raised in existing embankment slope areas to reduce pile lengths. It is our understanding that transportation of piles longer than 110 feet is problematic. Piles can be designed for nominal (ultimate) pile resistances provided in Table 9. A resistance factor (Φ) of 0.65, per the LRFD Code, must be applied to calculate the factored pile resistance

Table 9 - Piles for Pile Supported Embankments

Proposed Fill Height (feet)	Pile Type	Pile Size (in)	Nominal (ultimate) Pile Resistance (kips)	Estimated Pile Tip Elevation (ft)
5 or less	Square Precast Concrete	12	90	-49
5 to 10			143	-64
10 to 15			215	-69
15 to 20			350	-75
20 to 30			447	-79

It is noted that the piles were not designed for downdrag loads because settlements adjacent to piles were expected to be small enough that downdrag loads would not develop on the piles. Piles should be spaced at a center-to-center spacing of 7 feet. A concrete pile cap 3.5 feet square should be constructed at the top of each pile. The pile supported embankment calculations are included in Appendix E. Additional pile recommendations are included in the "Pile Installation Consideration" Section 10.2 of this report.

A three-foot thick Load Transfer Platform (LTP) system shall be installed over the piles and should extend 5 feet beyond the last row of piles. The LTP should extend below the embankment fill and on top of the pile caps. The LTP fill material should be crushed stone such as VDOT CBR No. 30 Coarse Aggregate. The LTP should consist of three "doubled" layers of High Strength GeoSynthetic reinforcement (HSGS). Each "doubled" HSGS layer should consist of two layers of HSGS placed such that the strong direction is perpendicular to the alignment for one layer and parallel to the alignment for the second layer. The first "doubled" HSGS layer should be placed over a 6-inch lift of crushed stone above the tops of the pile caps. The second "doubled" HSGS layer should be placed above the first "doubled" geosynthetic layer, separated by a 6 in lift of crushed stone. The third "doubled" layer of geosynethetic should be placed above the second "doubled" geosynthetic layer, separated by a 6 in lift of crushed stone. Eighteen inches of crushed stone should be placed over the top "doubled" layer if HSGS. The HSGS material should have a minimum long-term allowable tensile strength of 800 pounds per linear foot and a minimum long-term stiffness of 16,000 pounds per linear foot.

9.9.7 Temporary On Ramp A from Witchduck Road Station 203+00 to 205+00

Temporary On Ramp A will be constructed to divert traffic temporarily while the proposed Witchduck Permanent Loop B is constructed. We understand that Temporary On Ramp A will remain in service for about 3 to 4 months. This temporary ramp will be removed after permanent Witchduck Ramp A and Loop B are opened to traffic. Construction of the Temporary On Ramp A will require placement of up to 26 feet of new fill. We calculated up to about 16 inches of settlement. Most of the settlement is expected to take place within about 3 to 4 months after fill is placed.

The use of PVDs as ground improvement is recommended for this temporary ramp to accelerate the dissipation of the primary consolidation due to the new fill material. A waiting period between 90 and 120 days is recommended after construction of the embankment to allow primary consolidation to dissipate prior to roadway paving. PVDs should generally be installed below the bottom of the Upper Clay 2 Stratum. This corresponds to approximately El. -45 ft in most areas. PVDs should be placed in a triangular pattern at a 5-foot center-to-center spacing from the proposed toe-of-slope to proposed toe-of-slope. A drainage blanket should be placed after subgrade preparation and prior to PVD installation. The drainage material should consist of a minimum of 18 inches of material with less than 5 percent passing the No. 200 sieve. Since this ramp will be used temporarily, we recommend that normal weight fill be placed in this area and that additional maintenance and overlays be considered for the area.

9.9.8 Temporary On Ramp B to Witchduck Road Station 400+00 to 406+00

Temporary On Ramp B will be constructed to divert traffic temporarily, while the proposed permanent Witchduck Ramp A and Wall K are constructed. Temporary On Ramp B will be in use for a short period of time and will be removed after permanent Witchduck Ramp A and Wall K are ready to be opened to traffic. Construction of temporary Ramp B in this area will require placement of up to 6 feet of new fill and as much as about 4 inches of settlement is expected. Since this ramp will be used temporarily, we recommend that normal weight fill be placed in this area and that additional maintenance and overlays be considered for the area.

9.9.9 Underground Utilities

Several existing underground utility pipes are present within some areas of the new proposed roadway embankments. Several proposed utilities will be installed as part of the proposed I-64/I-264 Witchduck Road interchange improvement project. The new fill material required to build the roadway embankments will induce additional stresses onto the Upper Clay 1 and Upper Clay 2 soils present at the site, which will cause these soils to consolidate and settle. The settlement analyses indicate that as much as 20 inches of settlement is expected in some areas of the project. Therefore, the existing pipes that are proposed to remain should be protected from damage by the settlement of the new fill placed above the existing pipes. Similarly, the proposed pipes can potentially be damaged if installed before the settlement has adequately dissipated.

Where existing critical underground utilities are present below the proposed embankments, Geofoam material should be used as fill material over the existing utilities to avoid excessive settlement. We recommend that Geofoam be placed over the critical utilities in the I-264 area where PVD/surcharging is performed, where normal weight fill is used and where normal weight fill heights exceed 3 feet. The Geofoam should extend a minimum of 3 times the height of fill above the pipe on each side of the utility (i.e., a 20 feet high fill should extend laterally 60 feet on each side of the utility). Geofoam is not considered necessary over utilities in areas where ground improvement consists of a pile-embankments.

Proposed underground utility pipes, if the construction schedule permits, should be installed after the primary settlement has dissipated (i.e., reasonable completion) and surcharge has been removed. However, if the proposed underground utility is installed during construction of the embankment, then Geofoam can generally be used as fill material over the new pipe as recommended above. Flexible connections may also be used to limit potential damage to new utilities, although “only flexible connections” should not be used if settlement is expected to exceed about 2 inches.

A new 60-inch storm sewer pipe is planned to extend below Witchduck Ramp A, Wall K and Witchduck Permanent Road Loop . This pipe should not be installed prior to the settlement waiting period is completed to avoid damage to this pipe. It is recommended to install a sacrificial corrugated high density polyethylene (HDPE) pipe prior to placement of fill and settlement and then install a replacement pipe after the waiting period is completed and the surcharge is removed. The final replacement pipe could be installed either by performing an open excavation below Witchduck Ramp A, Wall K and Witchduck Permanent Road Loop or by jack and bore.

It may be necessary to jack and bore the replacement pipe under Witchduck Ramp A, Wall K and Witchduck Permanent Road Loop areas due to the depths of excavation that would be required with an open-cut excavation. A receiving pit will be needed at the west end of Witchduck Ramp A and Wall K. Due to the proximity of Witchduck Ramp A and Wall K to the Elizabeth River, a three-sided cofferdam may be needed in the river and a special permit will likely be needed. The soils in the jack and bore excavation zone are expected to be very soft and below the ground water table. To avoid excavation face instability issues, it is our opinion that ground improvement of the excavation zone using jet grouting be performed. The jet grouting is recommended to extend at least 12 inches beyond the utility excavation. It would be easiest to install the ground improvement before the fill is placed, but then settlement of the grout zone will need to be considered and additional grouting will be needed above the pipe to account for soil settlement. If jet grouting is performed after the waiting period and surcharge removal, the jet grouting will need to be performed through the roadway embankment and through the sides of the embankment, which will make the jet grouting much more difficult.

10.0 CONSTRUCTION CONSIDERATIONS

10.1 Observational Method of Staged Construction Utilizing Instrumentation

The observational method is based upon the premise of instrumenting the embankments and subsoils and assessing the behavior as construction proceeds. Initial designs can often be adjusted based on observed performance, so that subsequent stages and areas of the project can best utilize actual field data and translate this information into cost savings and schedule improvements. In order to take advantage of the observational method, regular monitoring of instrumentation such as settlement platforms, piezometers, inclinometers, and magnetic extensometers in the embankments and subsoils should be performed during all phases of construction. Each of these instruments can provide useful information. The settlement platforms provide surface settlement information. The piezometers provide information on excess pore pressures in clay strata. The inclinometers indicate lateral movements at the toe of slopes. Magnetic extensometers are very critical for the subsurface conditions at this site because they provide information on the magnitude and rate of compression of the individual clay strata. A conceptual instrumentation plan is shown in Figure 6. A more detailed plan and description of instrumentation will be issued in a separate report.

The recommendations in this report were prepared with the assumption that AECOM would closely monitor all instrumentation data and provide written approval for subsequent stages to be constructed.

10.2 Pile Installation Considerations

The estimated pile penetration depths indicate the depths at which the factored resistance values are predicted to develop for the recommended pile sizes. Production pile order lengths should be established by pre-production test/indicator piles. The test piles in turn should be ordered somewhat longer than the estimated penetration length, typically at least 20 feet, but perhaps longer to ensure sufficient length to reach estimated pile tip elevations. Should there be any unusual observations during pile installation, such as unexpected soft or hard zones, lateral drift or “kick,” etc., they must be evaluated by the geotechnical engineer to determine if corrective procedures or additional evaluations are warranted.

The AASHTO code allows use of higher resistance factors for higher quality control levels of production piles. A factor of $\Phi=0.75$ may be used if dynamic testing is performed on all production piles, or if one successful static load test is completed for each site condition. A resistance factor of $\Phi=0.80$ may be used if both a successful static load test, and at least (2) dynamic tests, are completed for each site condition. While static load tests are often not cost effective, in some cases the additional dynamic testing to allow a factor of $\Phi=0.75$ may be cost effective.

As a precursor to test pile installation, the contractor shall propose equipment for driving, substantiated by wave equation analysis. During driving and re-striking the test piles, the entire procedure shall be monitored by dynamic testing, to verify pile stresses and capacities, as well as hammer efficiency and performance. After the minimum wait time and re-striking, the nominal pile capacity shall be refined by signal matching analysis of the dynamic data. Upon review of the driving records, dynamic test data, and signal matching analyses, the dynamic testing engineer shall propose the criteria for installing production piles, subject to review and approval by VDOT and the geotechnical engineer of record.

10.3 Fill Placement and Compaction

All new compacted structural fill and backfill should be placed in loose lifts not exceeding 8 inches in thickness and should be compacted in accordance with VDOT’s compaction requirements and specifications.

Materials to be used as compacted fill in non-reinforced zones should be classified as SM or more granular, and should have a Liquid Limit (LL) and Plasticity Index (PI) of less than 40 and 20, respectively. All material to be used a compacted fill in reinforced zones should satisfy VDOT's requirements and specifications.

Some undercutting of soft upper soils will be required. We suggest that a budget be established for undercutting of soft soils on site. Bridging of soft soils with geotextiles and about 2 feet to 3 feet of VDOT CBR No. 30 crushed stone may also be required in areas.

Excavations that extend below the level of the groundwater table will require construction dewatering. We anticipate that dewatering will need to consist of sumps with submersible pumps, collector trenches and diversion ditches

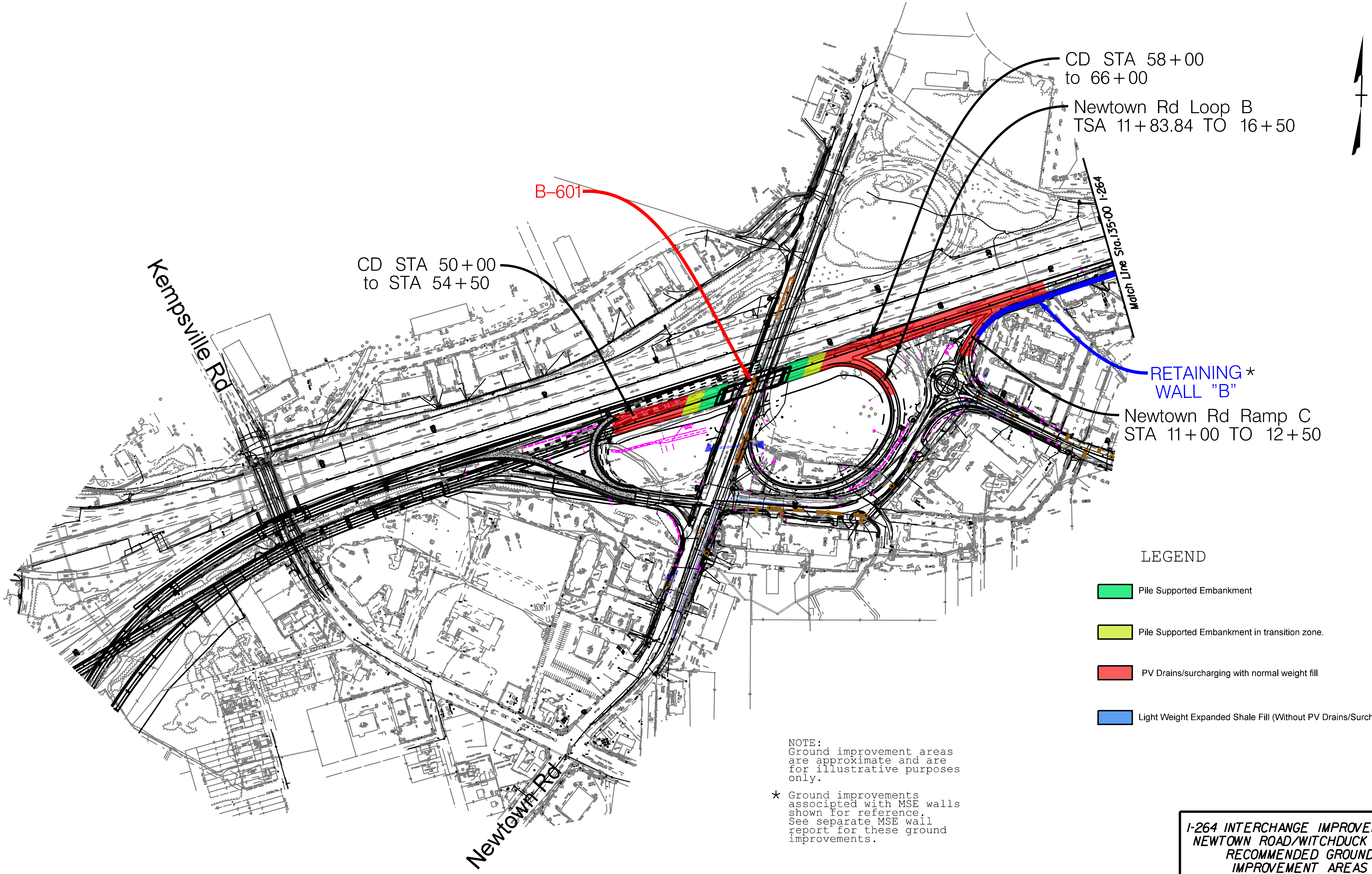
11.0 LIMITATIONS

The analyses and recommendations presented in this report are based on our understanding of the proposed project as described in this report, and data obtained from the previous subsurface exploration and lab testing performed at the site by HDR. We did not observe the subsurface soils during drilling of soil borings and cannot verify the accuracy of the boring information and soil laboratory data obtained by HDR.

This report does not reflect any variations that may occur between HDR's boring and cone locations across the site or in areas that were not sampled. The nature and extent of such variations may not become evident until construction. If variations occur, it will be necessary to reevaluate the recommendations in this report.

This report has been prepared for the exclusive use of the client for specific application to the project discussed, and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranty, express or implied, is provided. In the event that any changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report will not be considered valid unless the changes are reviewed and the conclusions of this report are modified or verified in writing by AECOM.

Figures



LEGEND

🟩 Pile Supported Embankment

🟨 Pile Supported Embankment in transition zone.

🟥 PV Drains/surcharging with normal weight fill

🟦 Light Weight Expanded Shale Fill (Without PV Drains/Surcharging)

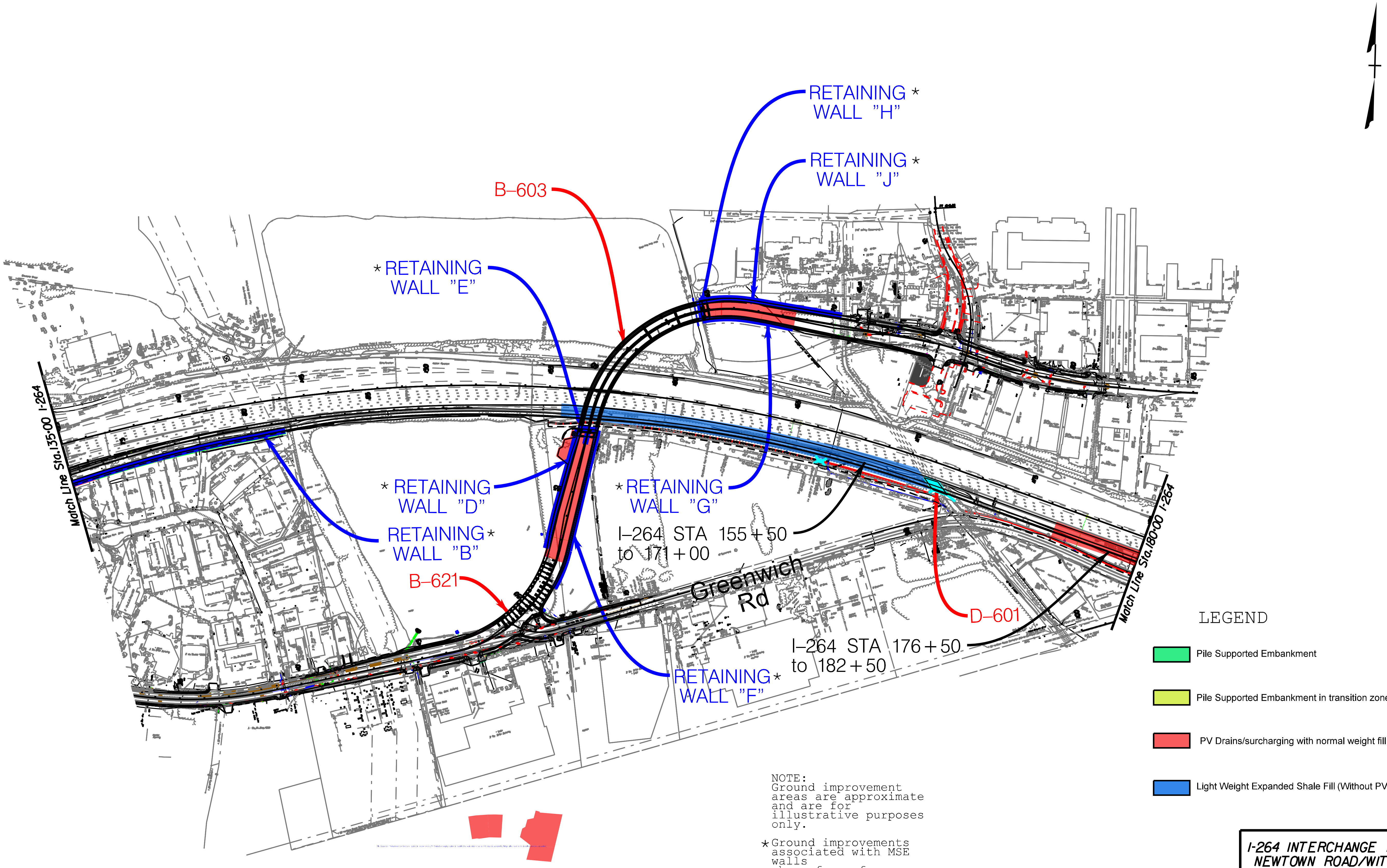
NOTE:
Ground improvement areas are approximate and are for illustrative purposes only.

★ Ground improvements associpted with MSE walls shown for reference. See separate MSE wall report for these ground improvements.

SCALE
0 200' 400'

I-264 INTERCHANGE IMPROVEMENTS
NEWTOWN ROAD/WITCHDUCK ROAD
RECOMMENDED GROUND
IMPROVEMENT AREAS

DATE	PROJECT	SHEET NO.
2-16-2017	17630	Figure 1



LEGEND

🟩 Pile Supported Embankment

🟨 Pile Supported Embankment in transition zone.

🟥 PV Drains/surcharging with normal weight fill

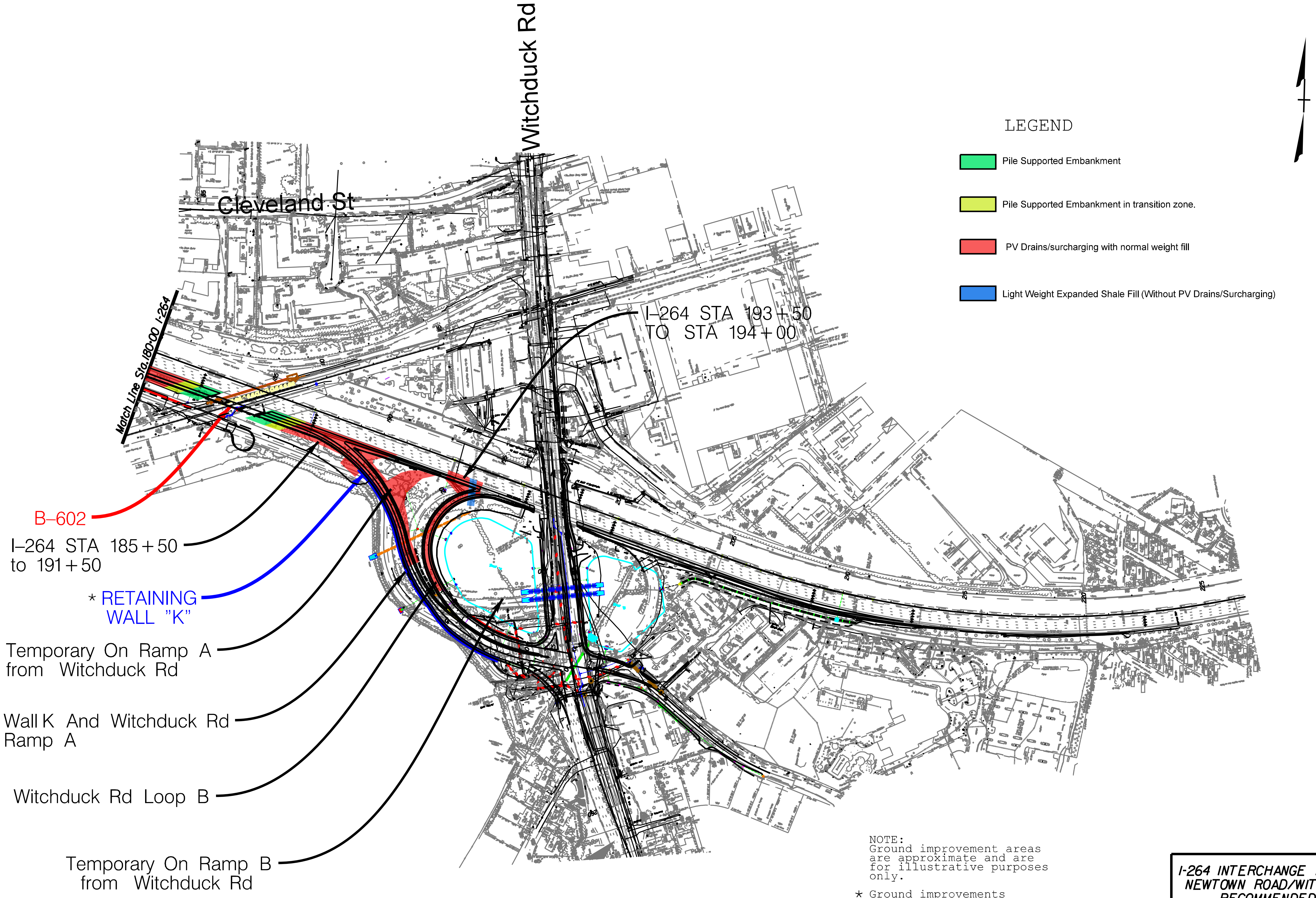
🟦 Light Weight Expanded Shale Fill (Without PV Drains/Surcharging)

NOTE:
Ground improvement areas are approximate and are for illustrative purposes only.

* Ground improvements associated with MSE walls shown for reference. See separate MSE wall report for these ground improvements.

I-264 INTERCHANGE IMPROVEMENTS
NEWTOWN ROAD/WITCHDUCK ROAD
RECOMMENDED GROUND
IMPROVEMENT AREAS

DATE	PROJECT	SHEET NO.
2-16-2017	17630	Figure 2



LEGEND

🟩 Pile Supported Embankment

🟨 Pile Supported Embankment in transition zone.

🟥 PV Drains/surcharging with normal weight fill

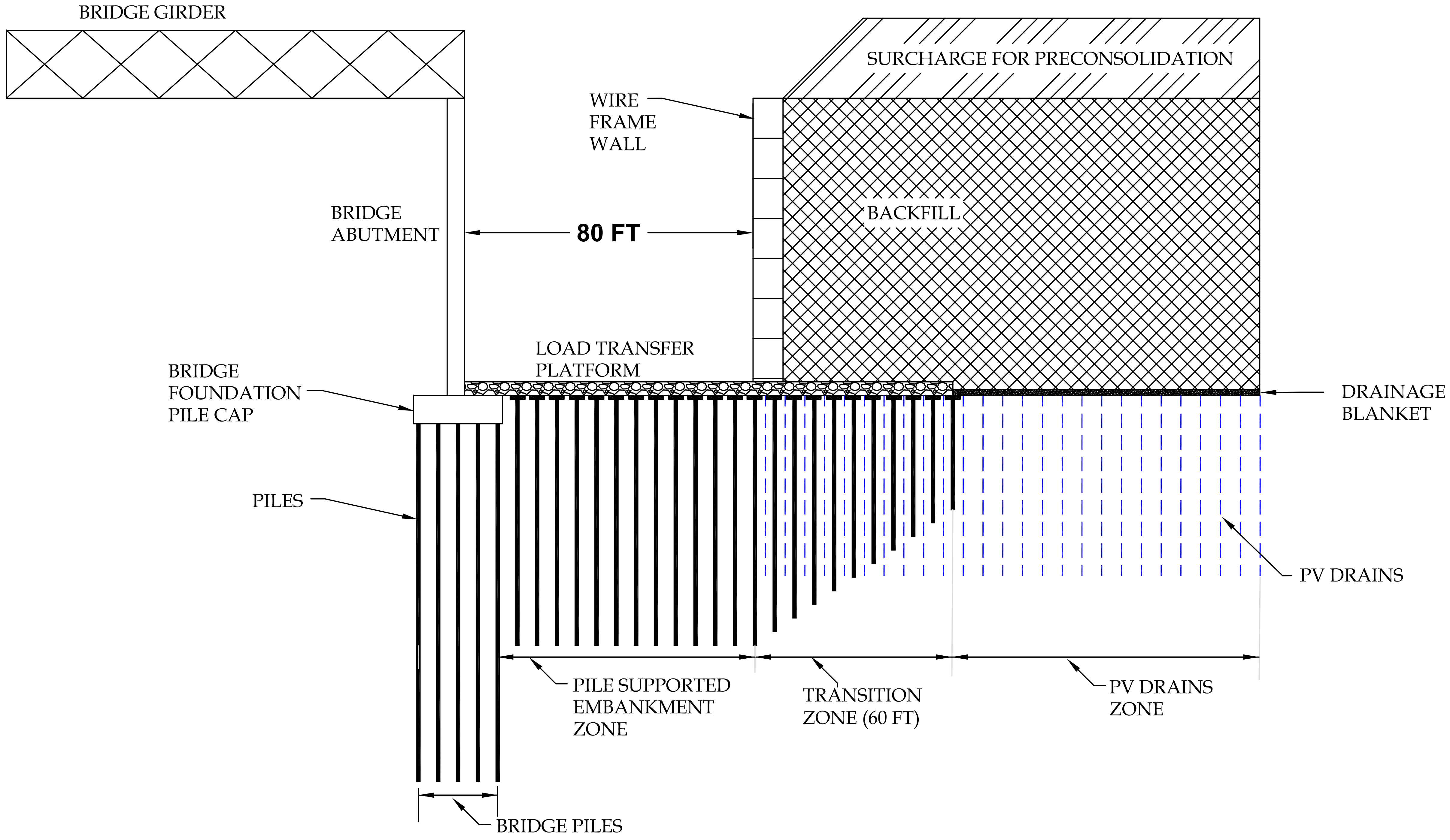
🟦 Light Weight Expanded Shale Fill (Without PV Drains/Surcharging)

NOTE:
Ground improvement areas
are approximate and are
for illustrative purposes
only.

* Ground improvements
associpted with MSE walls
shown for reference.
See separate MSE wall
report for these ground
improvements.

I-264 INTERCHANGE IMPROVEMENTS
NEWTOWN ROAD/WITCHDUCK ROAD
RECOMMENDED GROUND
IMPROVEMENT AREAS

DATE	PROJECT	SHEET NO.
2-16-2017	17630	Figure 3



AECOM

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12420 Milestone Center Dr, Suite 150
Germantown, MD 20876
Tel: (301) 820-3000

VDOT WITCHDUCK ROAD IMPROVEMENTS

PILE SUPPORTED EMBANKMENT
TRANSITION ZONE

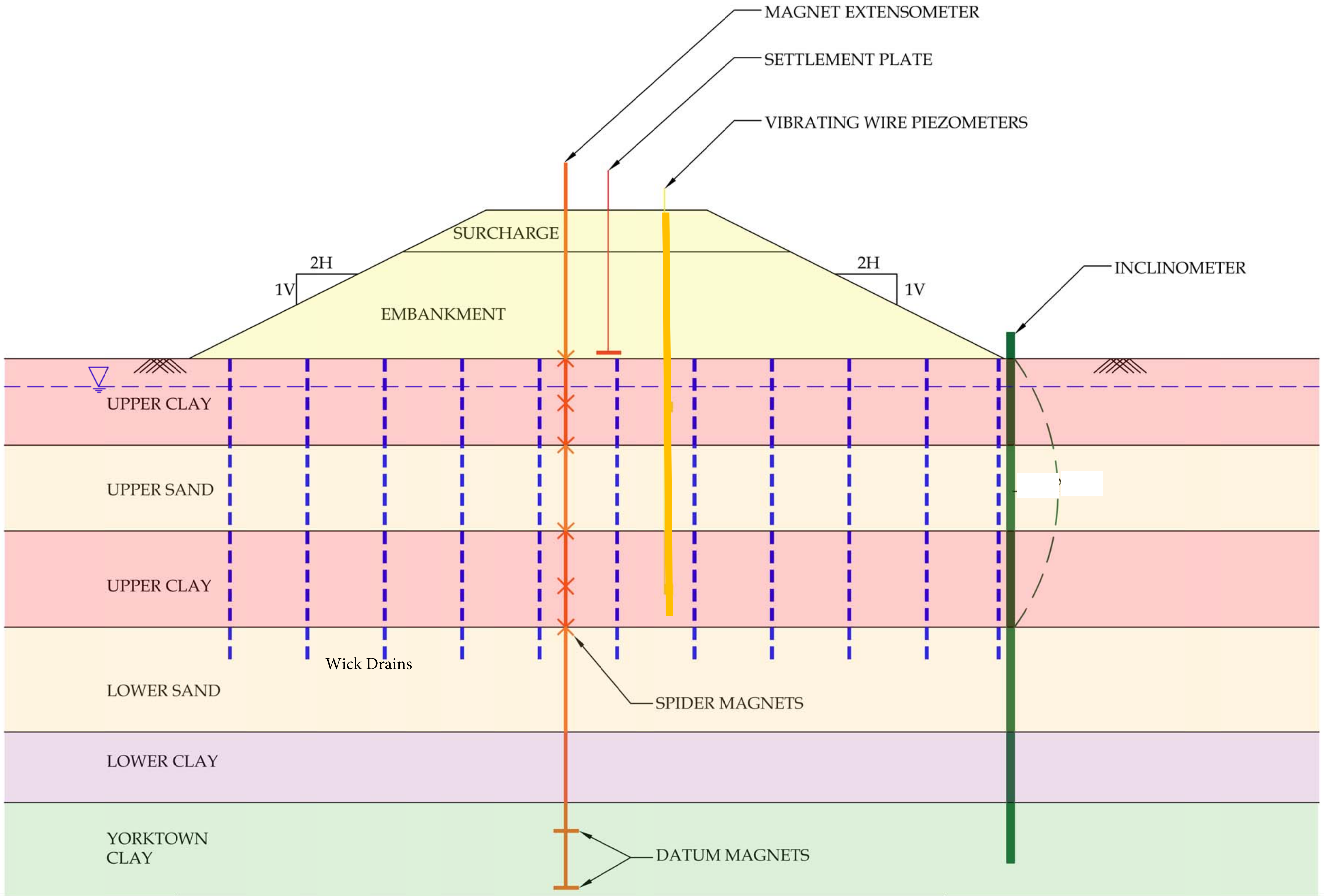
SCALE: NTS

FIGURE : 4

DATE: 01/05/2017

CHECKED BY: RT

PROJECT NO.: 60388899



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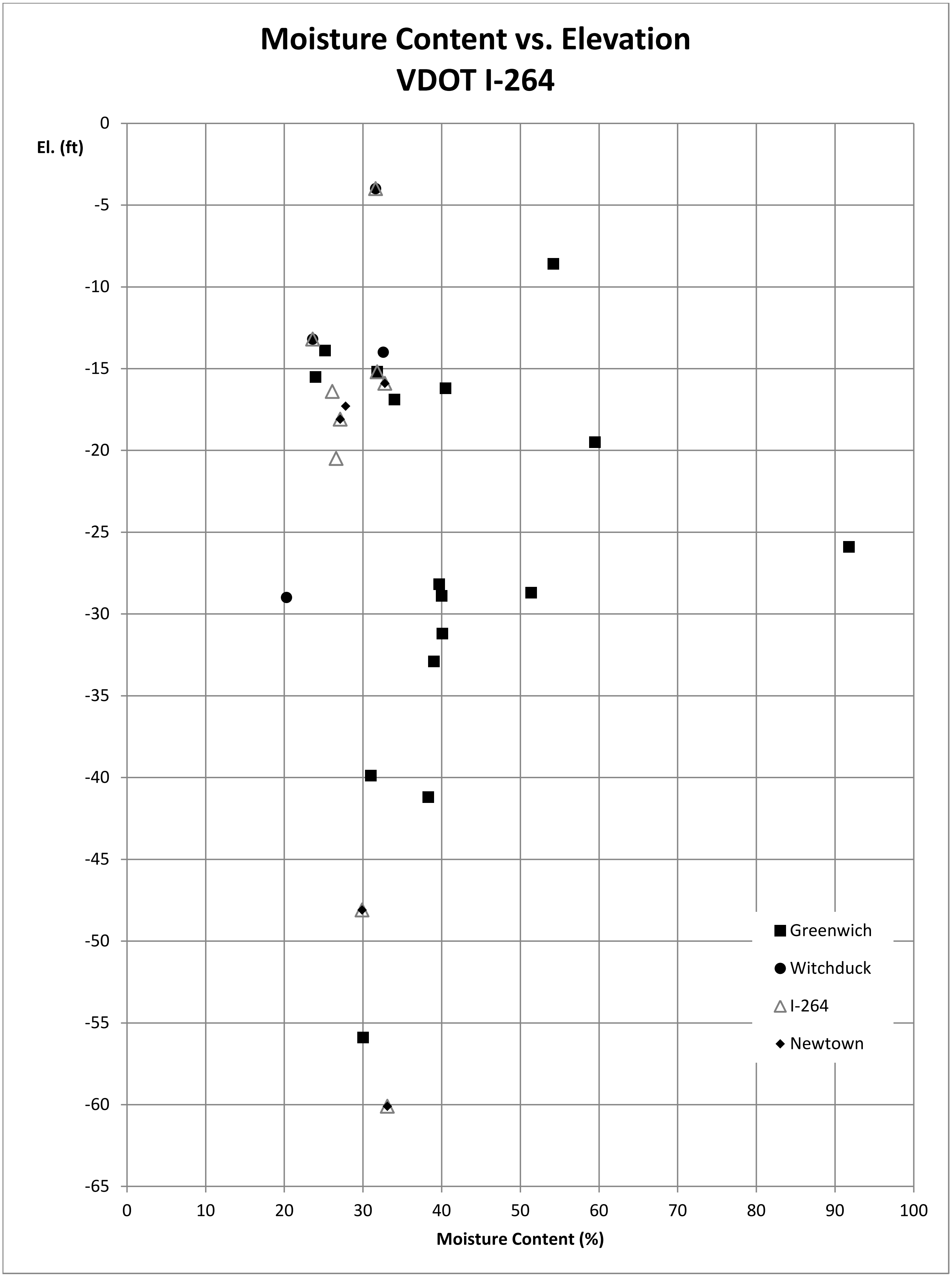
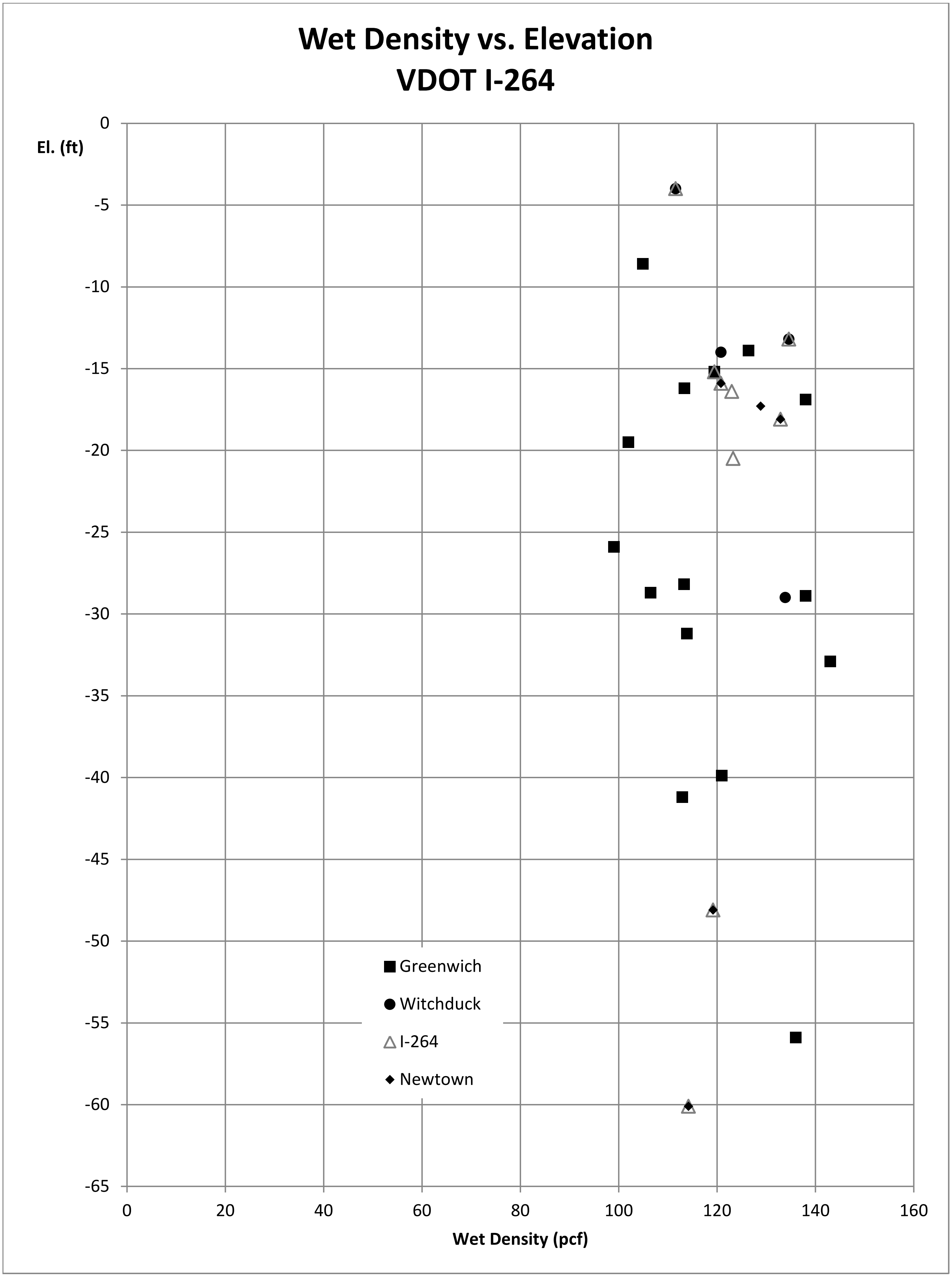
Germantown, MD 20876
Tel: (301) 820-3000

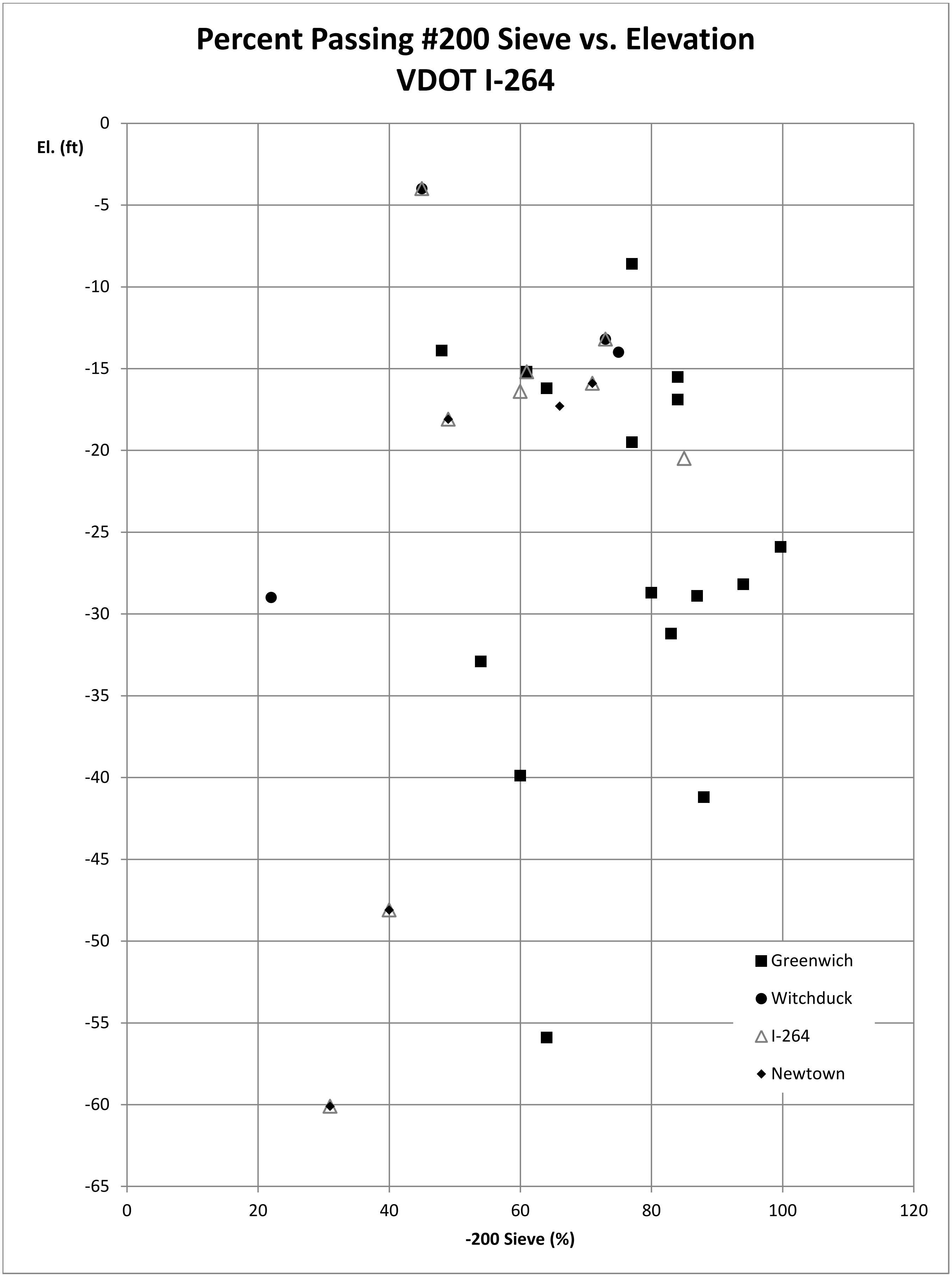
VDOT WITCHDUCK ROAD IMPROVEMENTS			
TYPICAL INSTRUMENTATION PLAN		SCALE: NTS	FIGURE : 5
DATE: 01/05/2017	CHECKED BY: RT	PROJECT NO.: 60388899	

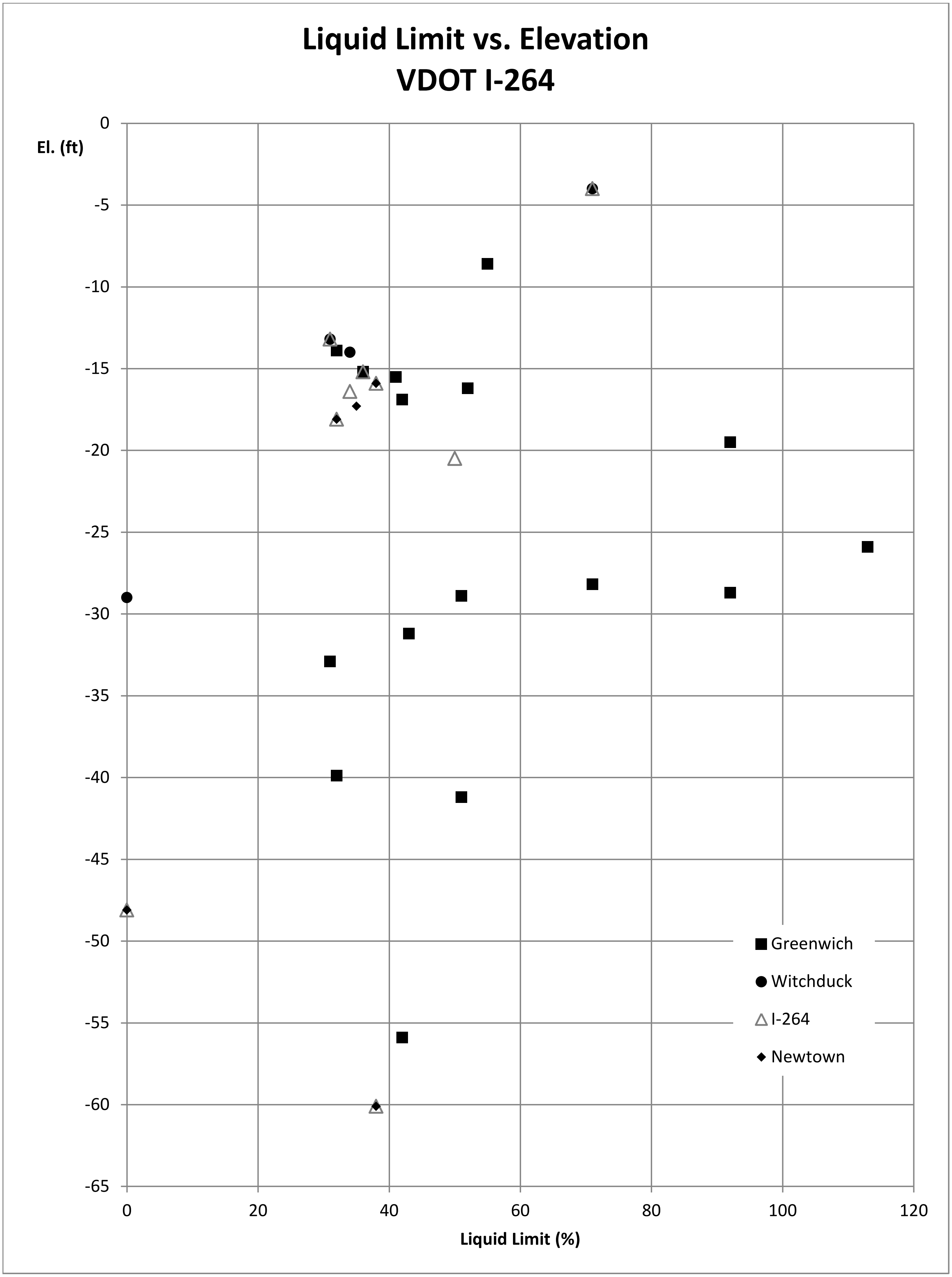
Appendix A:
Soil Laboratory Summary



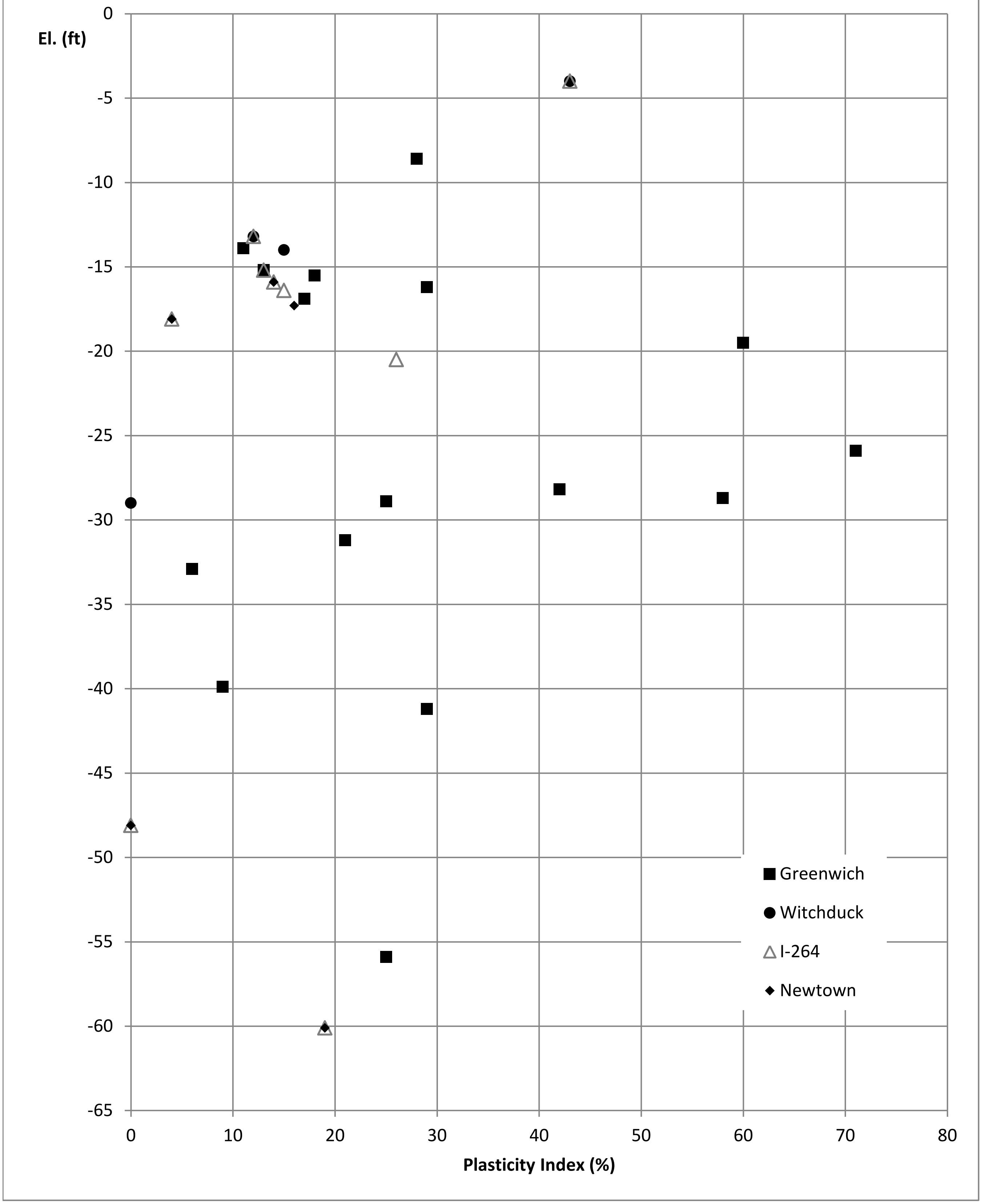
Moisture Content vs. Elevation
VDOT I-264

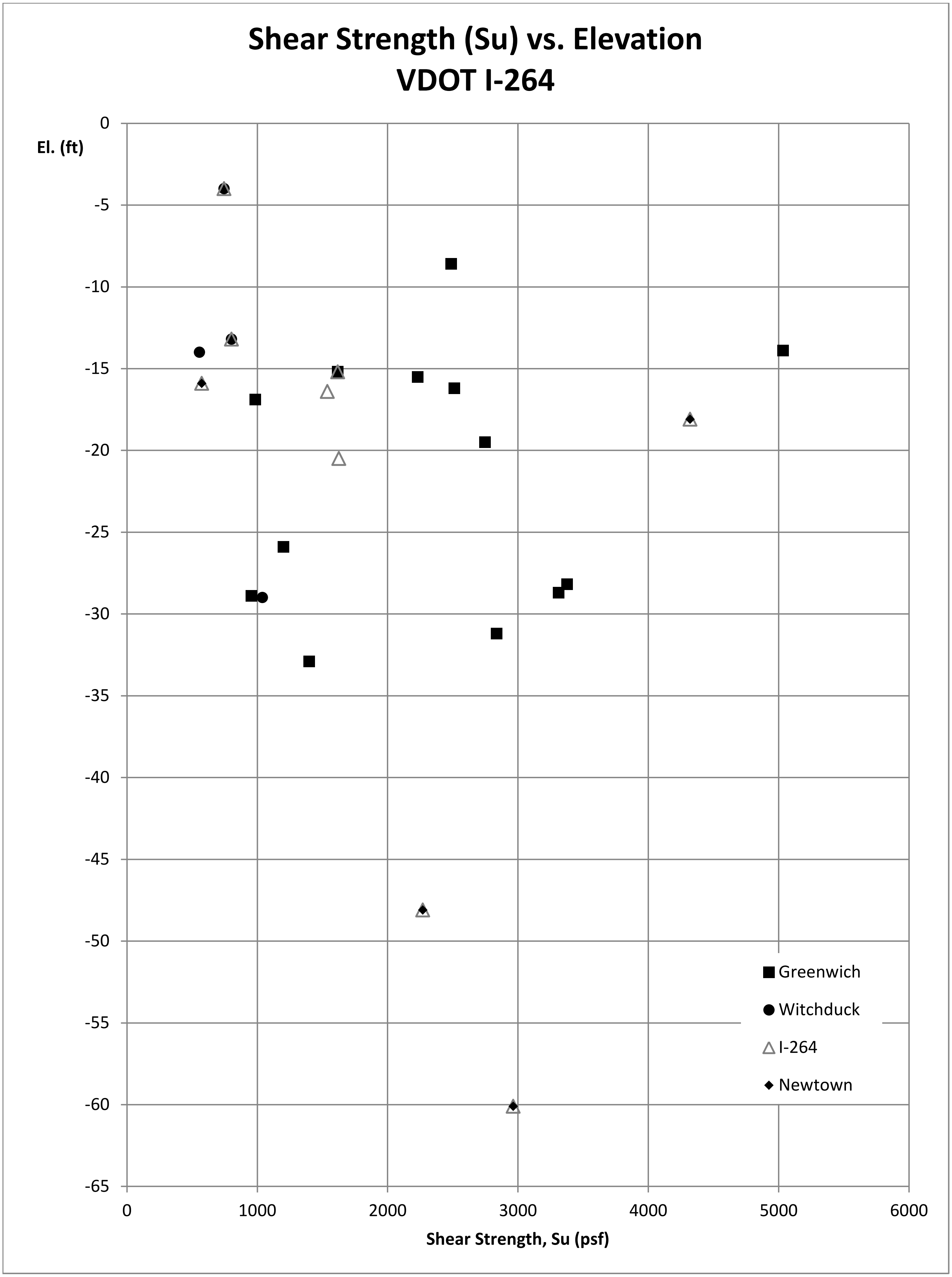

Wet Density vs. Elevation
VDOT I-264
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
20
40
60
80
100
120
140
160
Wet Density (pcf)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

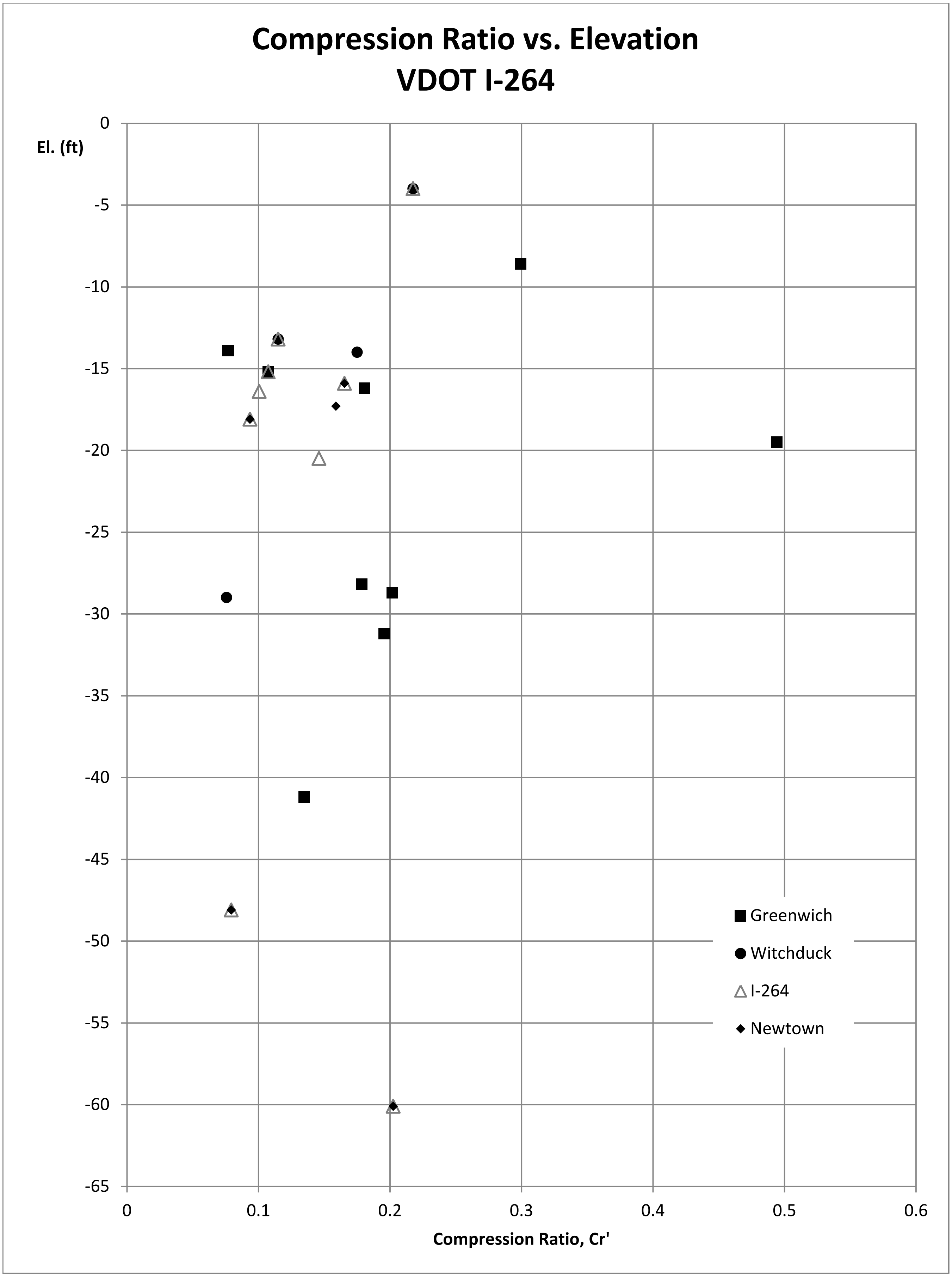

Percent Passing #200 Sieve vs. Elevation
VDOT I-264
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
20
40
60
80
100
120
-200 Sieve (%)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

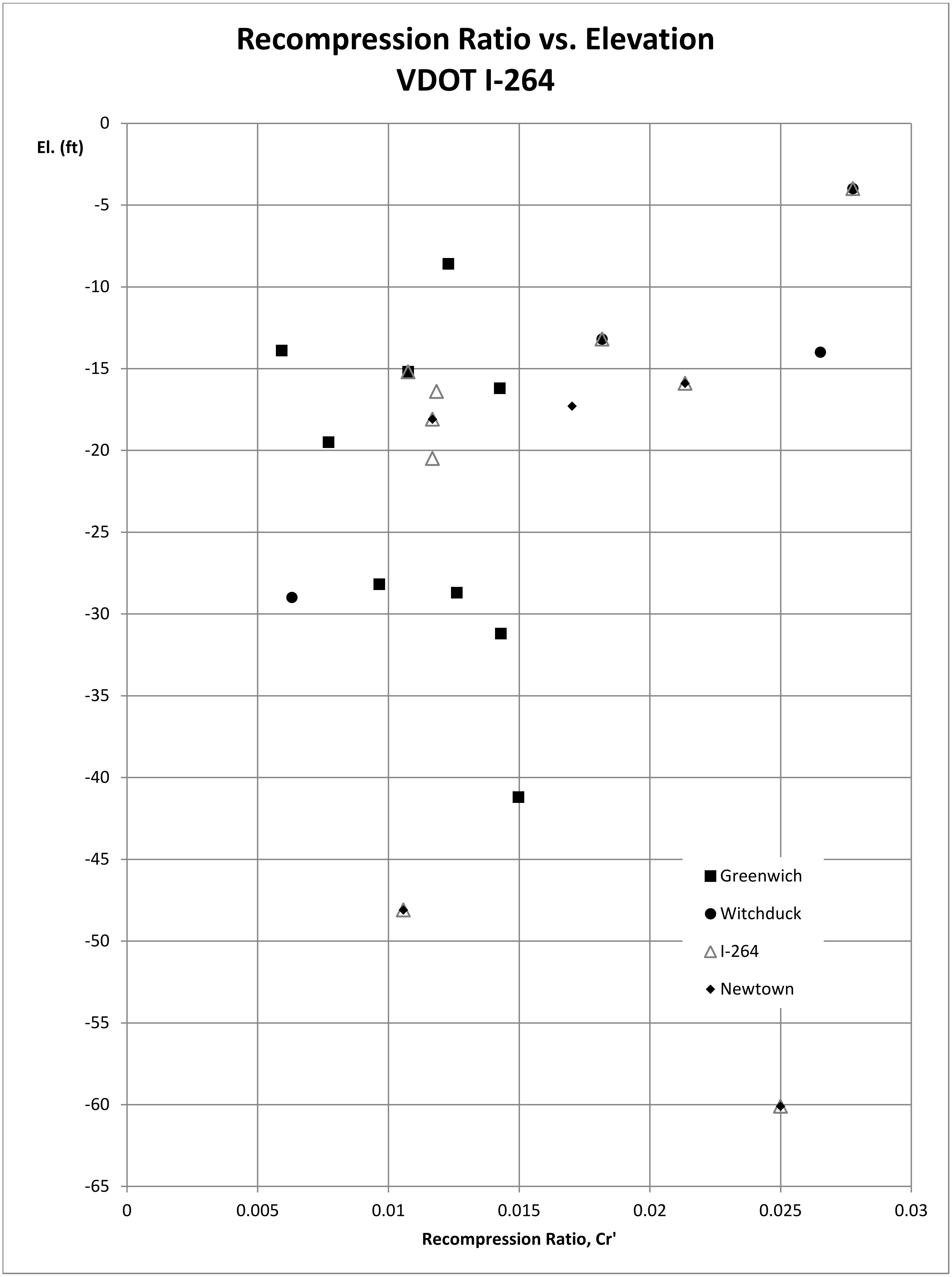

Liquid Limit vs. Elevation
VDOT I-264
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
20
40
60
80
100
120
Liquid Limit (%)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

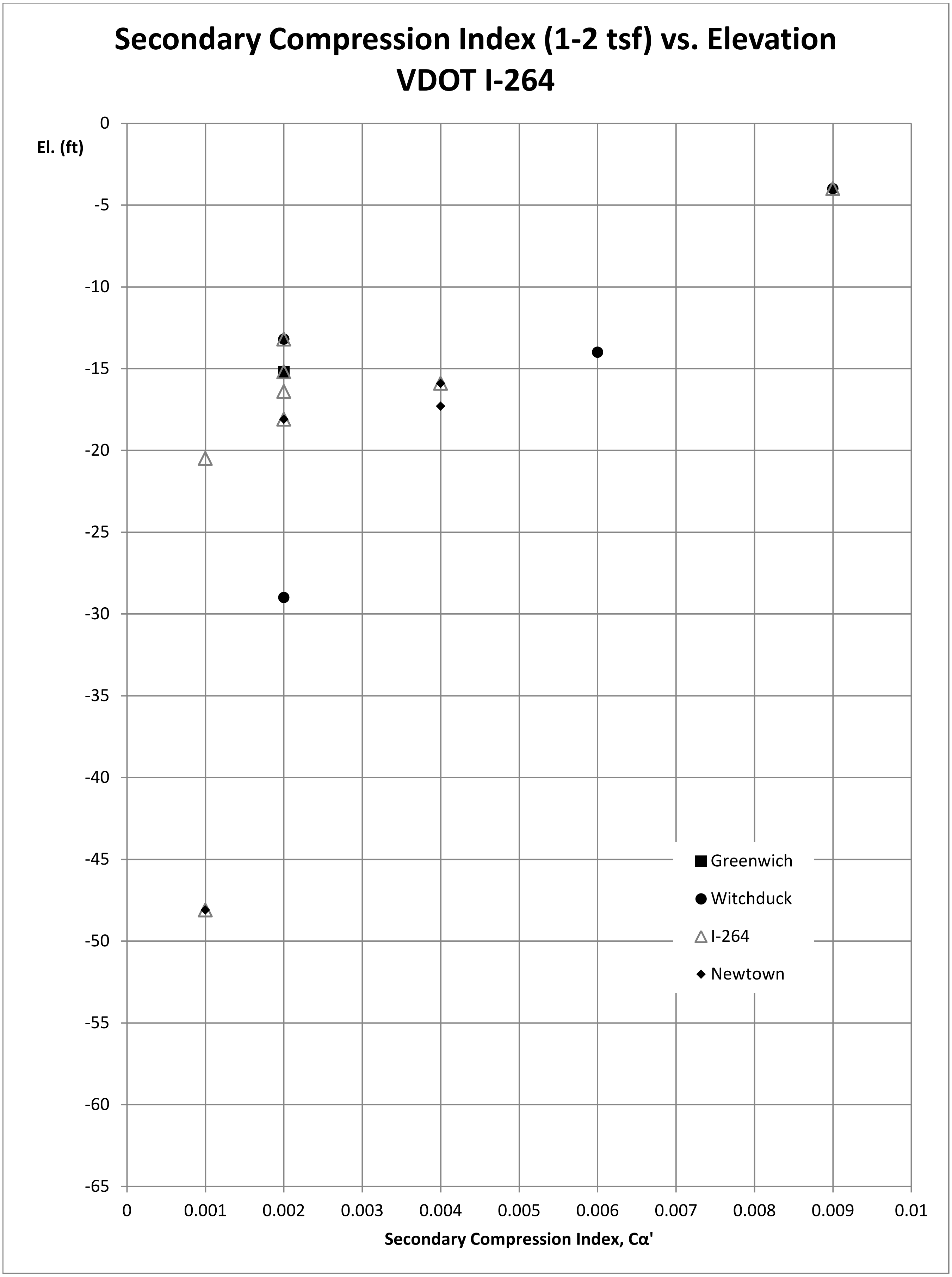
Plasticity Index vs. Elevation
VDOT I-264

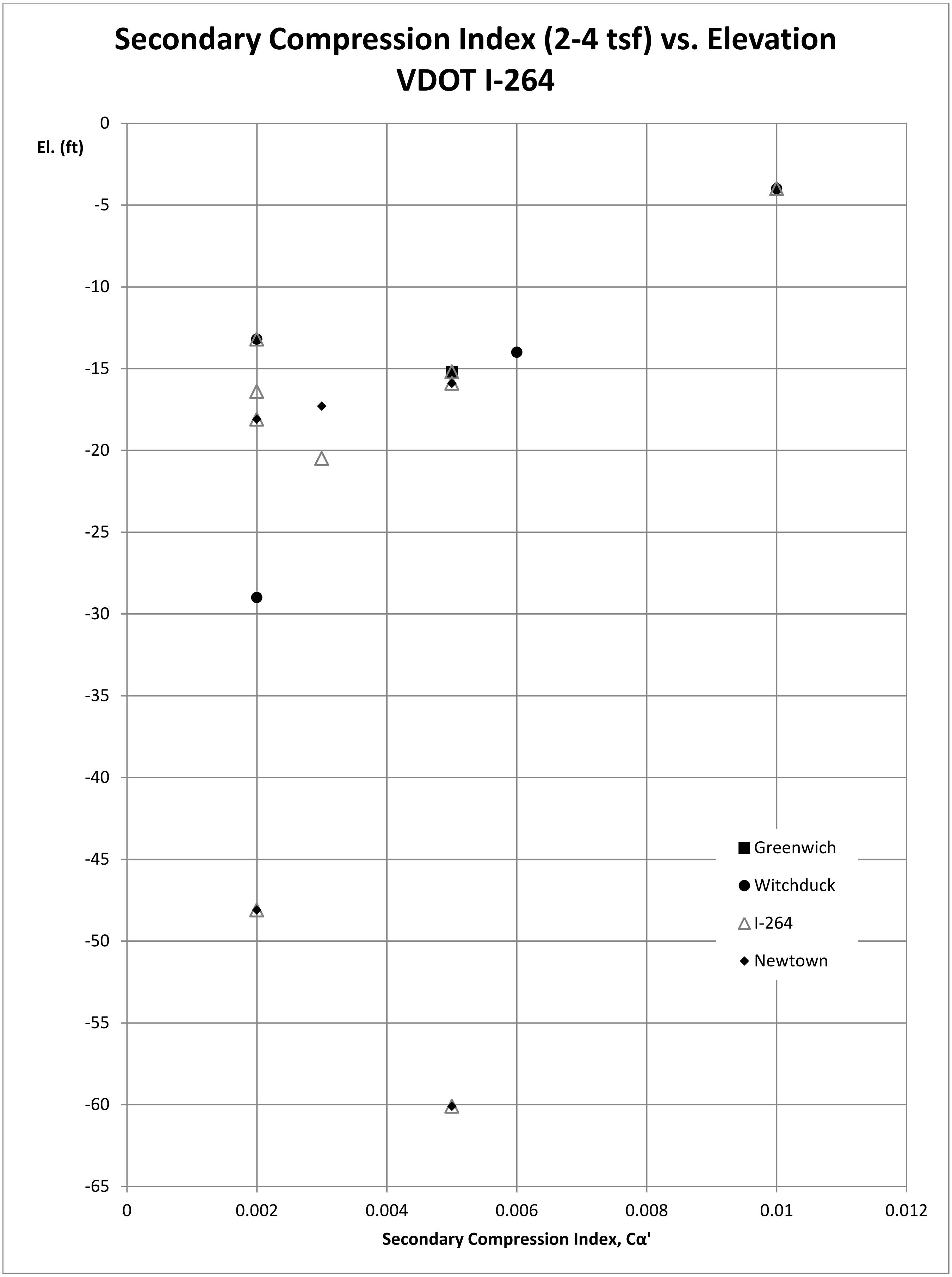


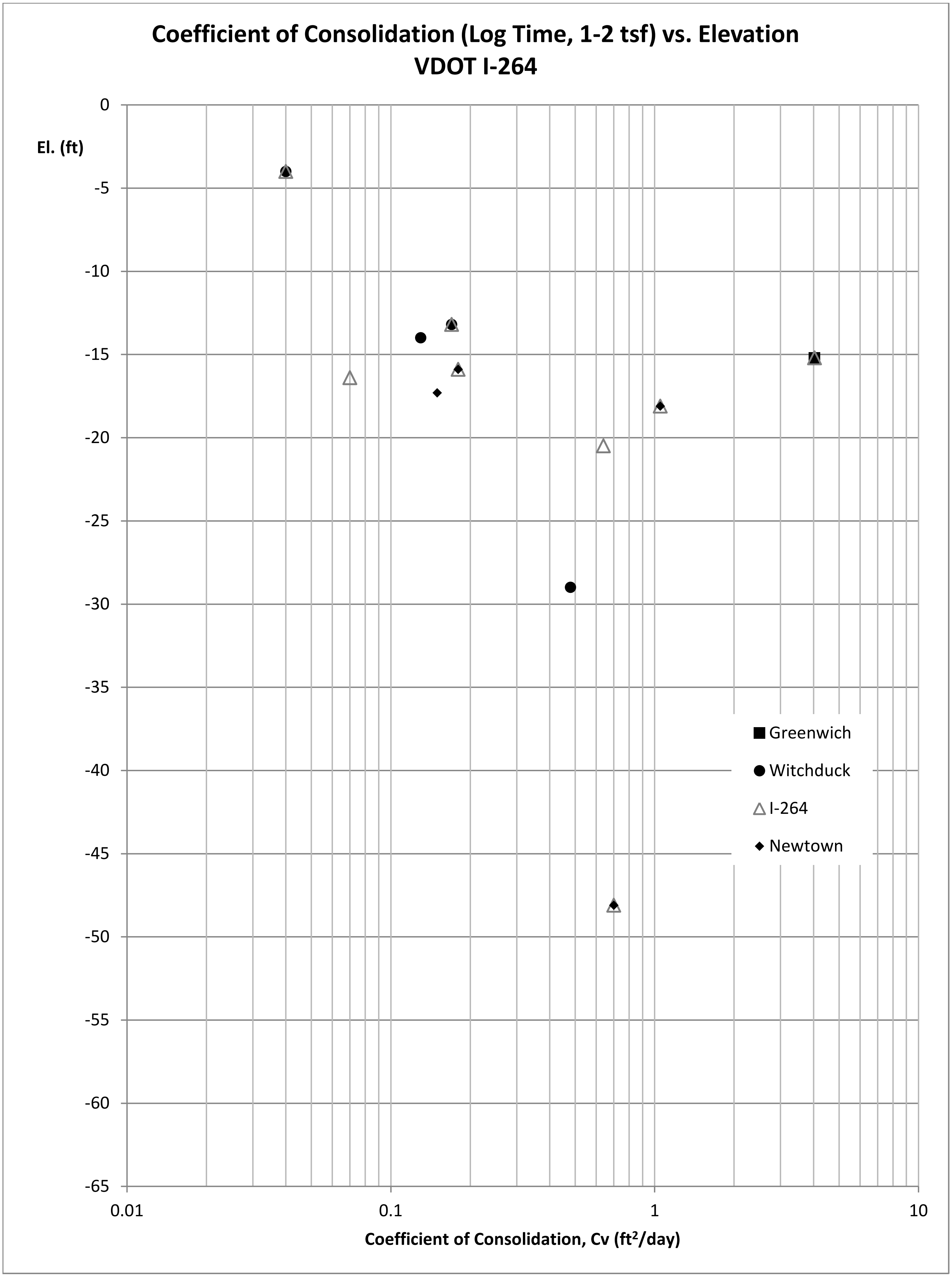

Shear Strength (Su) vs. Elevation
VDOT I-264
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
1000
2000
3000
4000
5000
6000
Shear Strength, Su (psf)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

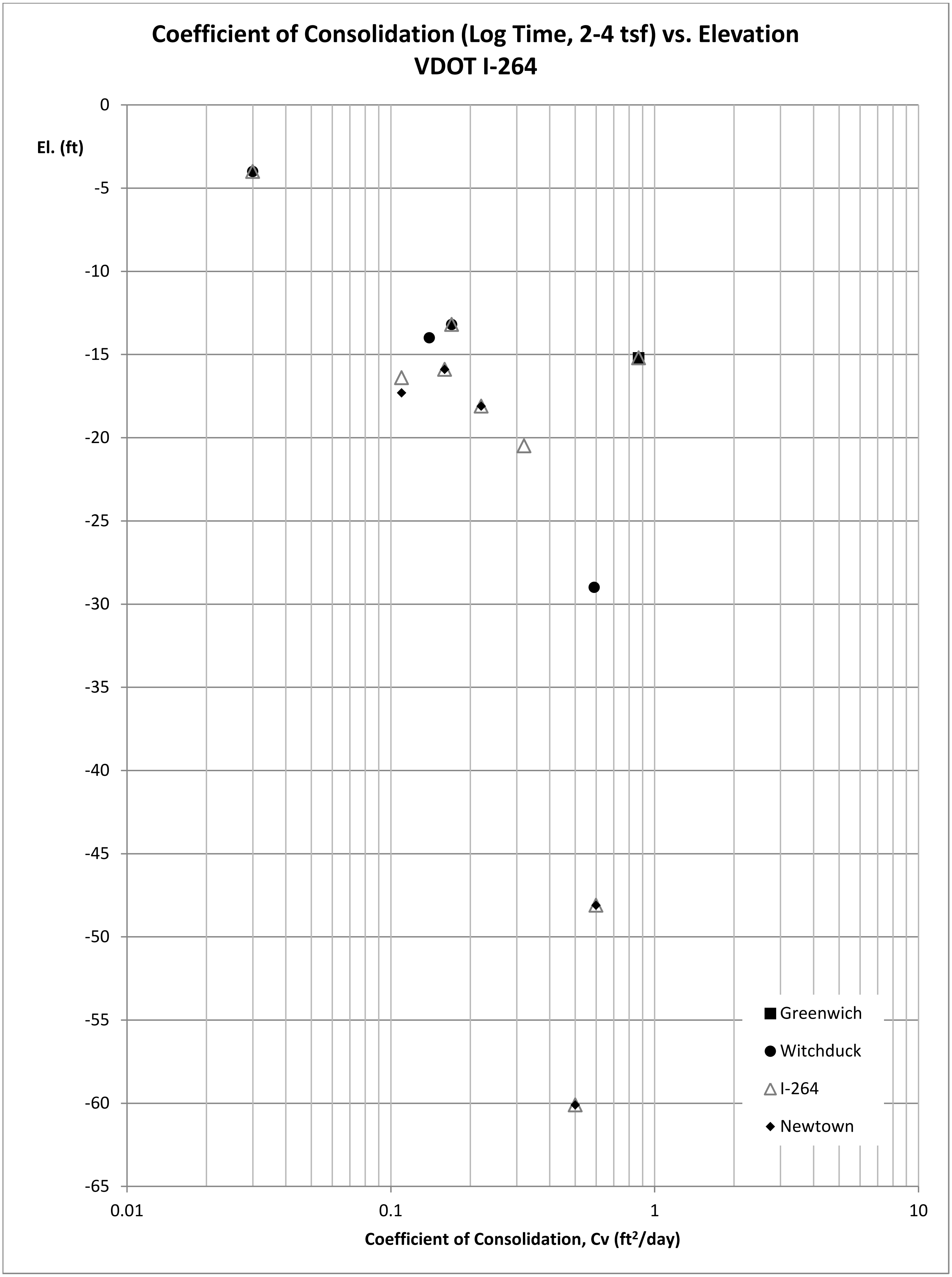

Compression Ratio vs. Elevation
VDOT I-264
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.1
0.2
0.3
0.4
0.5
0.6
Compression Ratio, Cr'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown


Recompression Ratio vs. Elevation
VDOT I-264
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.005
0.01
0.015
0.02
0.025
0.03
Recompression Ratio, Cr'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

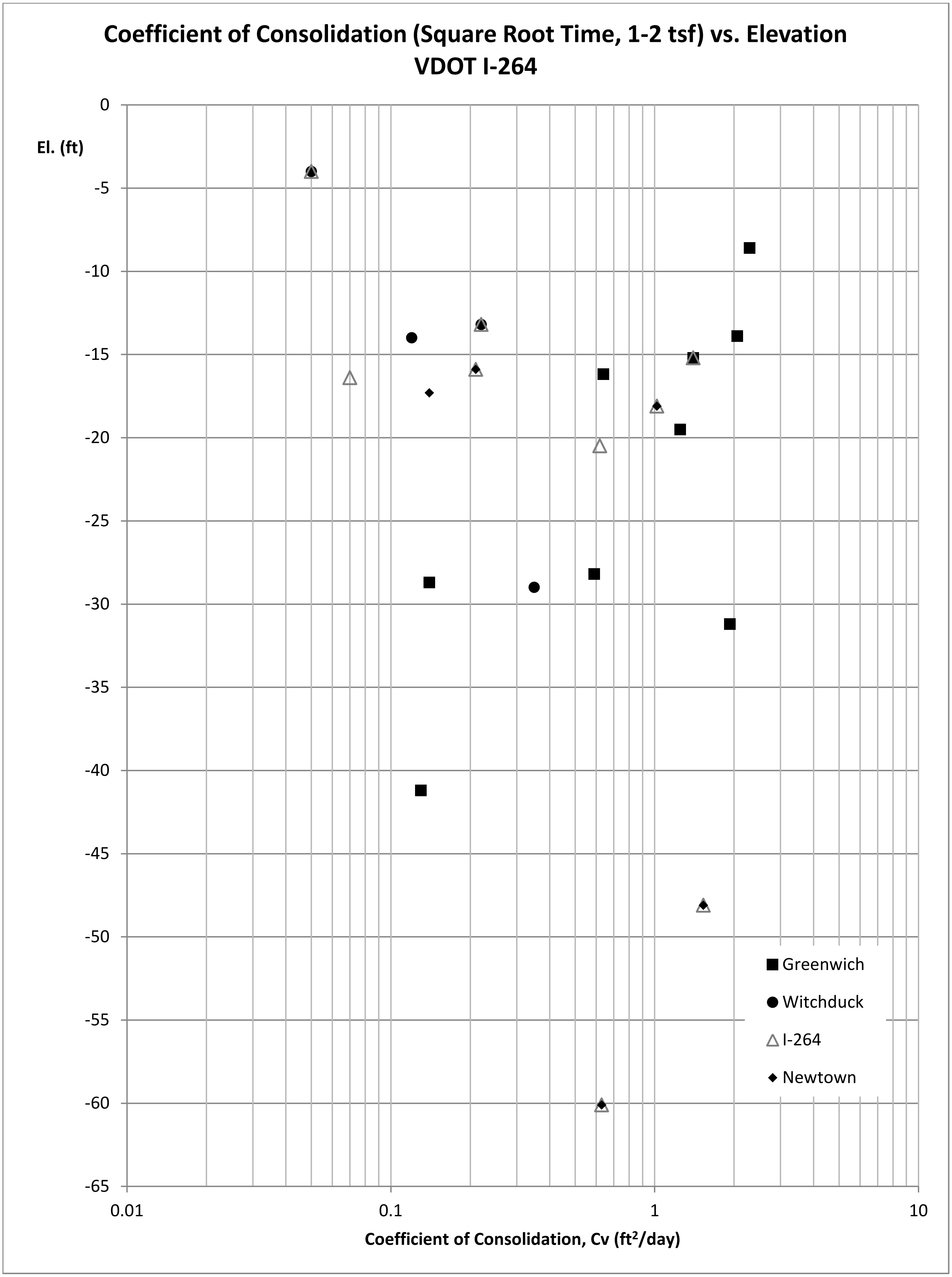

Secondary Compression Index (1-2 tsf) vs. Elevation
VDOT I-264
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
Secondary Compression Index, Cα'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

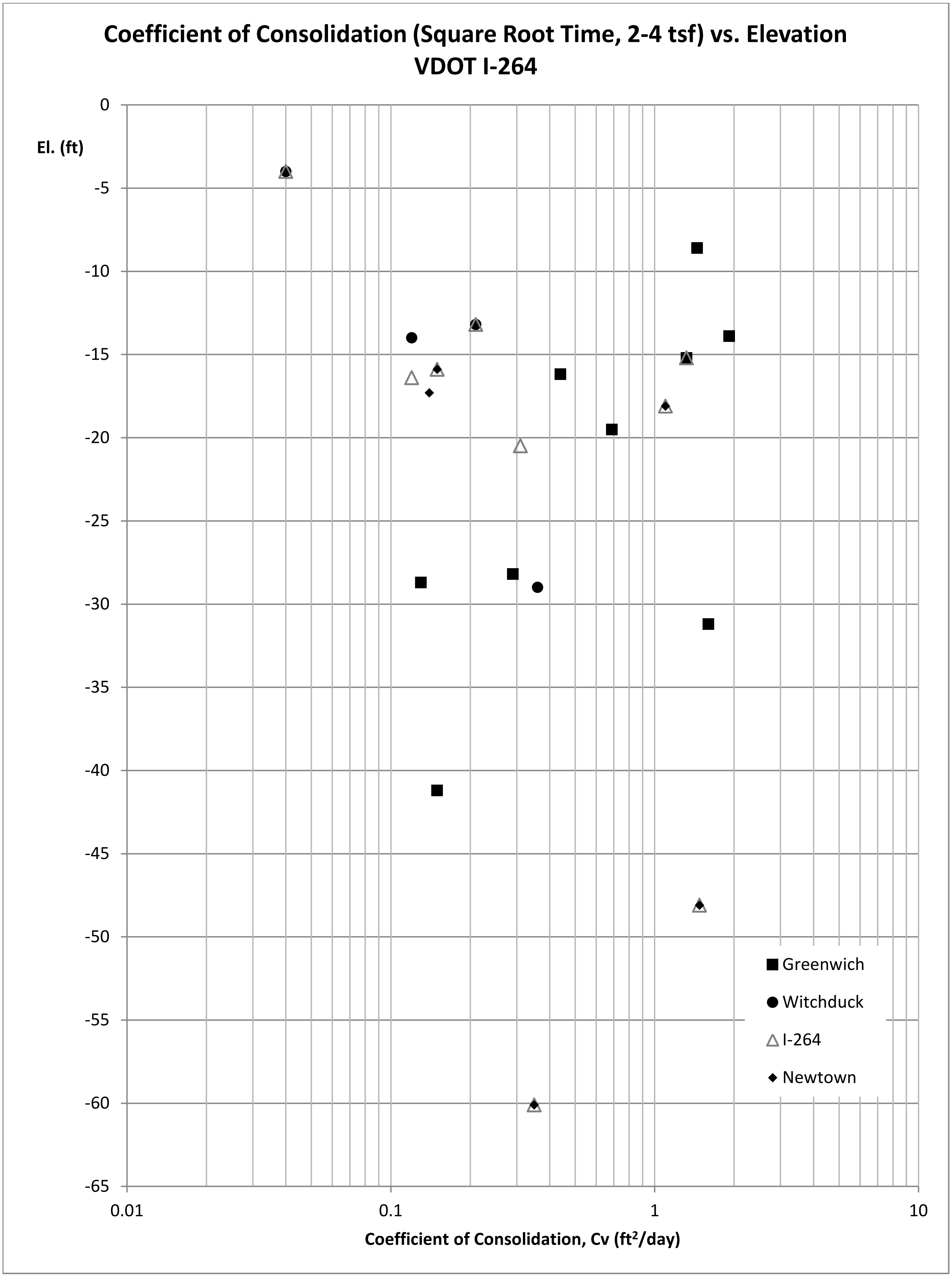

Secondary Compression Index (2-4 tsf) vs. Elevation
VDOT I-264
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.002
0.004
0.006
0.008
0.01
0.012
Secondary Compression Index, Cα'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

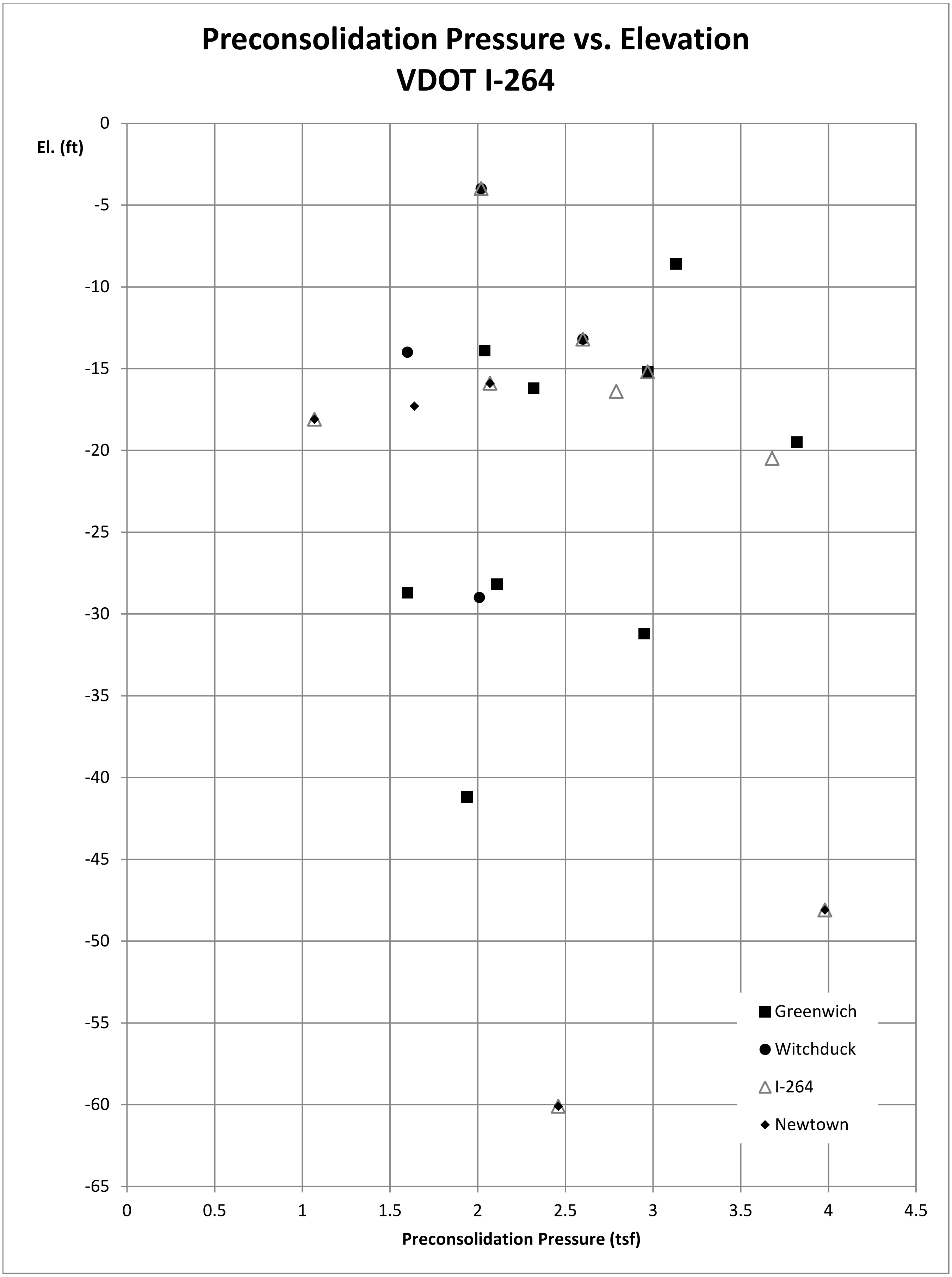

Coefficient of Consolidation (Log Time, 1-2 tsf) vs. Elevation
VDOT I-264
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0.01
0.1
1
10
Coefficient of Consolidation, Cv (ft²/day)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

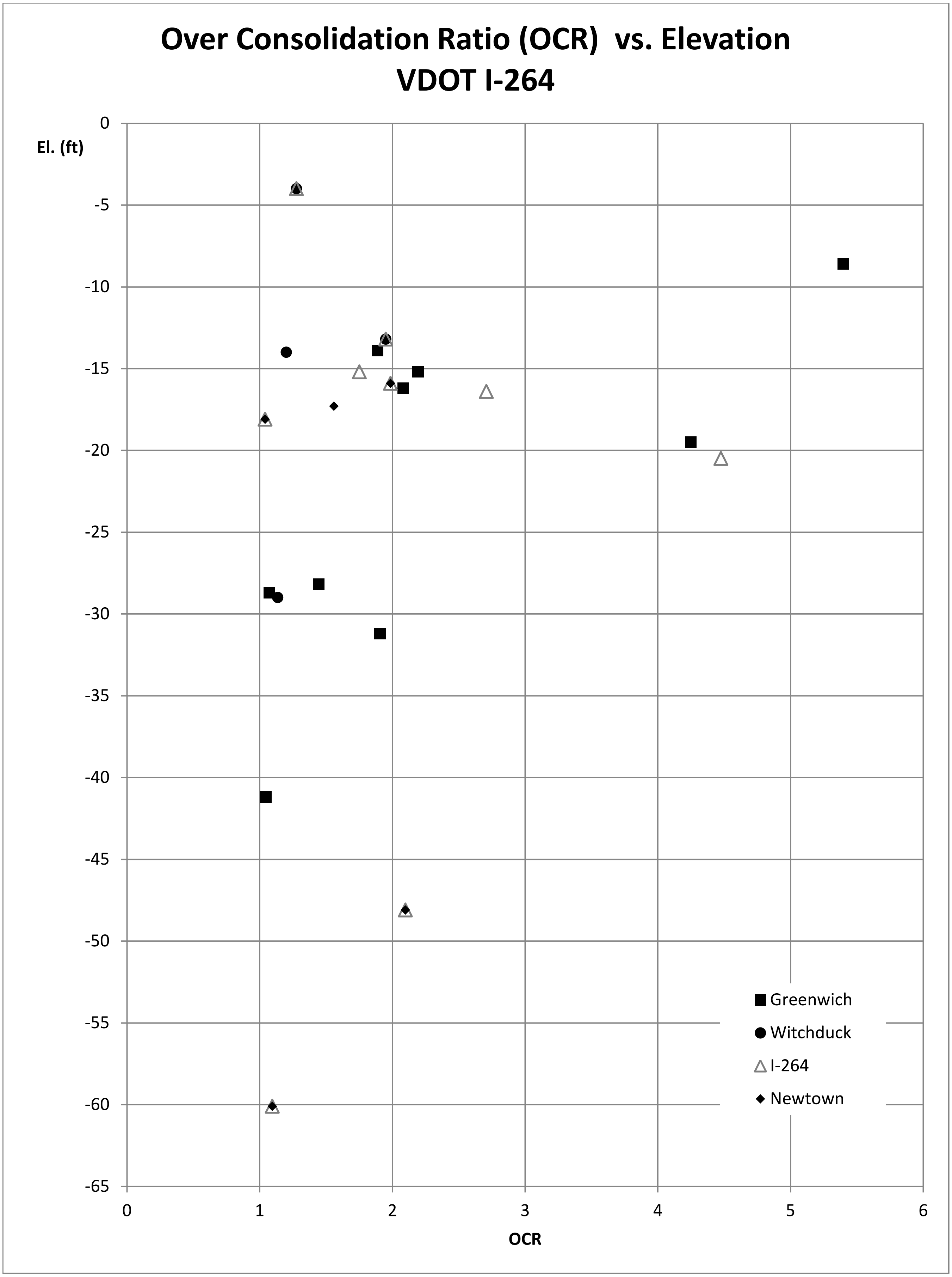


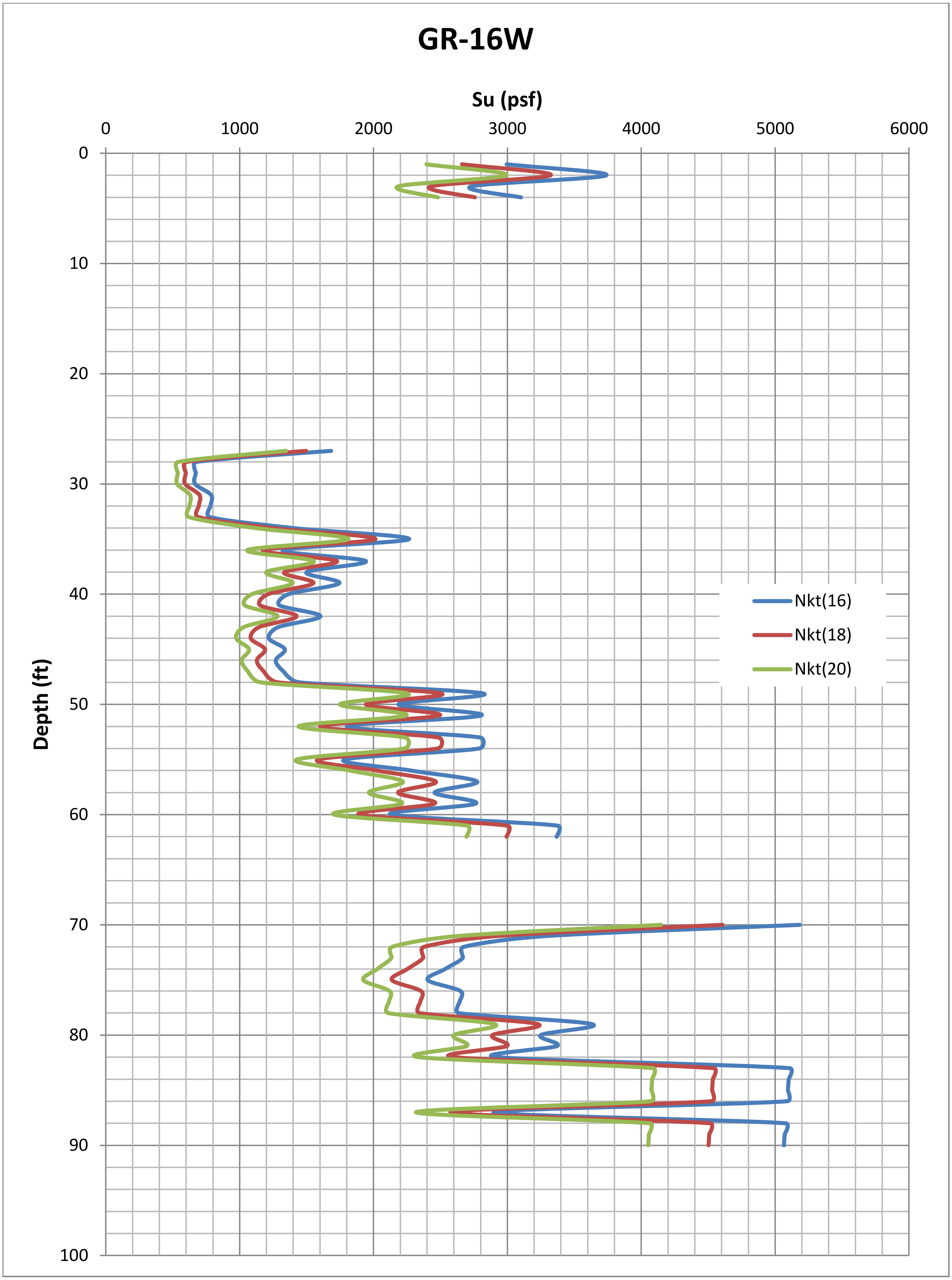
Coefficient of Consolidation (Log Time, 2-4 tsf) vs. Elevation
VDOT I-264


Coefficient of Consolidation (Square Root Time, 1-2 tsf) vs. Elevation
VDOT I-264
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0.01
0.1
1
10
Coefficient of Consolidation, Cv (ft²/day)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

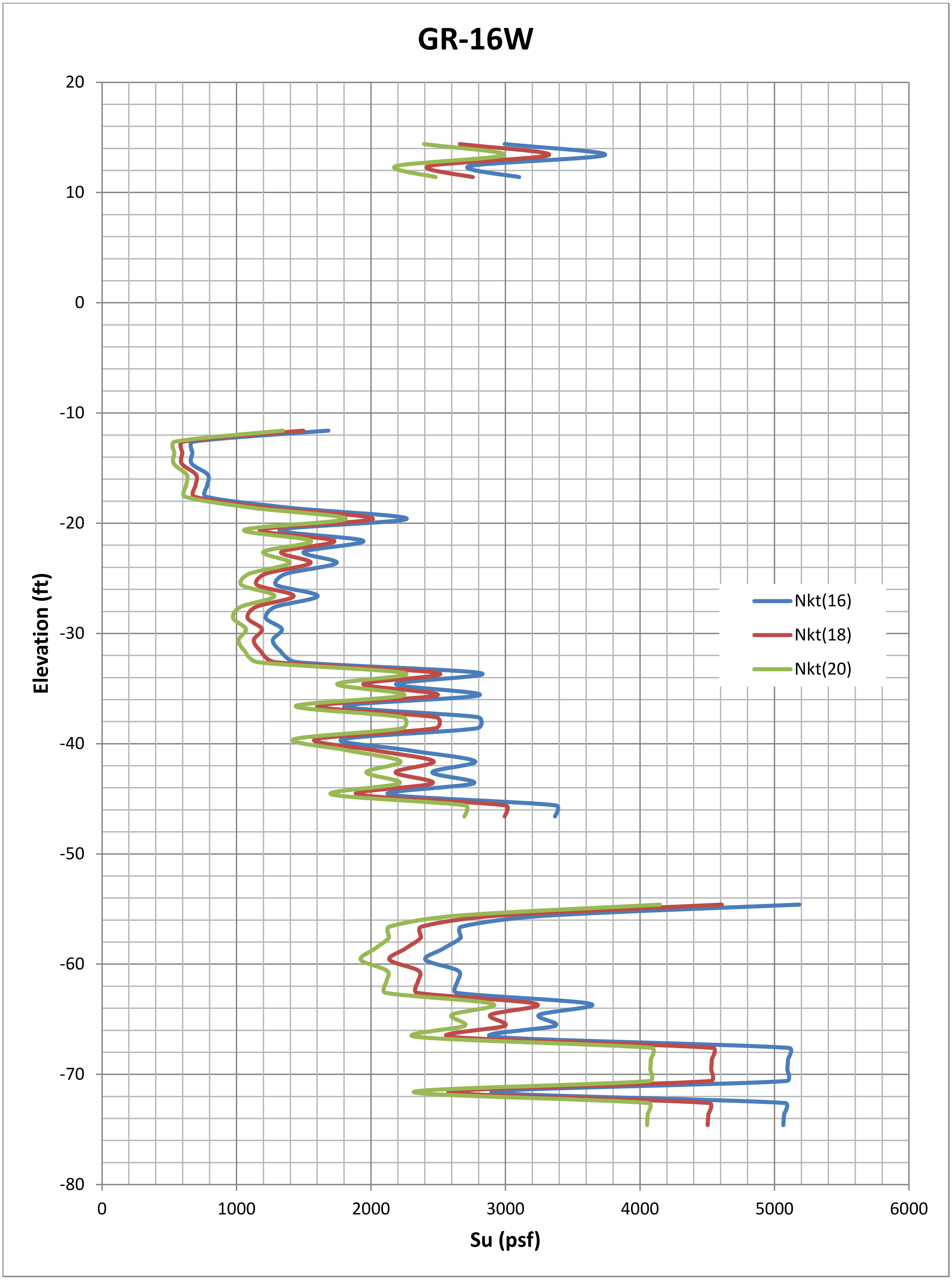

Coefficient of Consolidation (Square Root Time, 2-4 tsf) vs. Elevation
VDOT I-264
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0.01
0.1
1
10
Coefficient of Consolidation, Cv (ft²/day)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

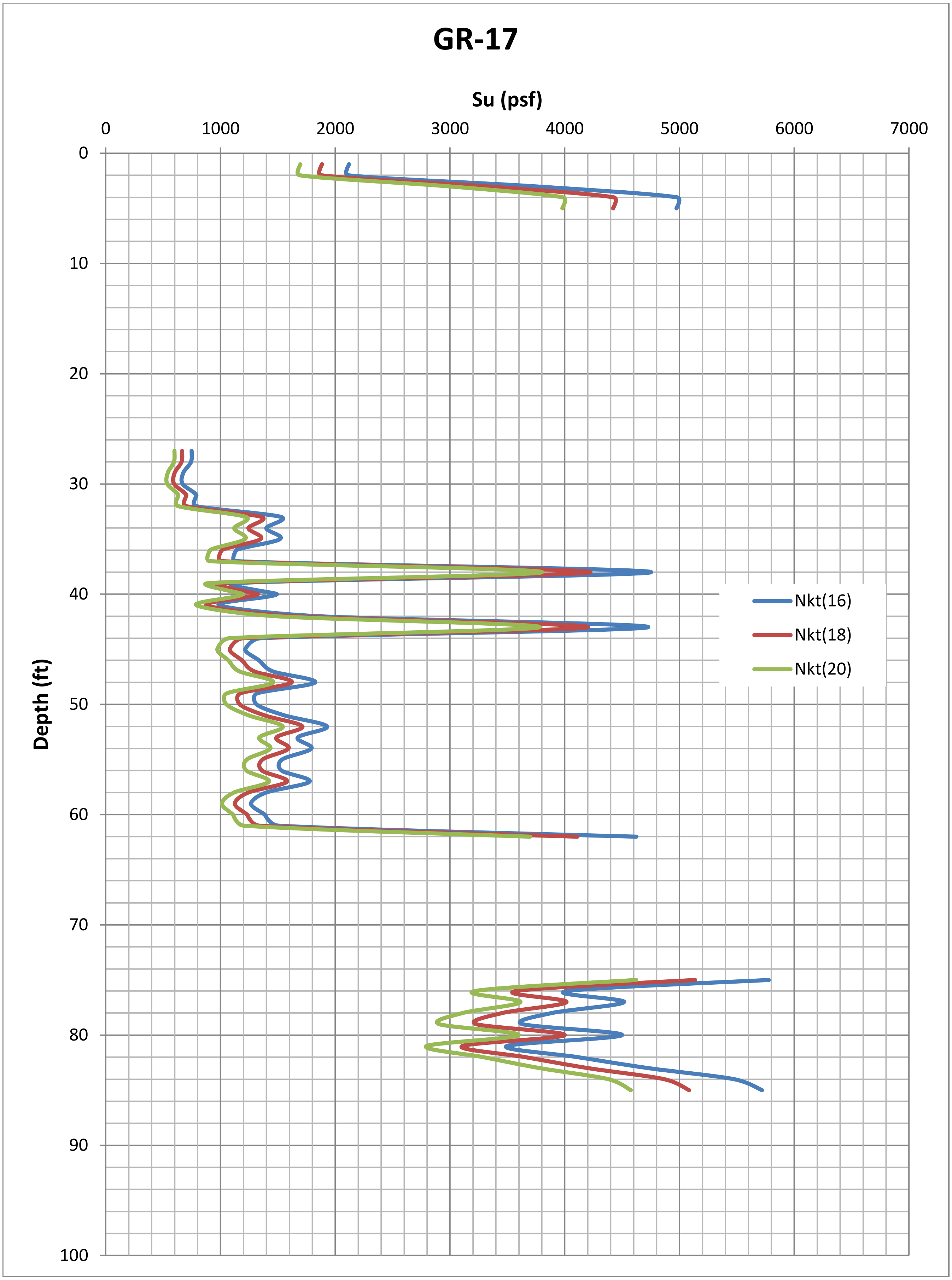

Preconsolidation Pressure vs. Elevation
VDOT I-264
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Preconsolidation Pressure (tsf)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

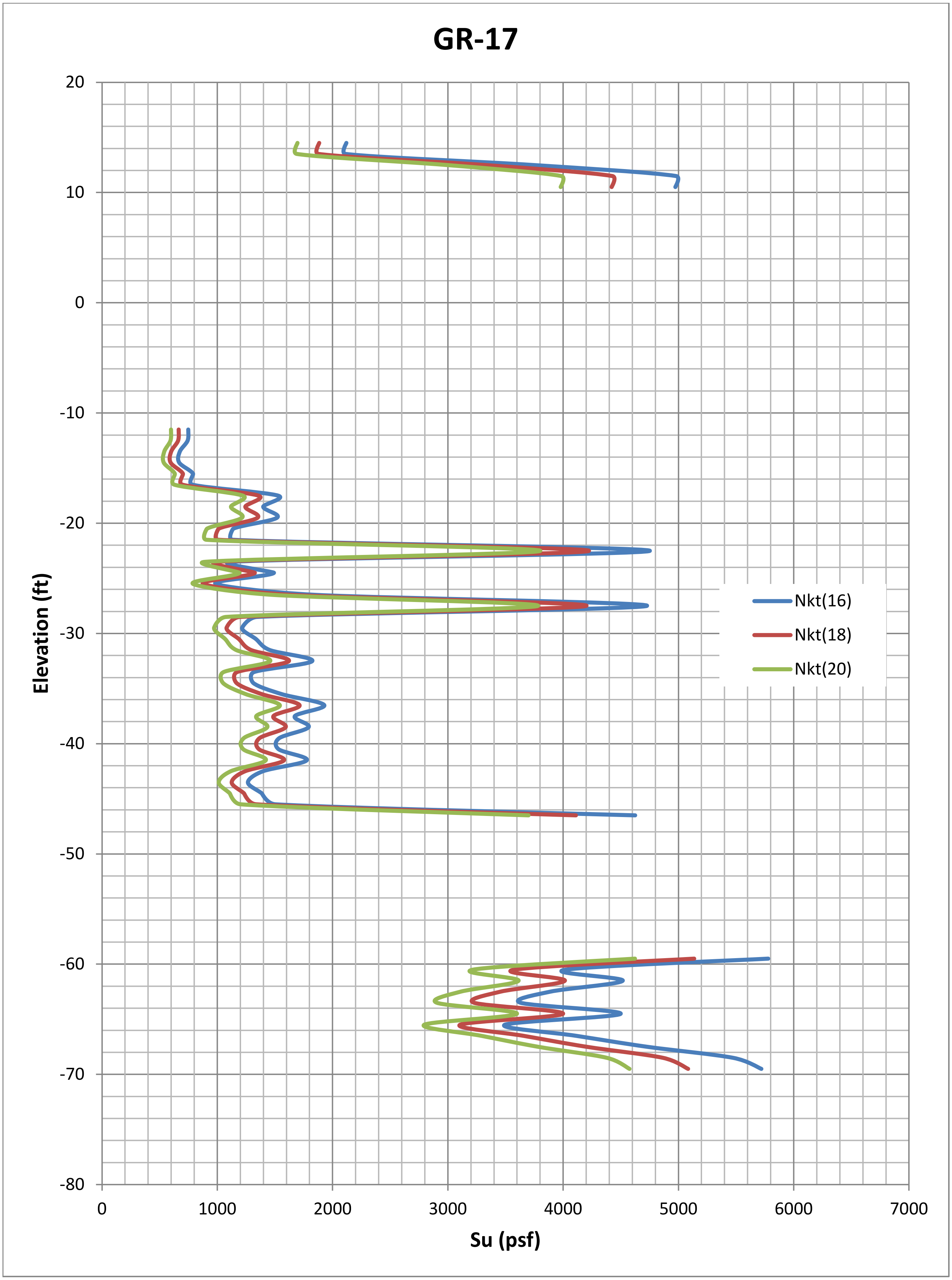

Over Consolidation Ratio (OCR) vs. Elevation
VDOT I-264
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
1
2
3
4
5
6
OCR
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

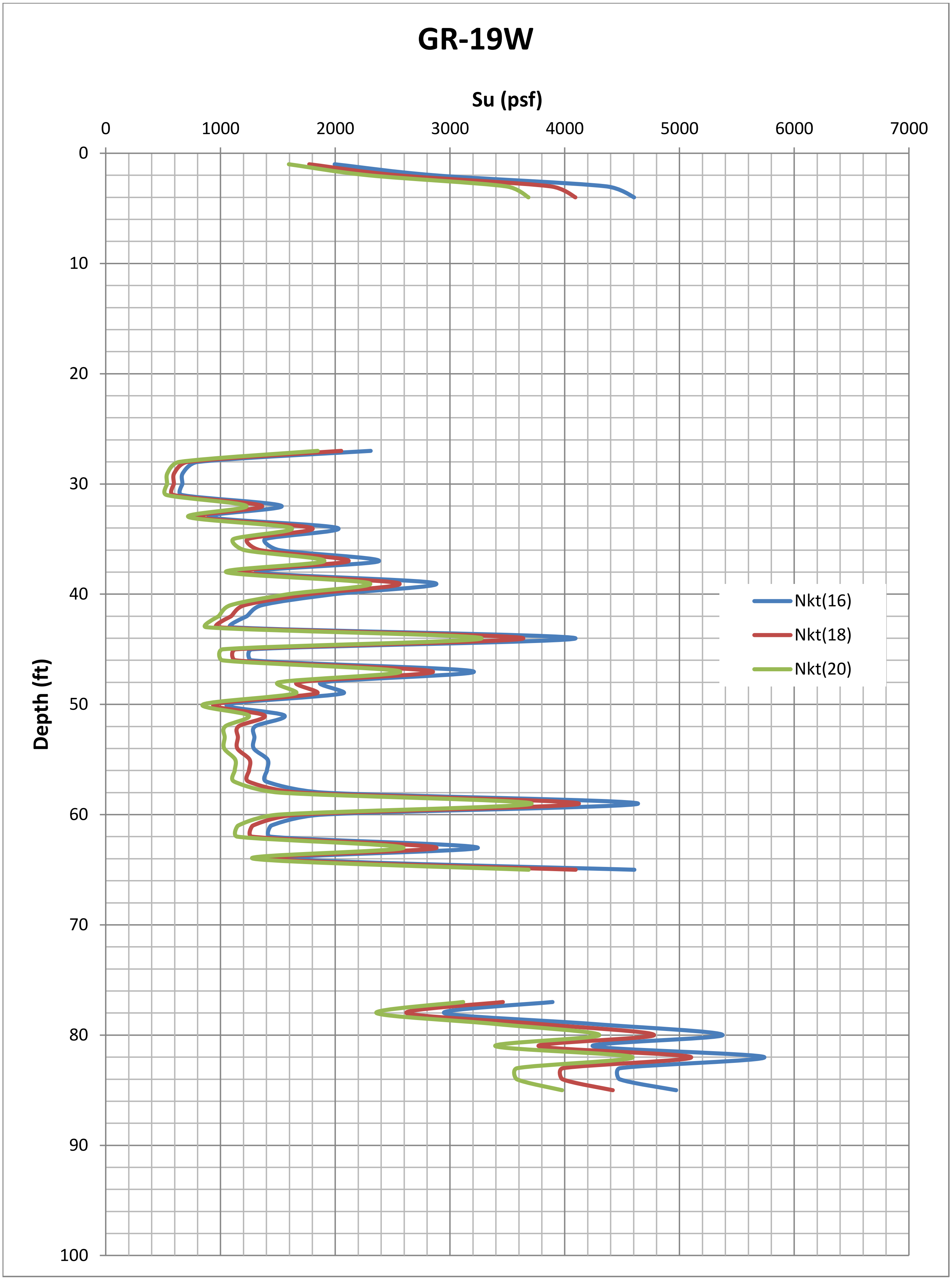

GR-16W
Su (psf)
0
1000
2000
3000
4000
5000
6000
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
Nkt(16)
Nkt(18)
Nkt(20)

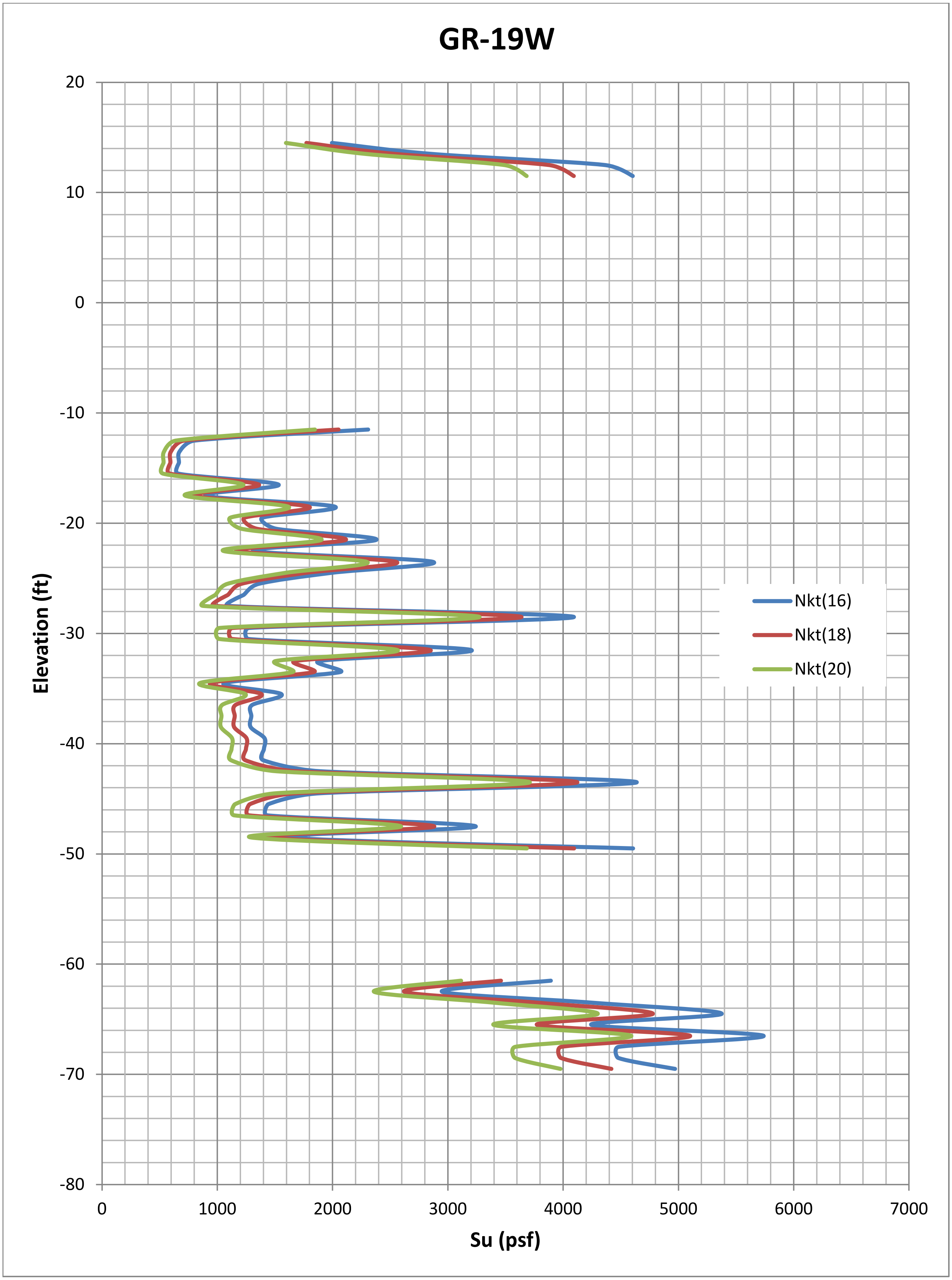
GR-16W


Elevation (ft)
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Su (psf)
0
1000
2000
3000
4000
5000
6000
Nkt(16)
Nkt(18)
Nkt(20)

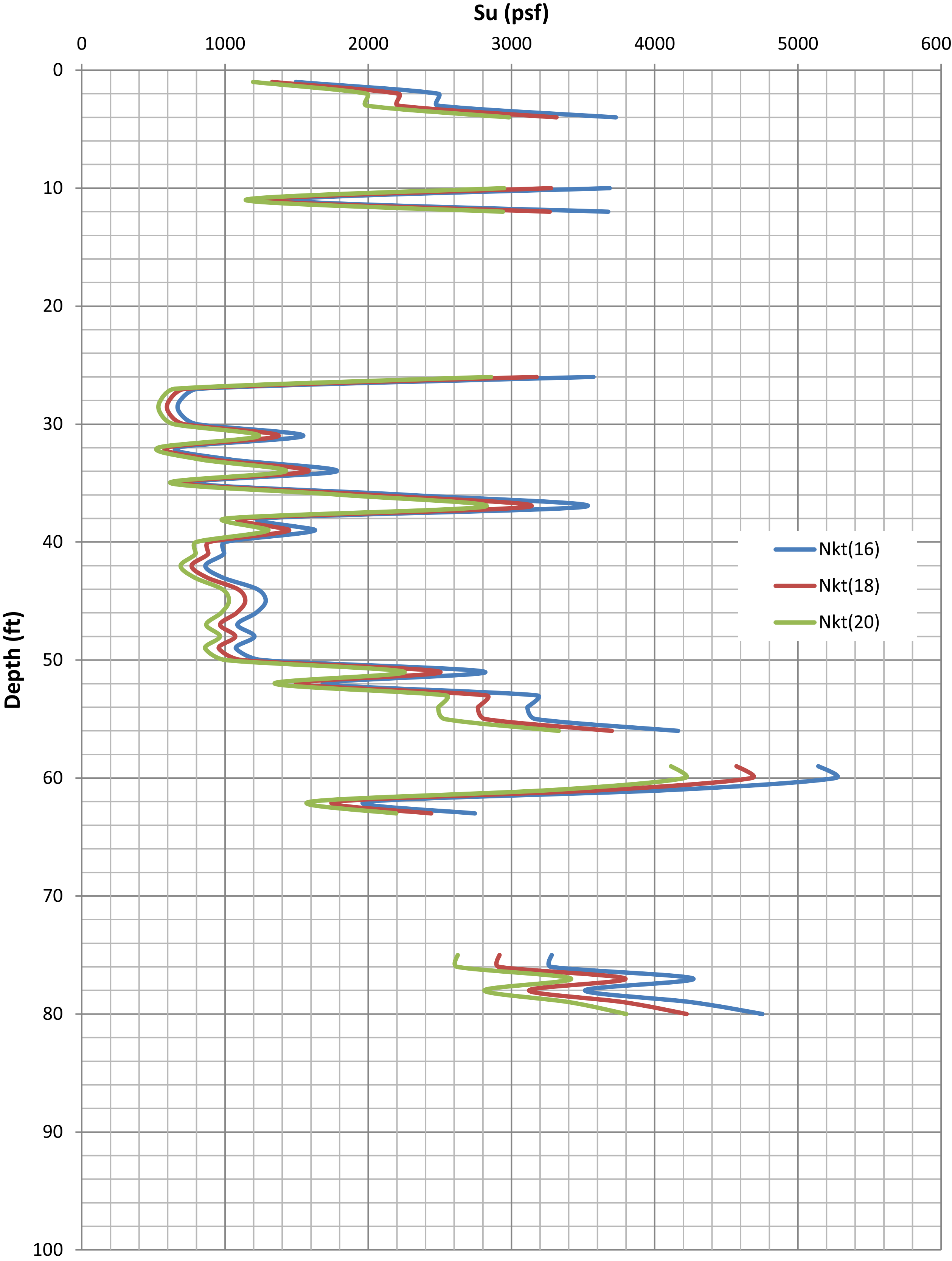

GR-17
Su (psf)
0
1000
2000
3000
4000
5000
6000
7000
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
Nkt(16)
Nkt(18)
Nkt(20)


GR-17
Elevation (ft)
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Su (psf)
0
1000
2000
3000
4000
5000
6000
7000
Nkt(16)
Nkt(18)
Nkt(20)

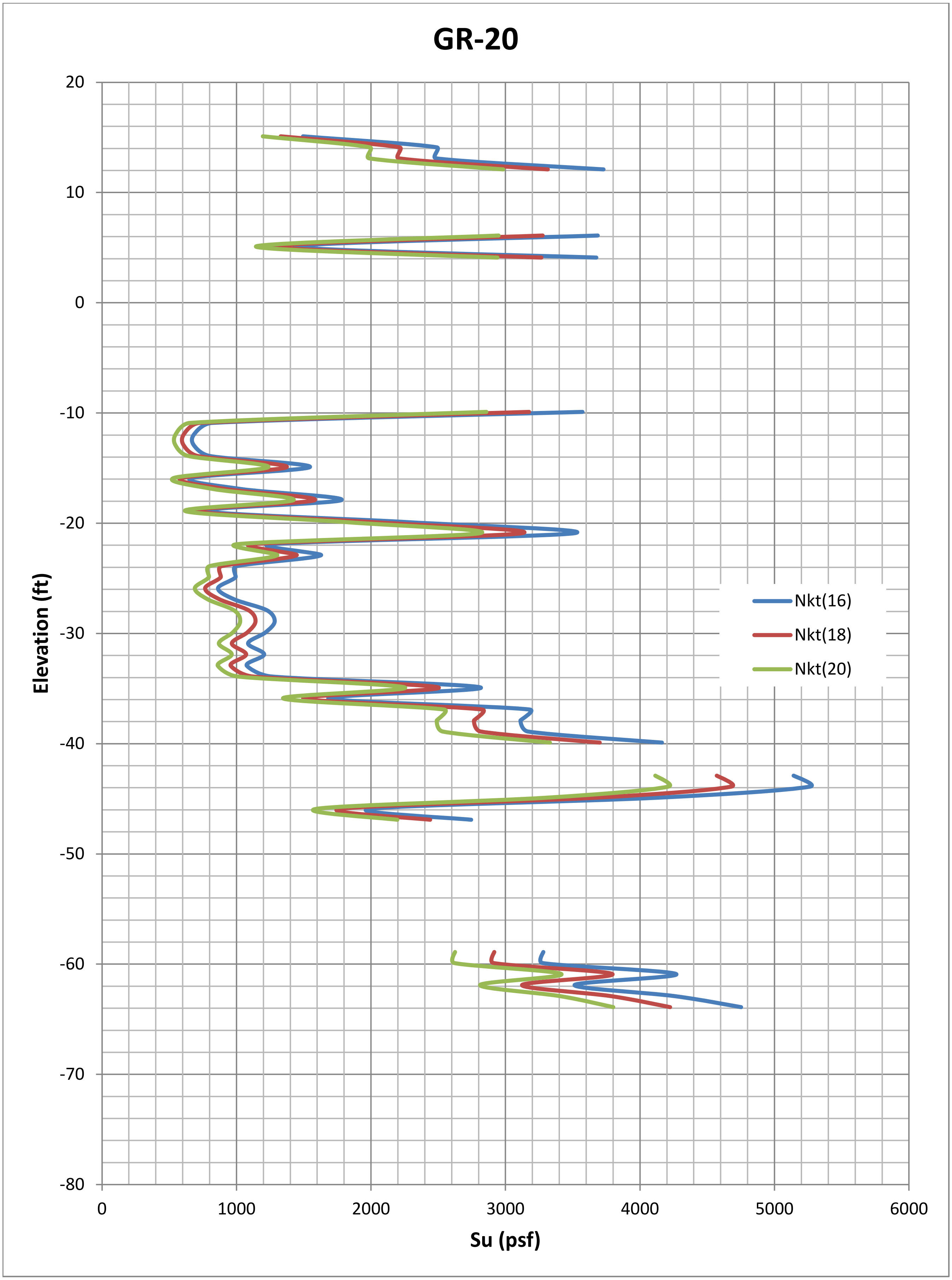

GR-19W
Su (psf)
0
1000
2000
3000
4000
5000
6000
7000
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
Nkt(16)
Nkt(18)
Nkt(20)


GR-19W
Elevation (ft)
Su (psf)
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
0
1000
2000
3000
4000
5000
6000
7000
Nkt(16)
Nkt(18)
Nkt(20)

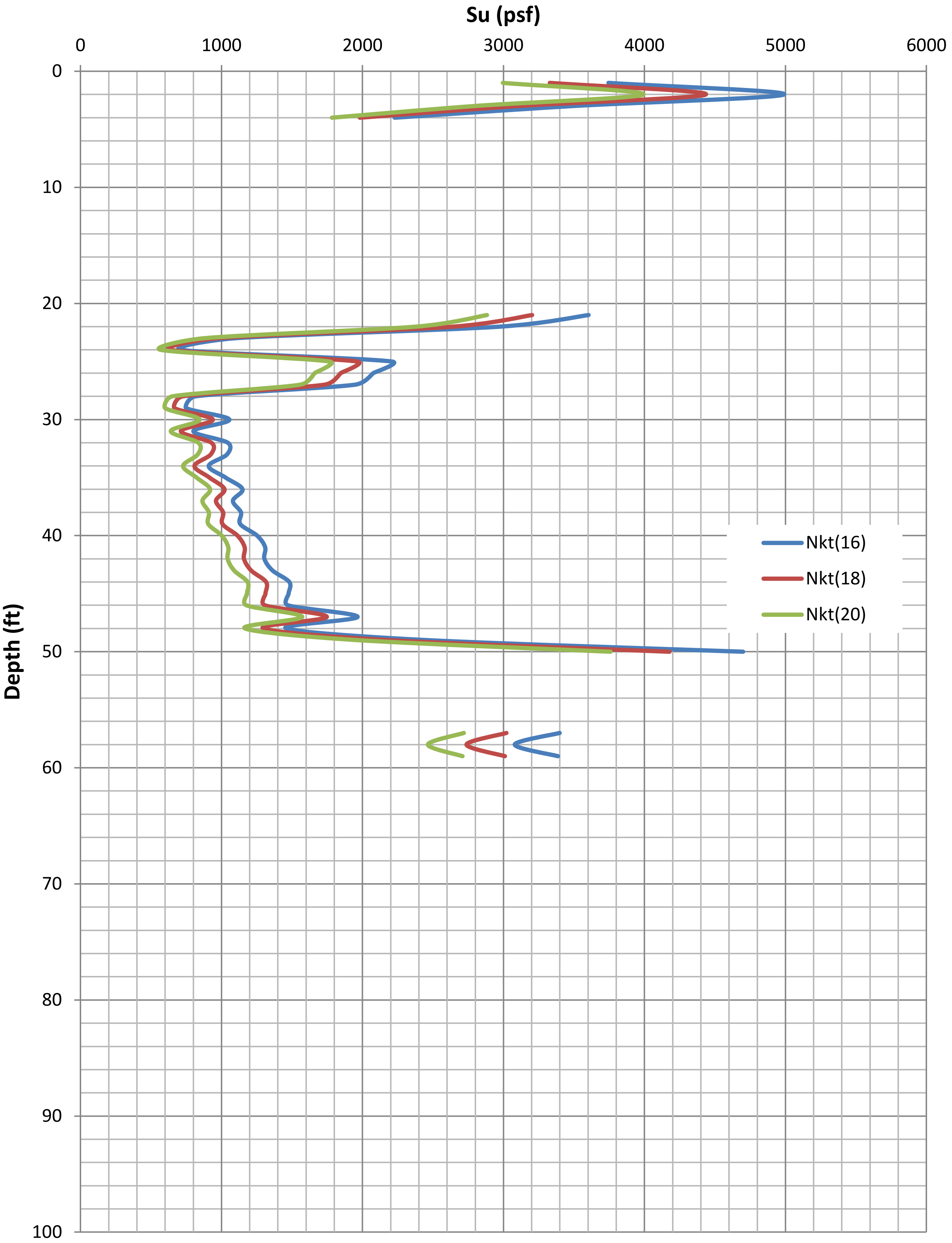
GR-20



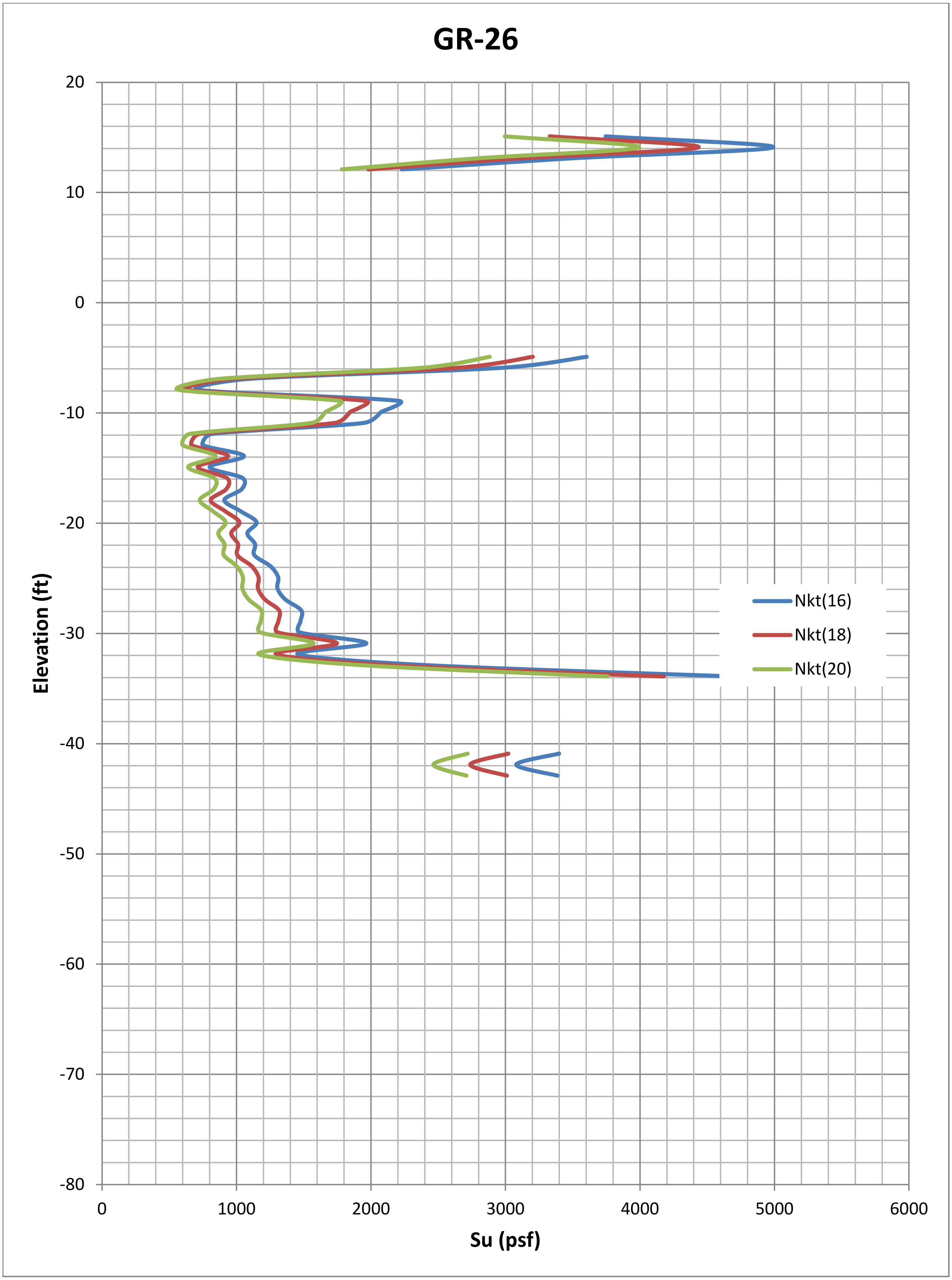
Su (psf)
0
1000
2000
3000
4000
5000
6000
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
Nkt(16)
Nkt(18)
Nkt(20)

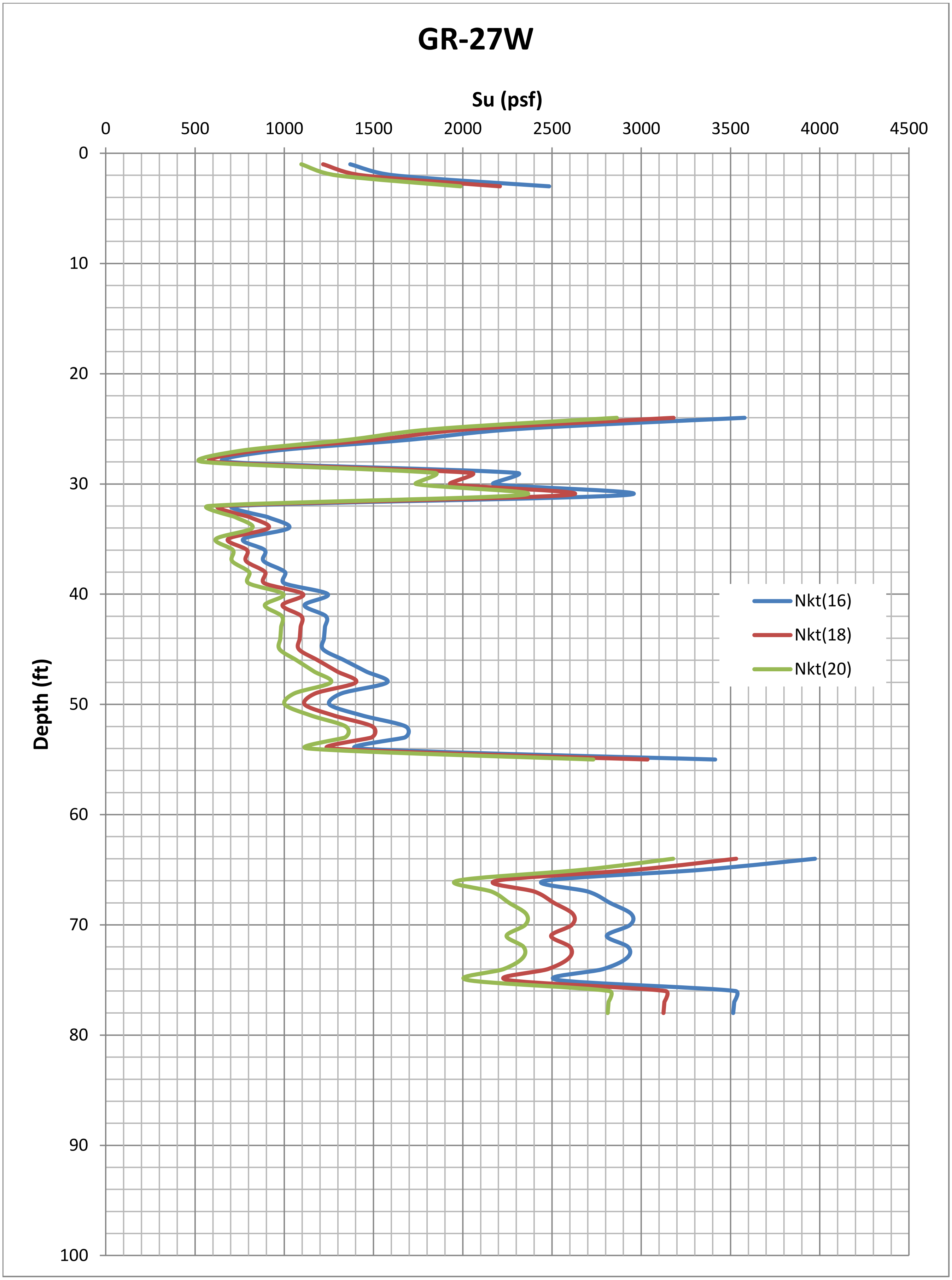

GR-20
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Elevation (ft)
0
1000
2000
3000
4000
5000
6000
Su (psf)
Nkt(16)
Nkt(18)
Nkt(20)

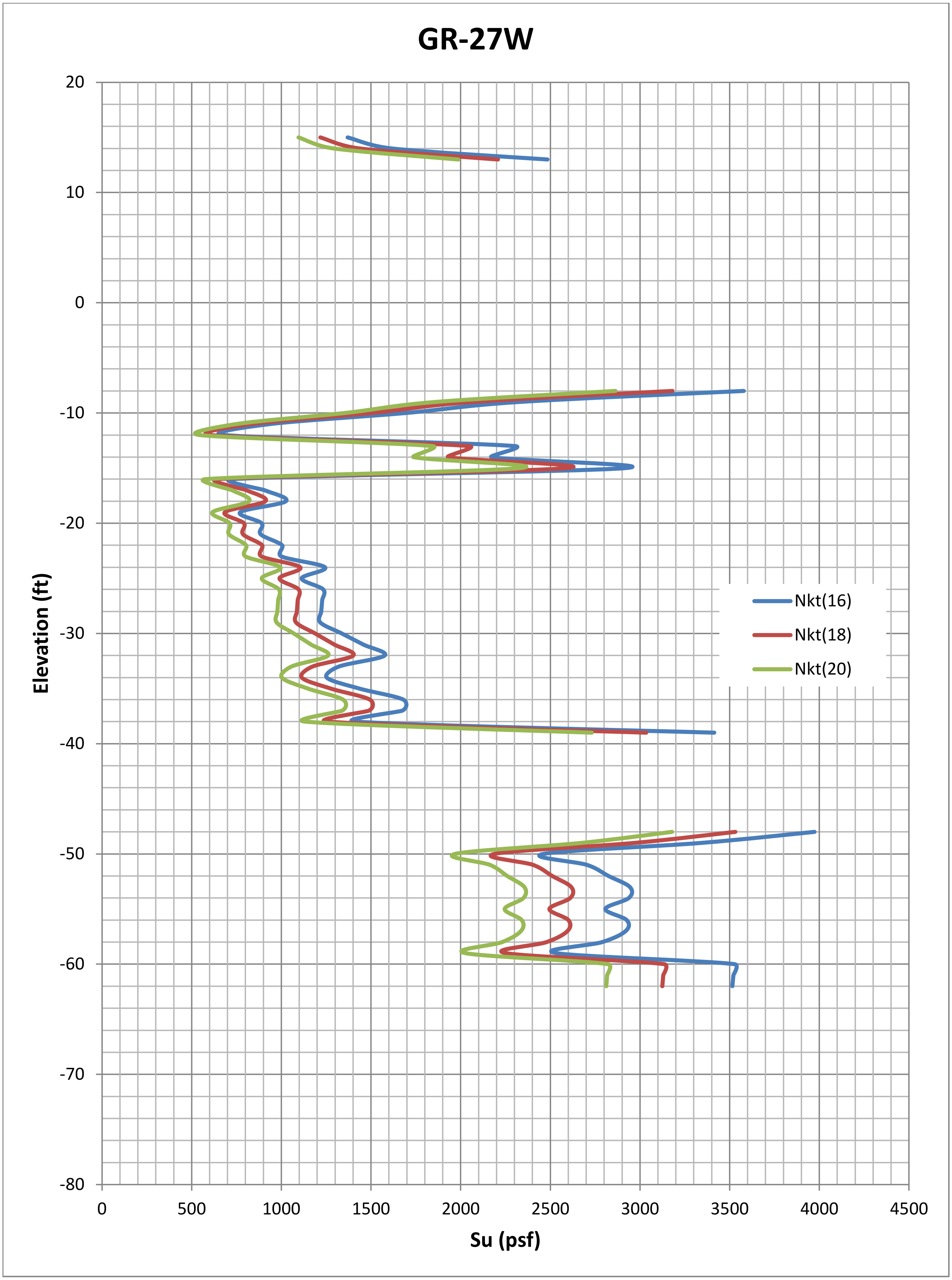
GR-26

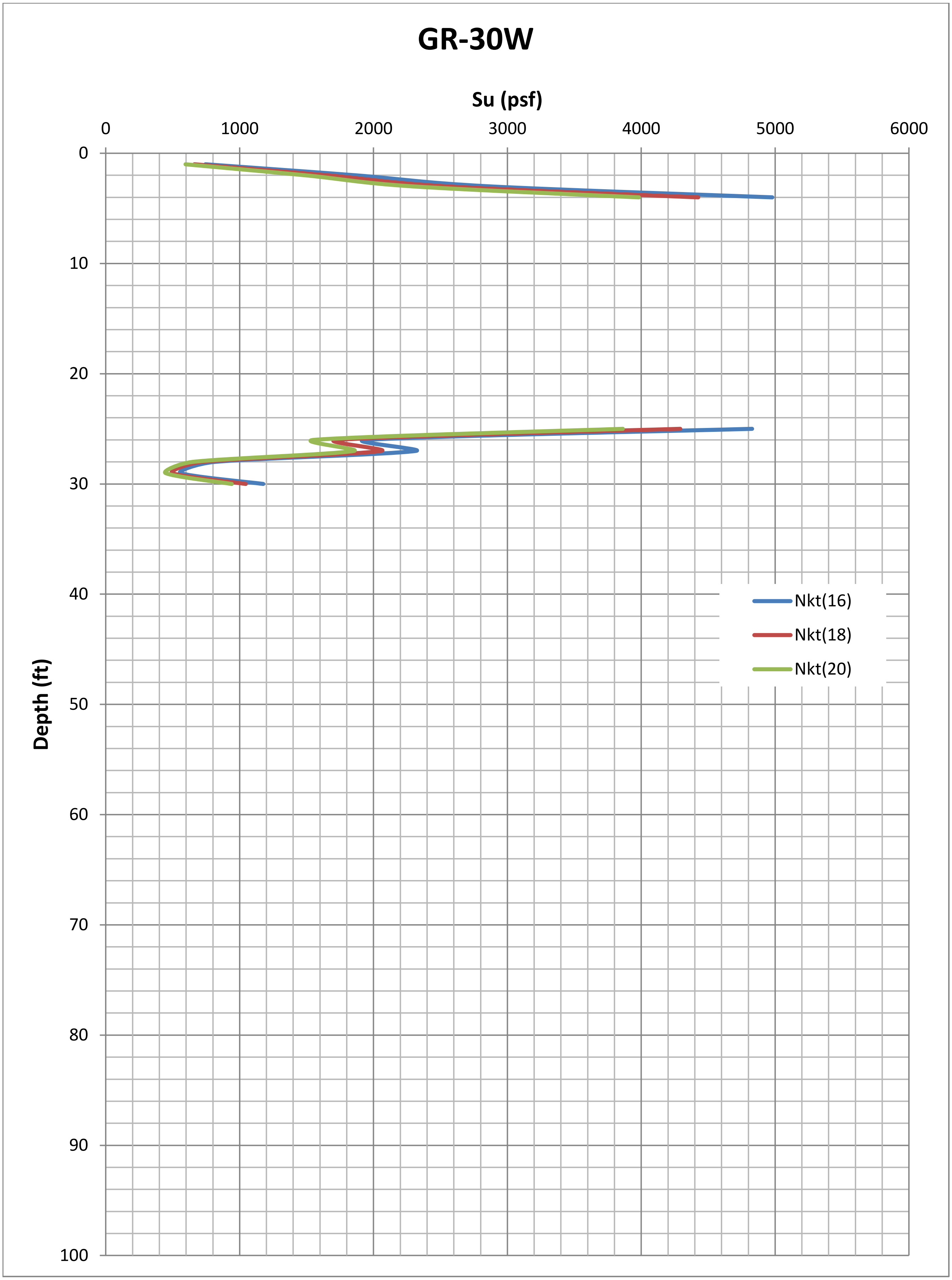


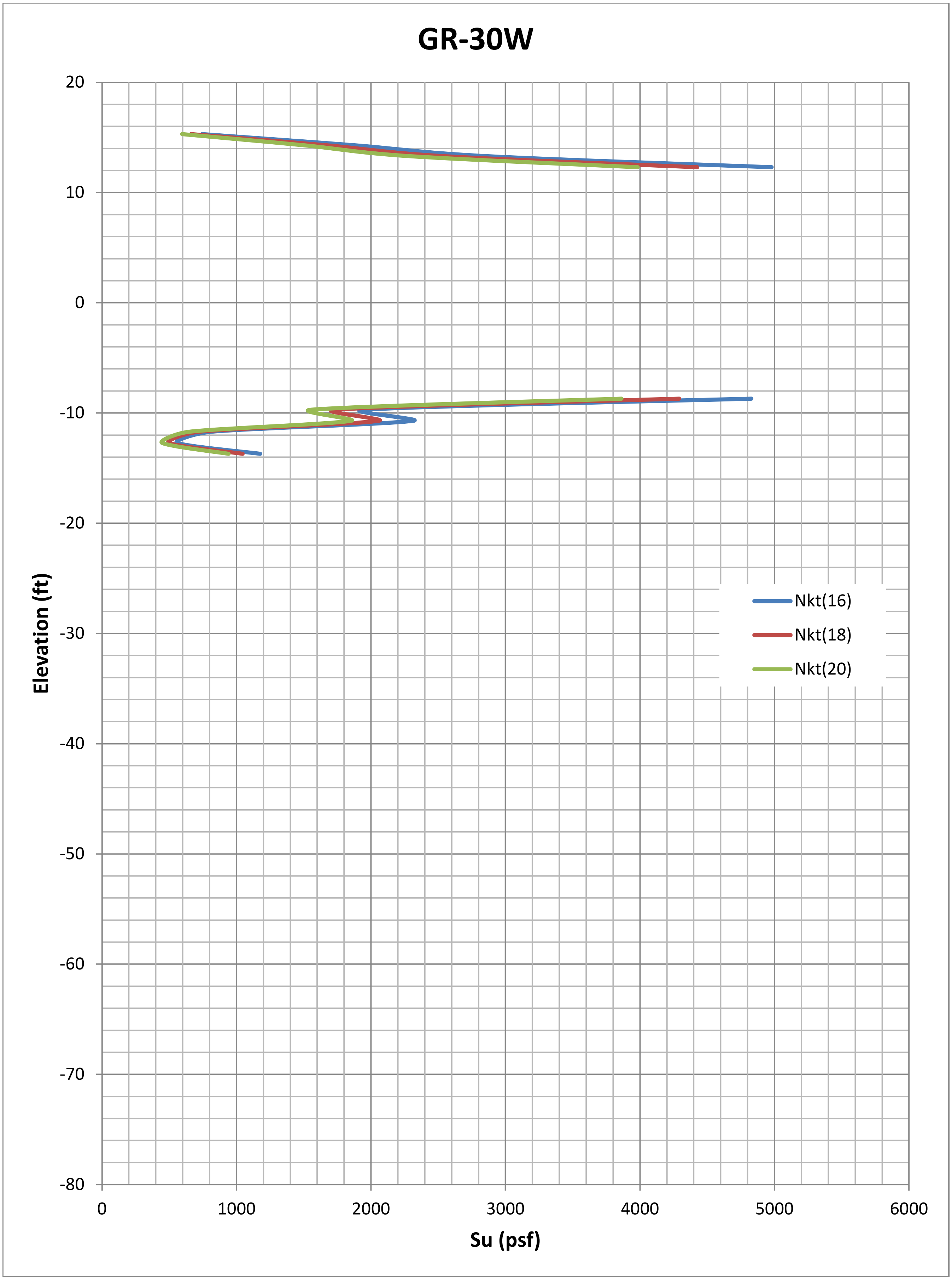
Su (psf)
0
1000
2000
3000
4000
5000
6000
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
Nkt(16)
Nkt(18)
Nkt(20)

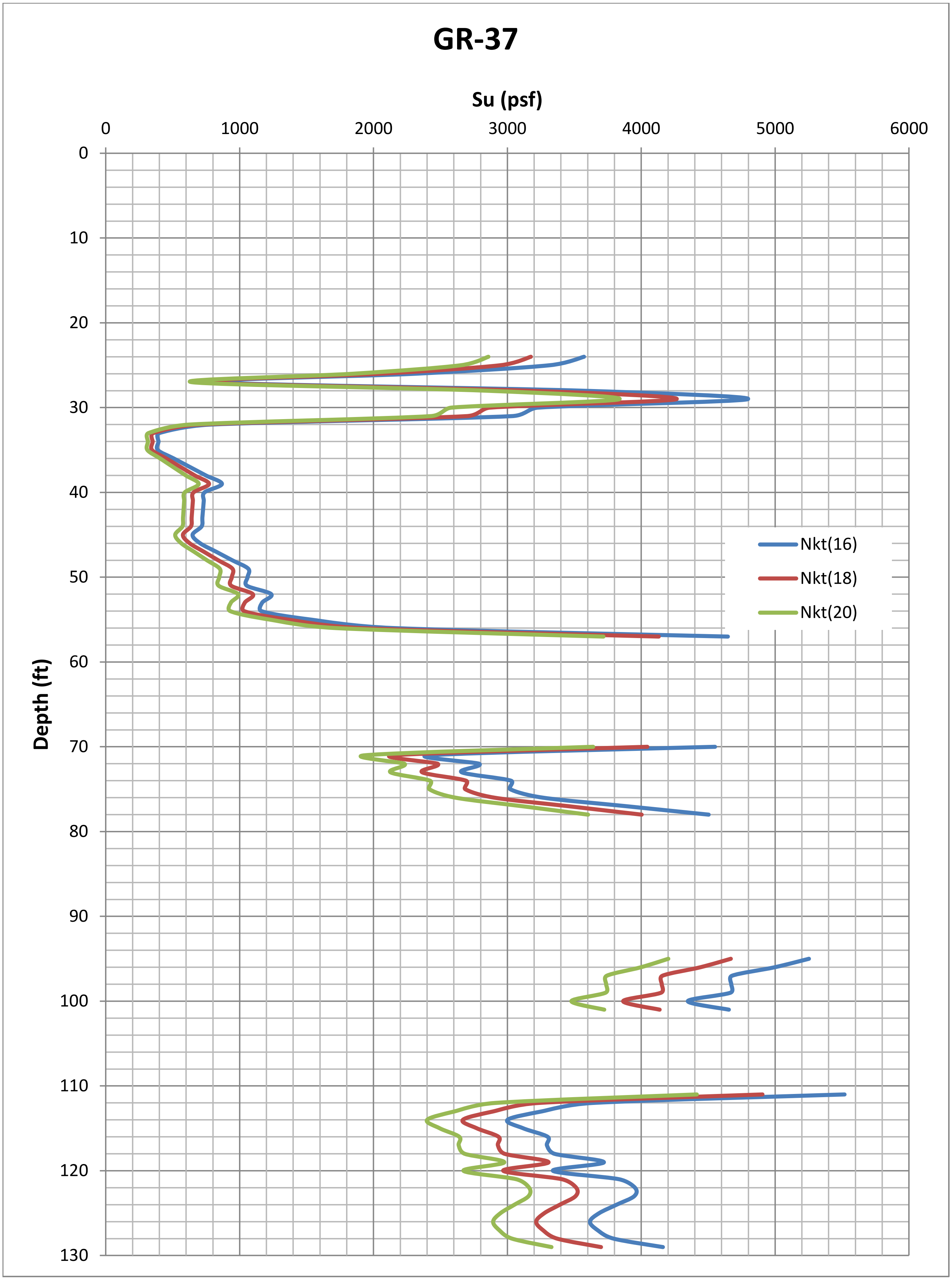

GR-26
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Elevation (ft)
0
1000
2000
3000
4000
5000
6000
Su (psf)
Nkt(16)
Nkt(18)
Nkt(20)

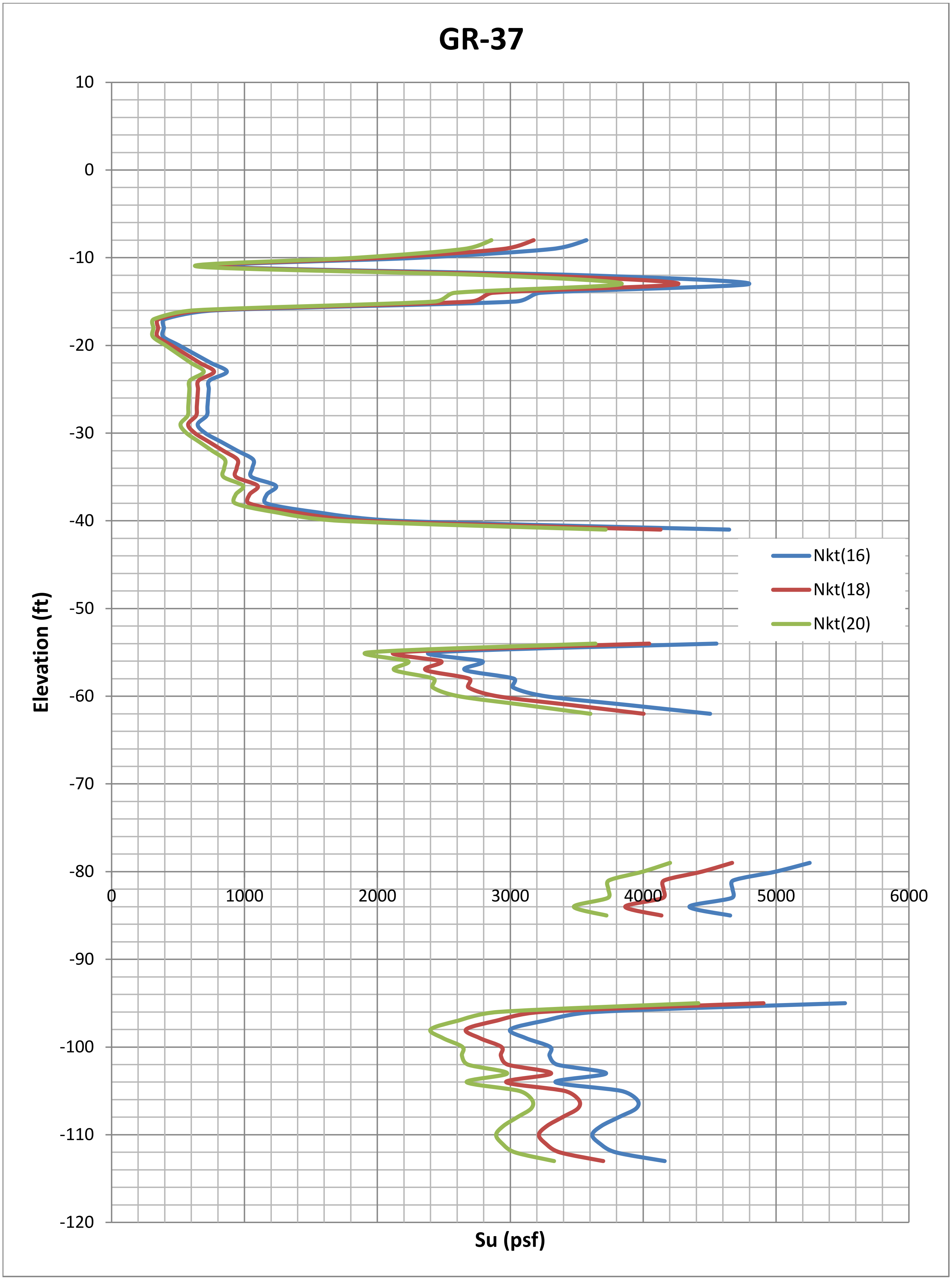

GR-27W
Su (psf)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
Nkt(16)
Nkt(18)
Nkt(20)

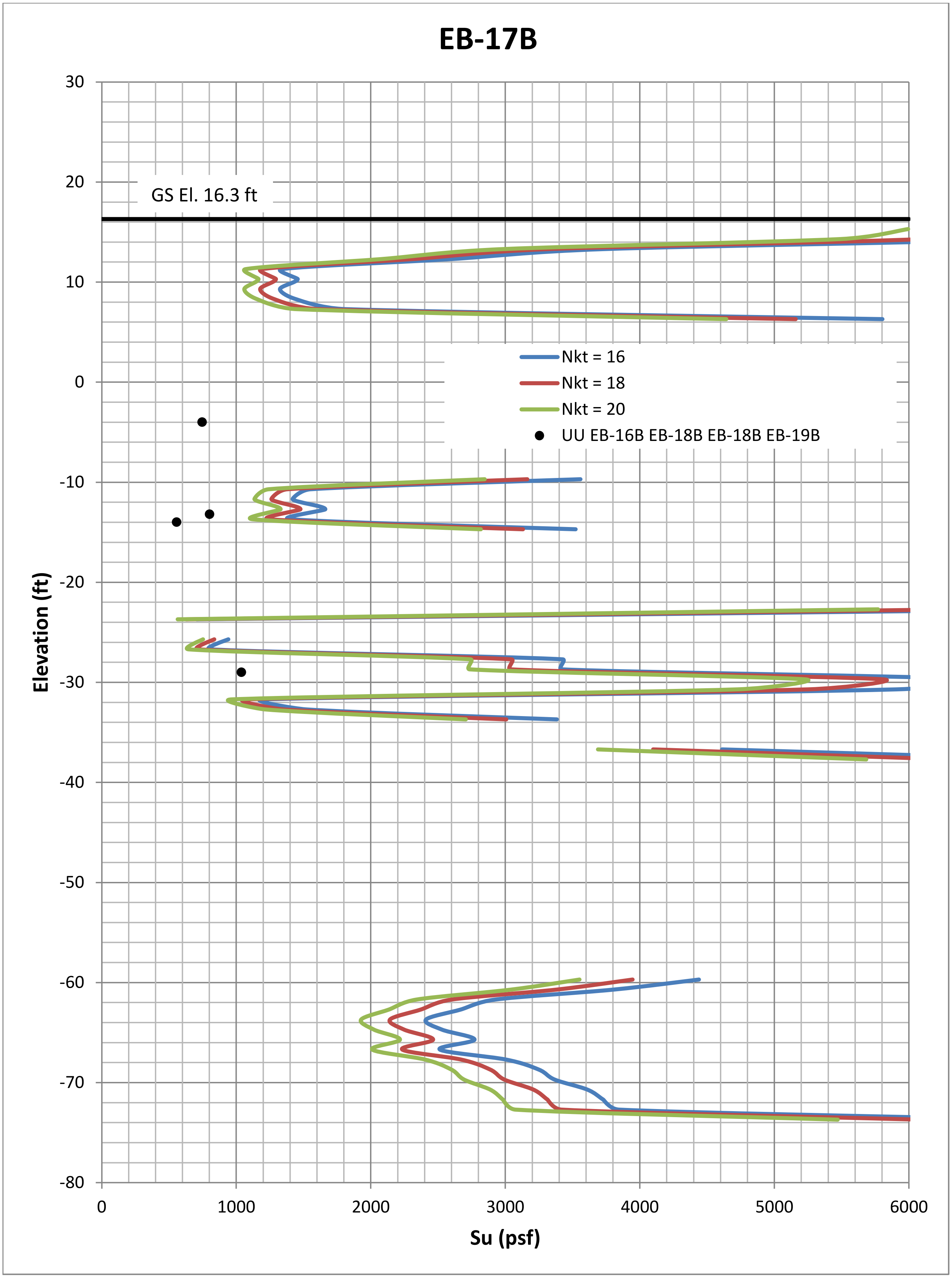

GR-27W
Elevation (ft)
Su (psf)
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Nkt(16)
Nkt(18)
Nkt(20)

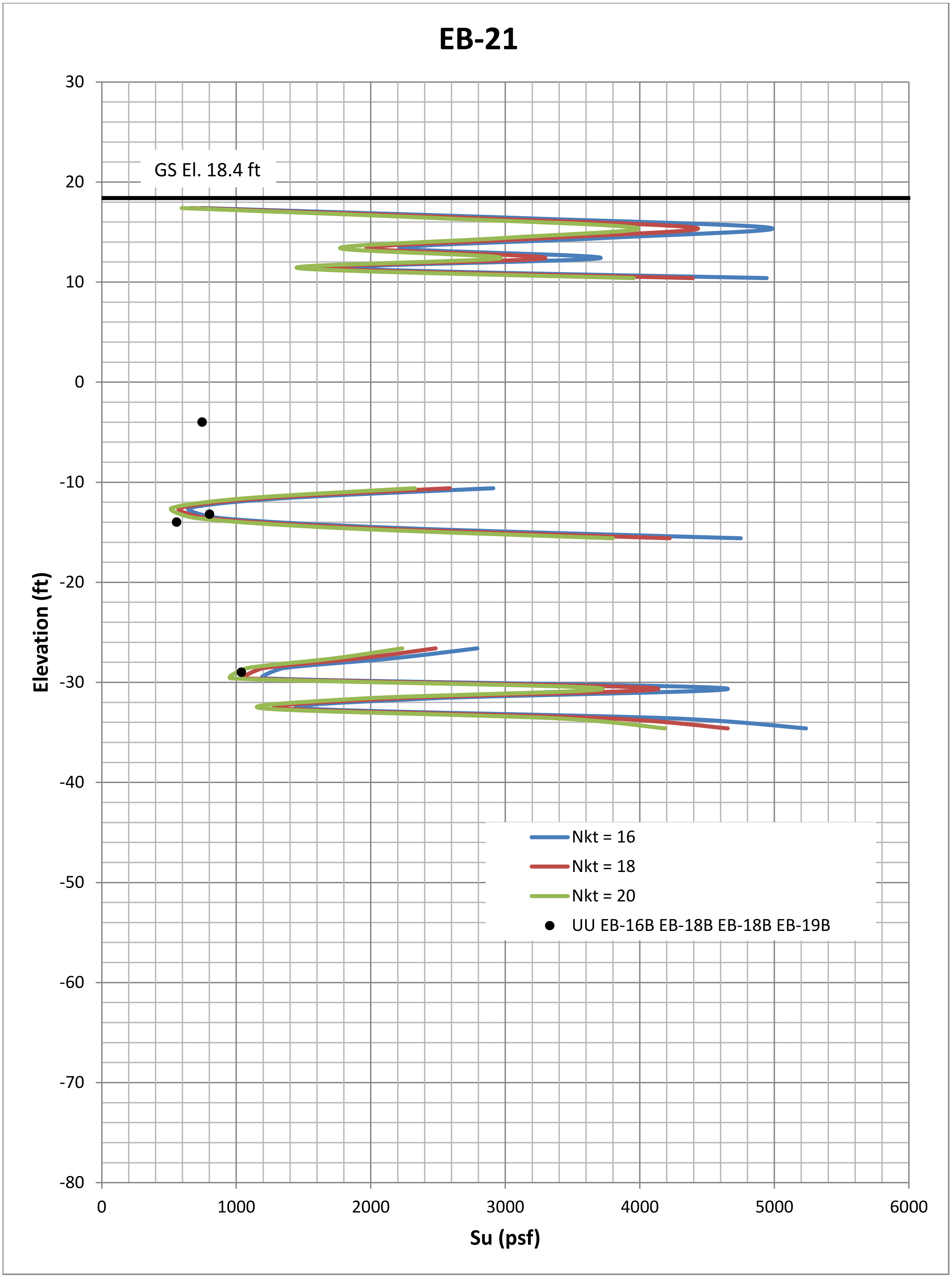

GR-30W
Su (psf)
0
1000
2000
3000
4000
5000
6000
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
Nkt(16)
Nkt(18)
Nkt(20)

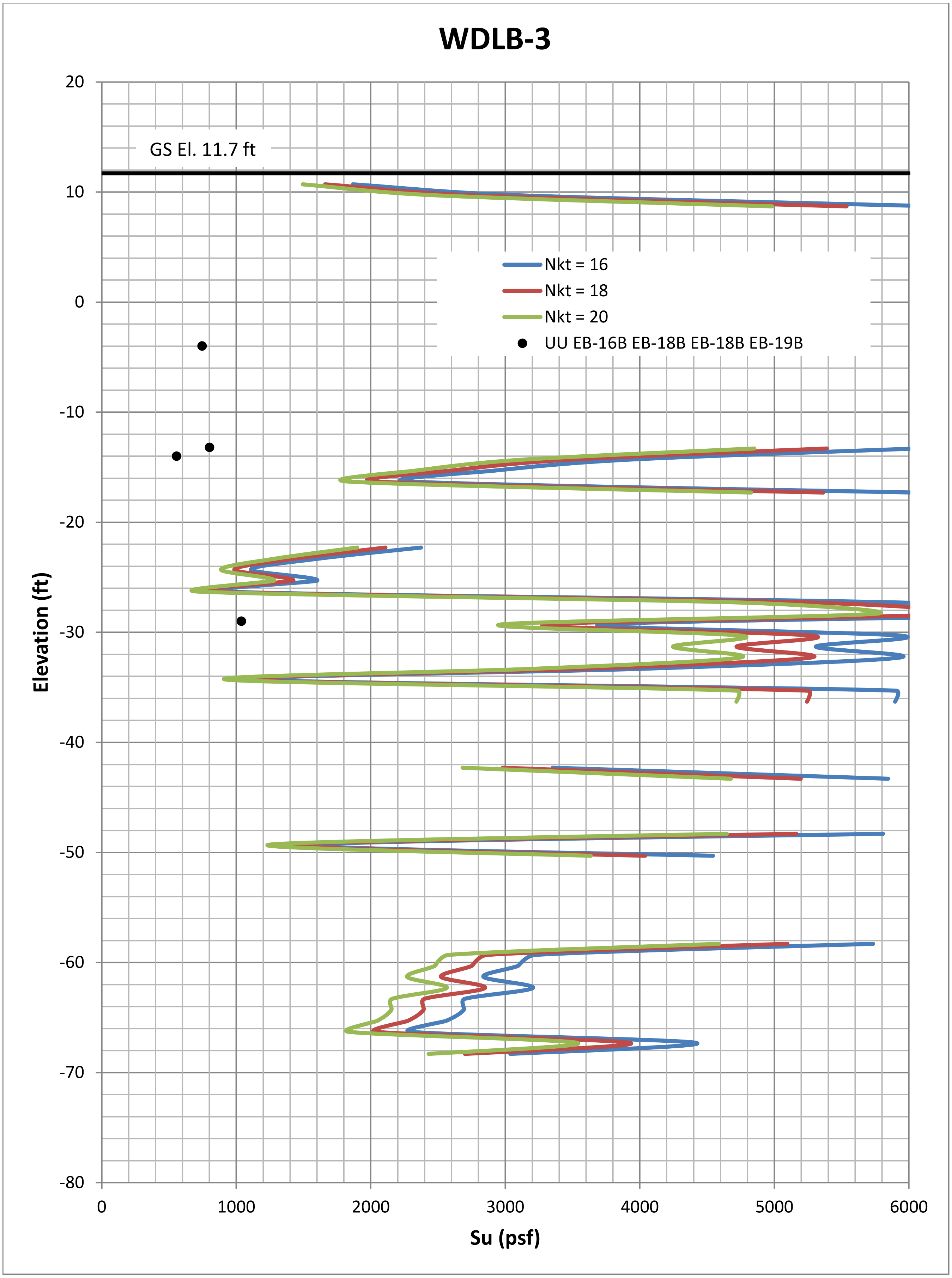

GR-30W
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Elevation (ft)
0
1000
2000
3000
4000
5000
6000
Su (psf)
Nkt(16)
Nkt(18)
Nkt(20)

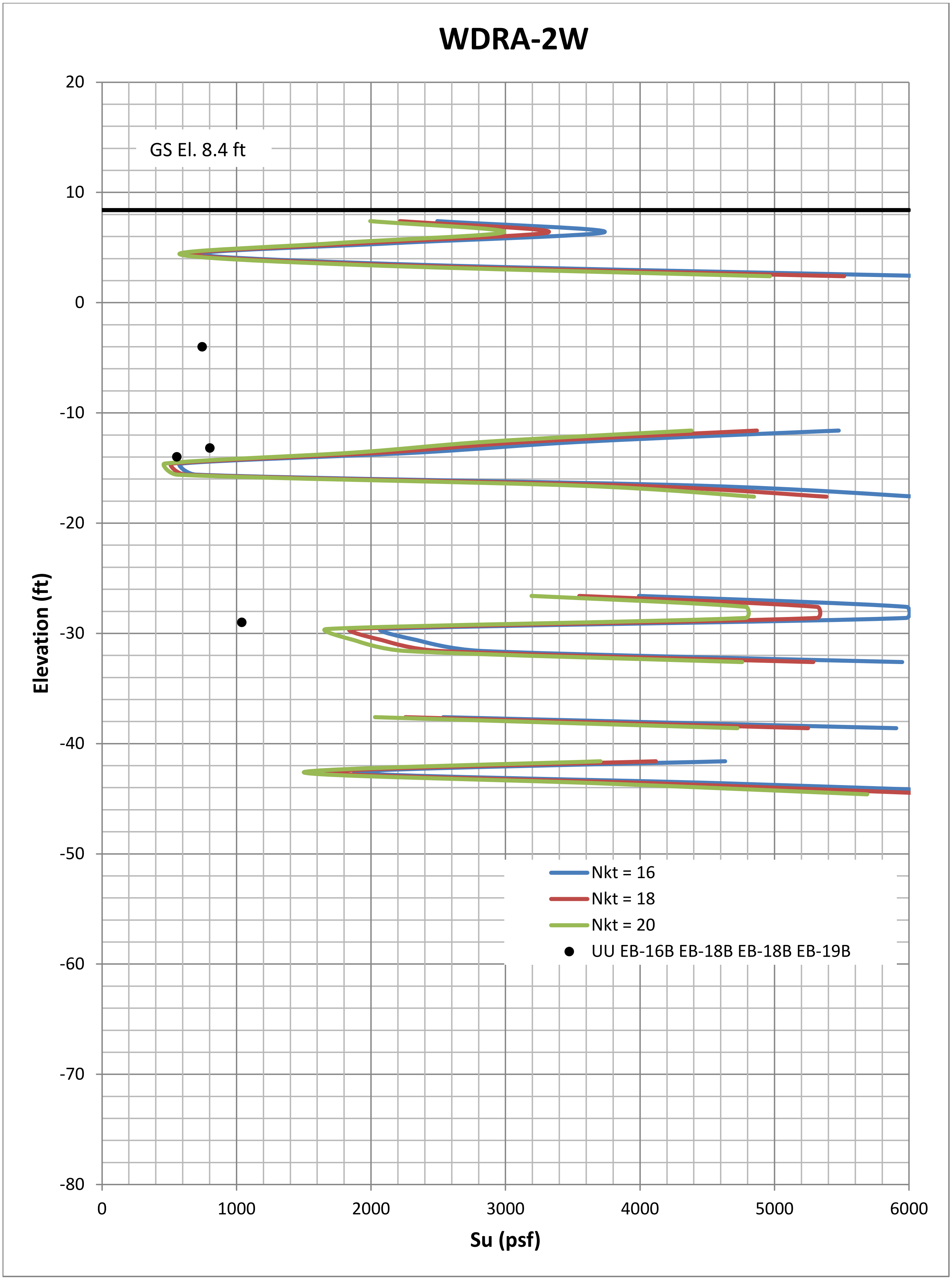

GR-37
Su (psf)
0
1000
2000
3000
4000
5000
6000
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Nkt(16)
Nkt(18)
Nkt(20)


GR-37
Elevation (ft)
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
0
1000
2000
3000
4000
5000
6000
Su (psf)
Nkt(16)
Nkt(18)
Nkt(20)

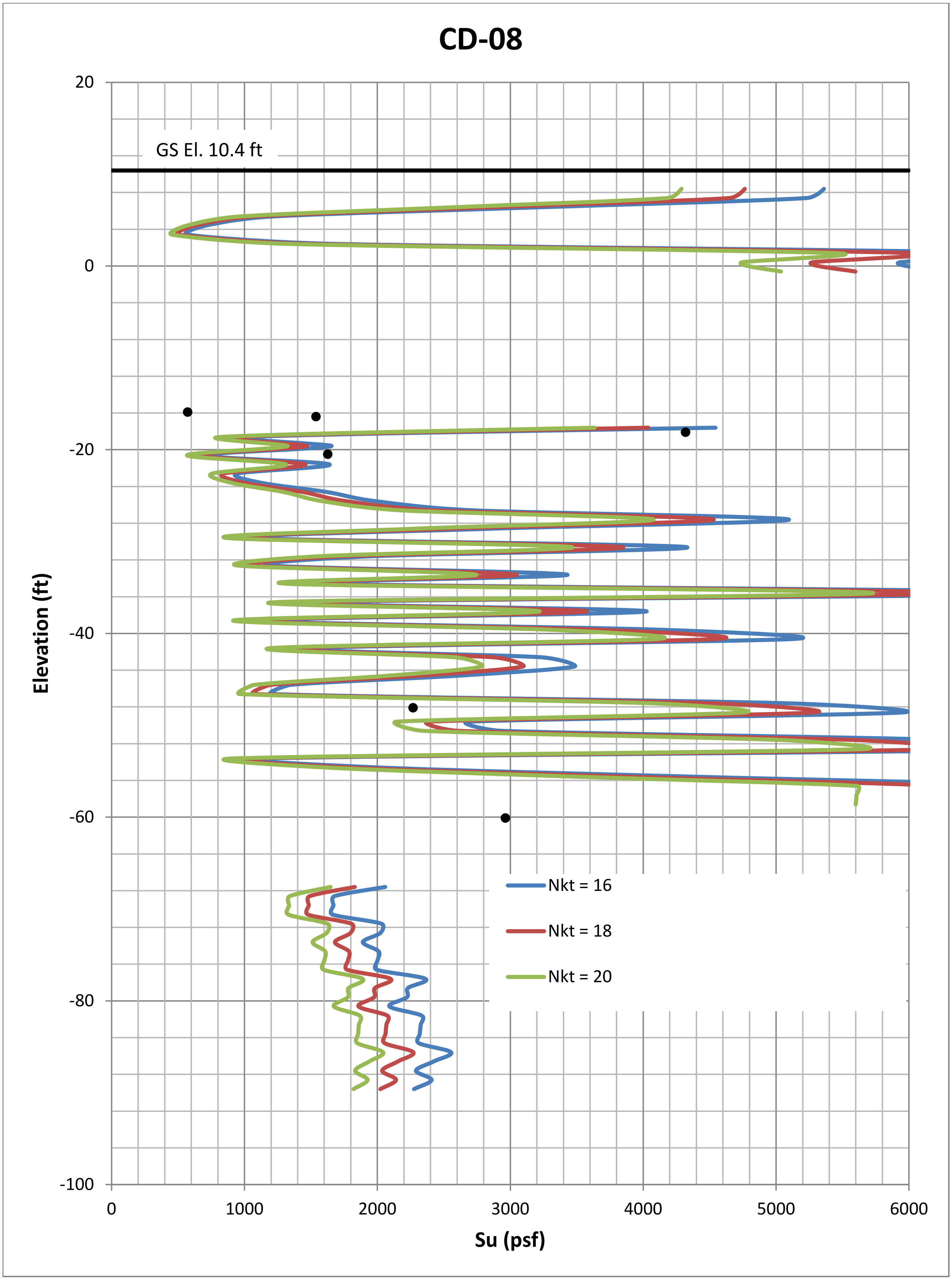

EB-17B
GS El. 16.3 ft
Nkt = 16
Nkt = 18
Nkt = 20
UU EB-16B EB-18B EB-18B EB-19B
Elevation (ft)
Su (psf)
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
0
1000
2000
3000
4000
5000
6000

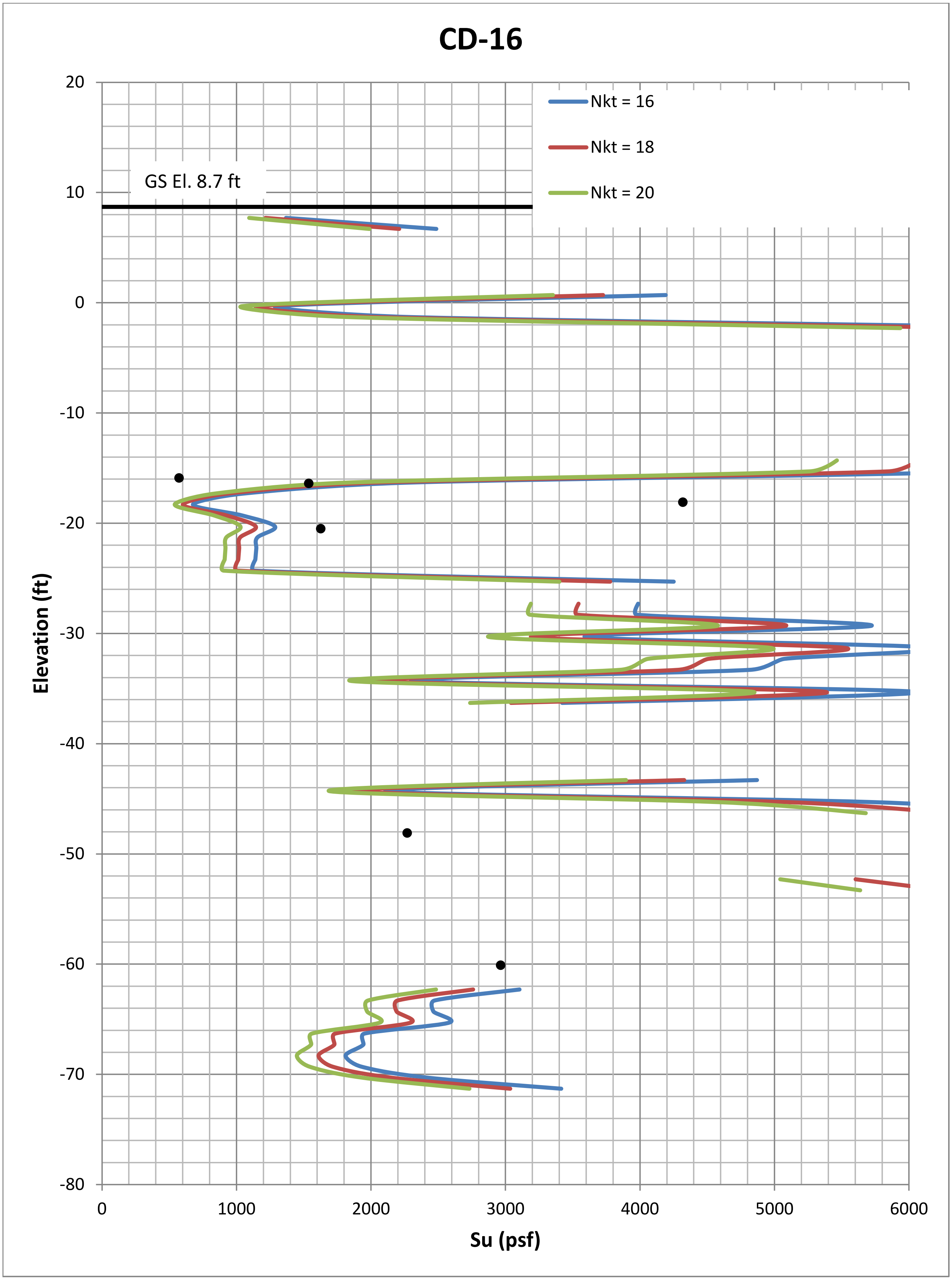

EB-21
GS El. 18.4 ft
Elevation (ft)
Su (psf)
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
0
1000
2000
3000
4000
5000
6000
Nkt = 16
Nkt = 18
Nkt = 20
UU EB-16B EB-18B EB-18B EB-19B

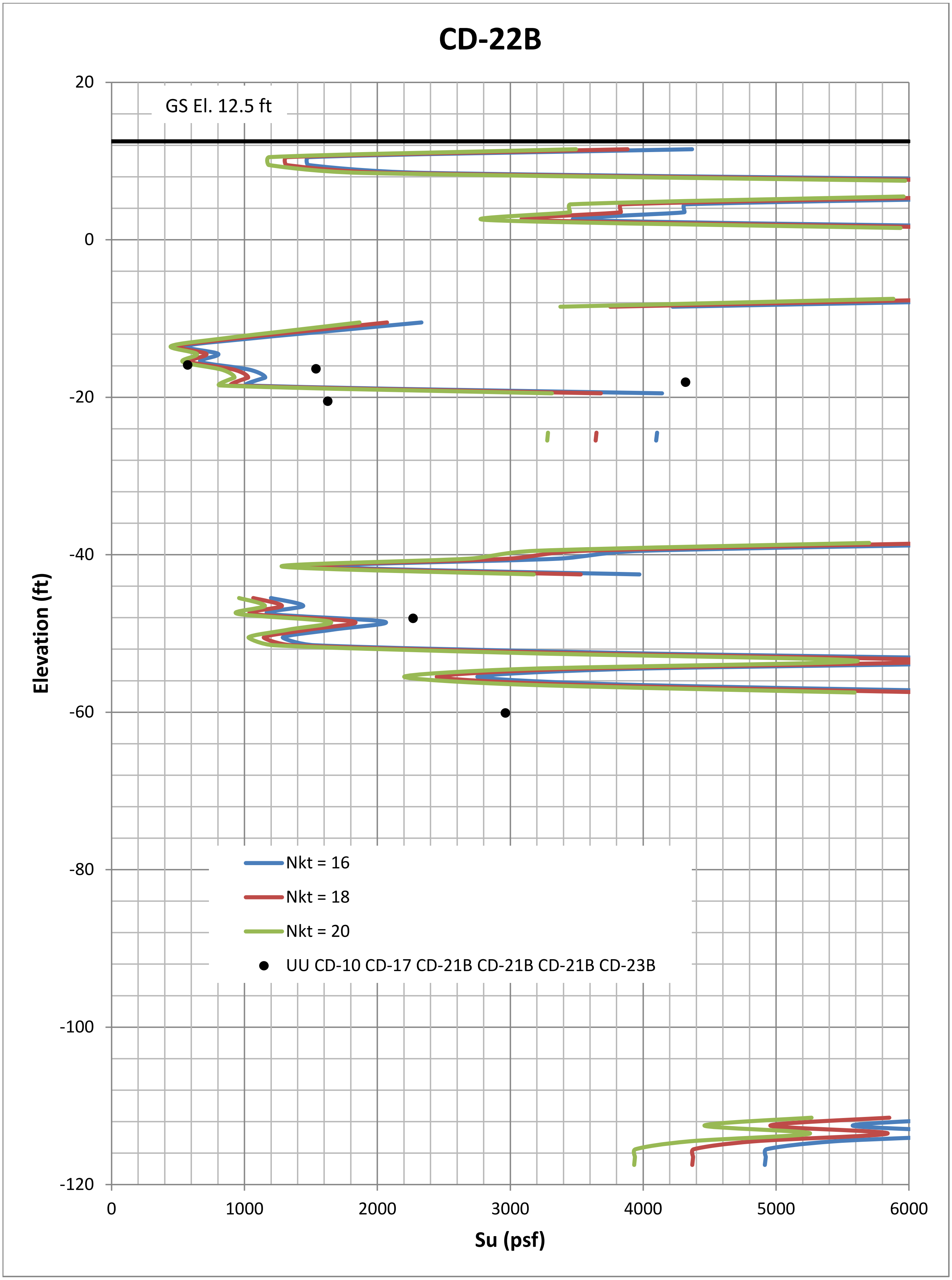

WDLB-3
GS El. 11.7 ft
Nkt = 16
Nkt = 18
Nkt = 20
● UU EB-16B EB-18B EB-18B EB-19B
Elevation (ft)
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
0
1000
2000
3000
4000
5000
6000
Su (psf)

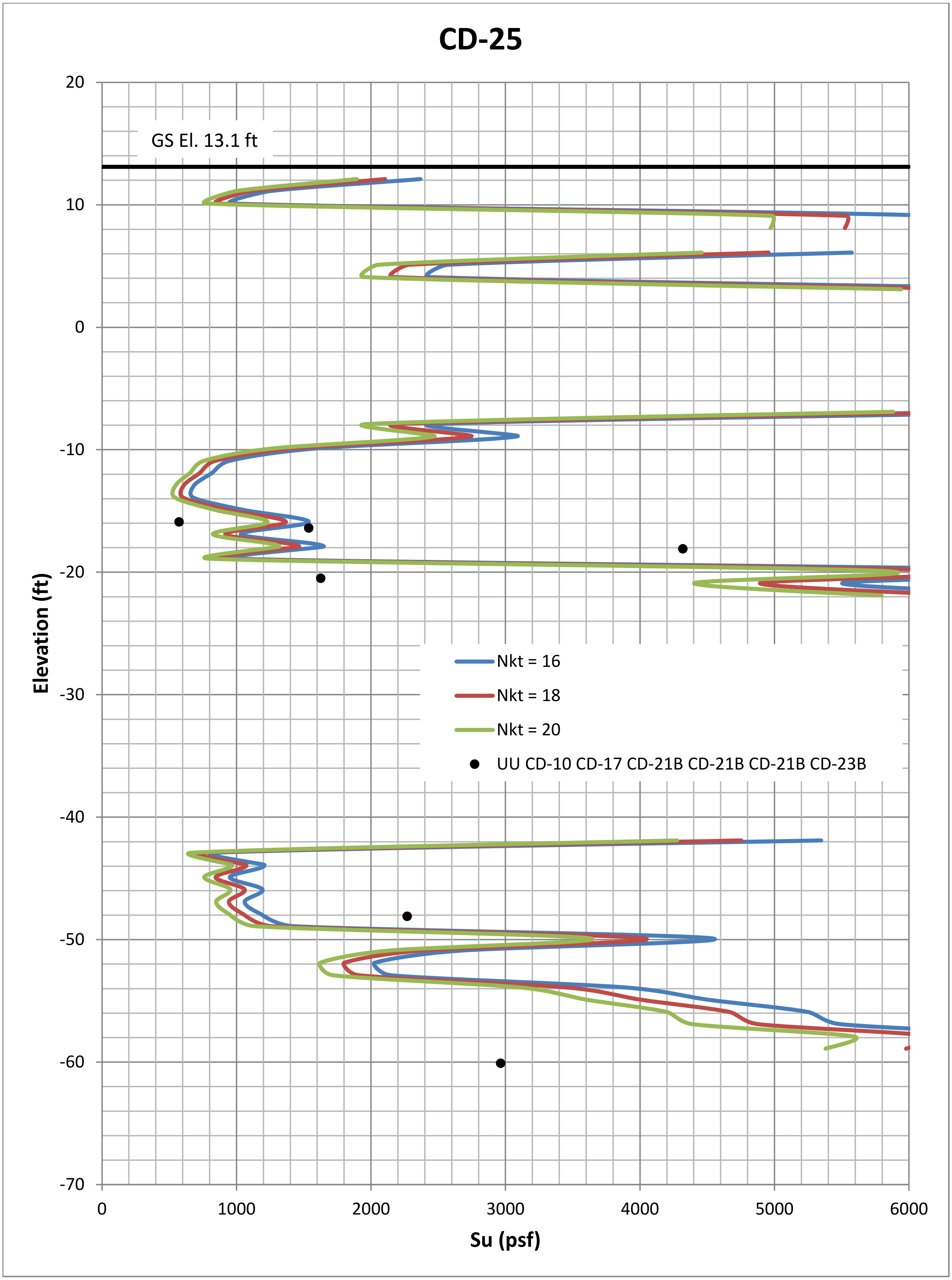


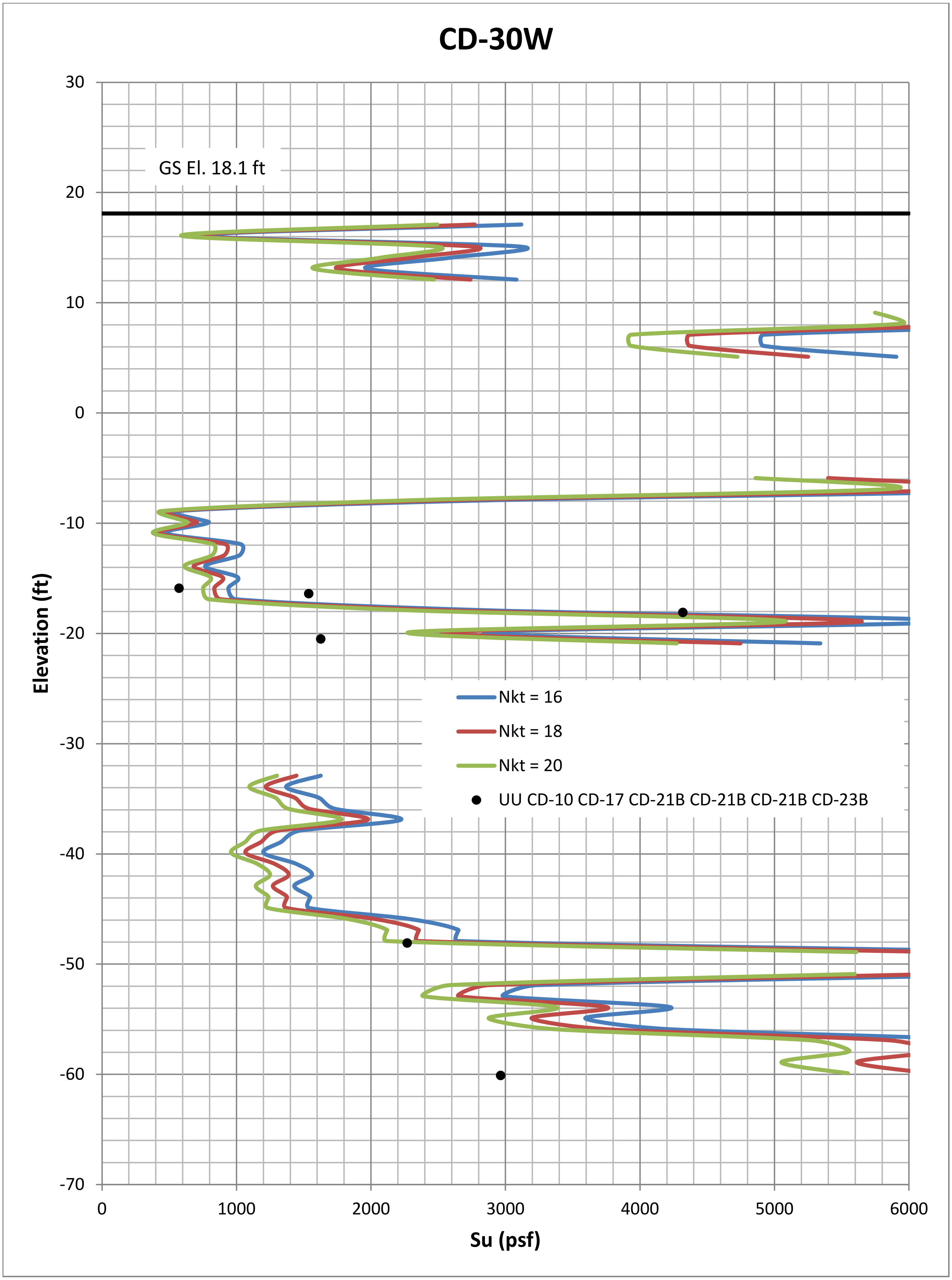
WDRA-2W
GS El. 8.4 ft
Elevation (ft)
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Su (psf)
0
1000
2000
3000
4000
5000
6000
Nkt = 16
Nkt = 18
Nkt = 20
UU EB-16B EB-18B EB-18B EB-19B


CD-08
GS El. 10.4 ft
Elevation (ft)
Su (psf)
20
0
-20
-40
-60
-80
-100
0
1000
2000
3000
4000
5000
6000
Nkt = 16
Nkt = 18
Nkt = 20

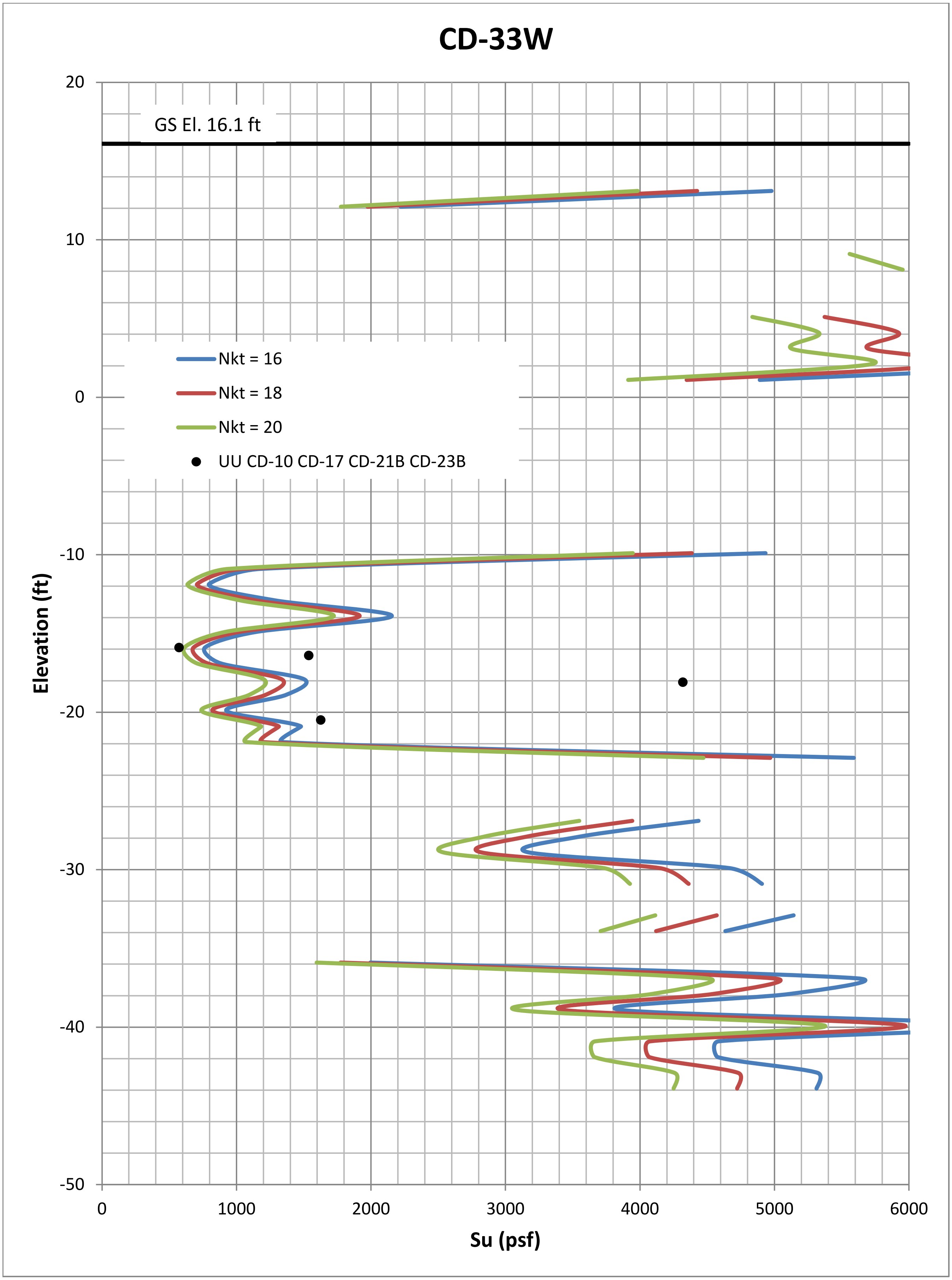

CD-16
Nkt = 16
Nkt = 18
Nkt = 20
GS El. 8.7 ft
Elevation (ft)
Su (psf)
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
0
1000
2000
3000
4000
5000
6000

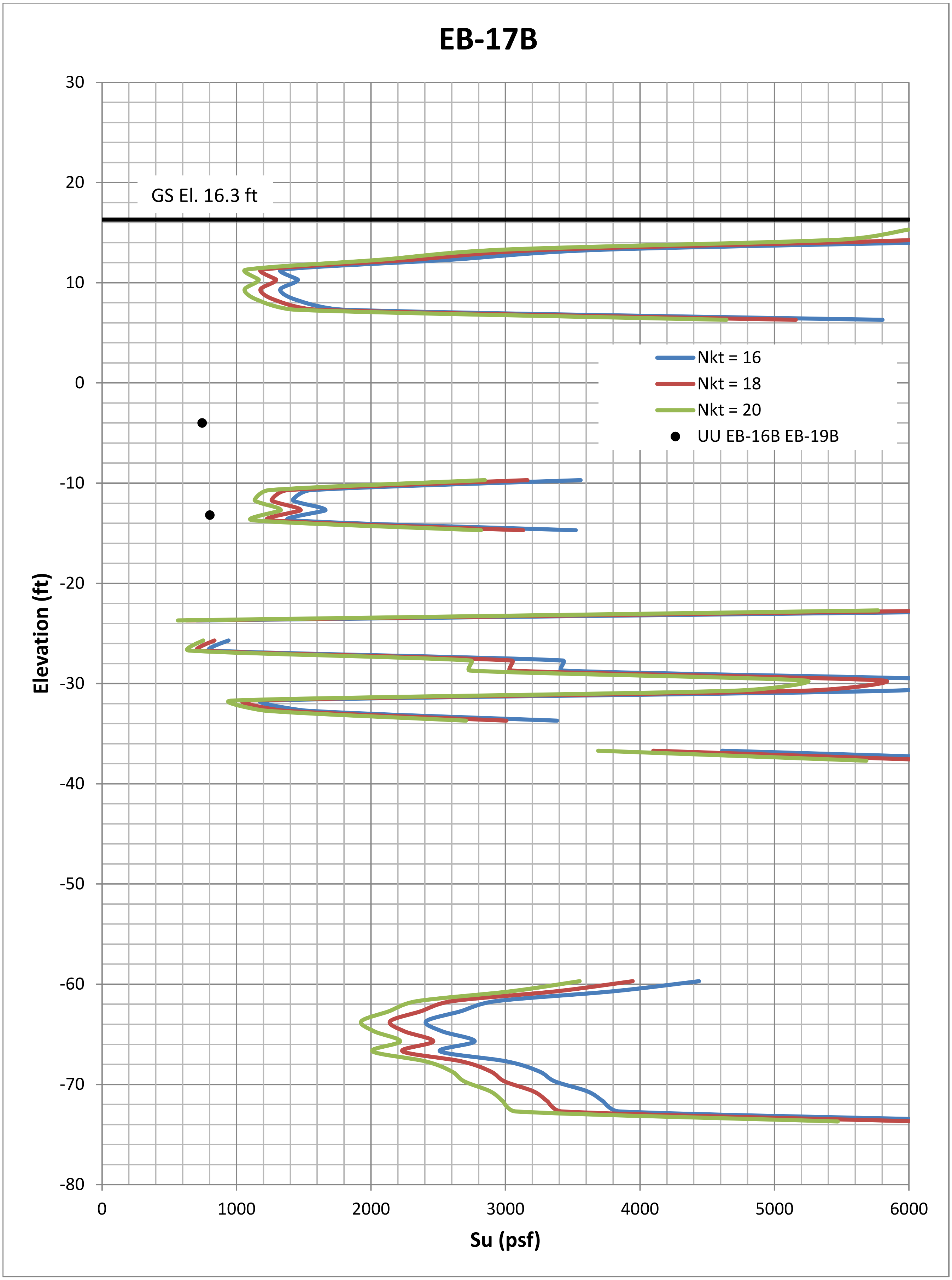

CD-22B
GS El. 12.5 ft
Elevation (ft)
20
0
-20
-40
-60
-80
-100
-120
0
1000
2000
3000
4000
5000
6000
Su (psf)
Nkt = 16
Nkt = 18
Nkt = 20
UU CD-10 CD-17 CD-21B CD-21B CD-21B CD-23B


CD-25
20
10
0
-10
-20
-30
-40
-50
-60
-70
0
1000
2000
3000
4000
5000
6000
GS El. 13.1 ft
Elevation (ft)
Su (psf)
Nkt = 16
Nkt = 18
Nkt = 20
UU CD-10 CD-17 CD-21B CD-21B CD-21B CD-23B

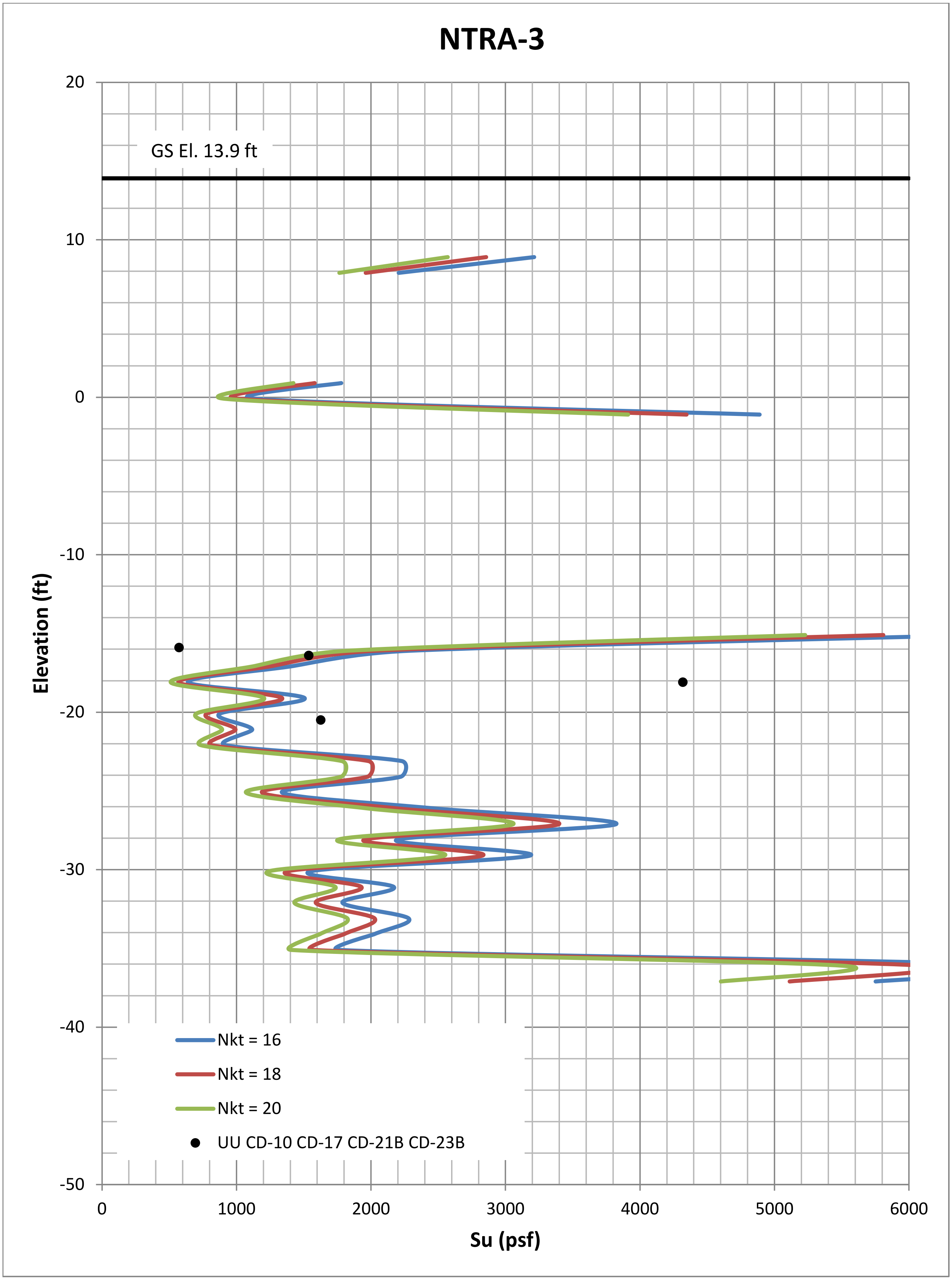


CD-30W
GS El. 18.1 ft
Elevation (ft)
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
Su (psf)
0
1000
2000
3000
4000
5000
6000
Nkt = 16
Nkt = 18
Nkt = 20
● UU CD-10 CD-17 CD-21B CD-21B CD-21B CD-23B


CD-33W
GS El. 16.1 ft
Nkt = 16
Nkt = 18
Nkt = 20
UU CD-10 CD-17 CD-21B CD-23B
Elevation (ft)
20
10
0
-10
-20
-30
-40
-50
0
1000
2000
3000
4000
5000
6000
Su (psf)



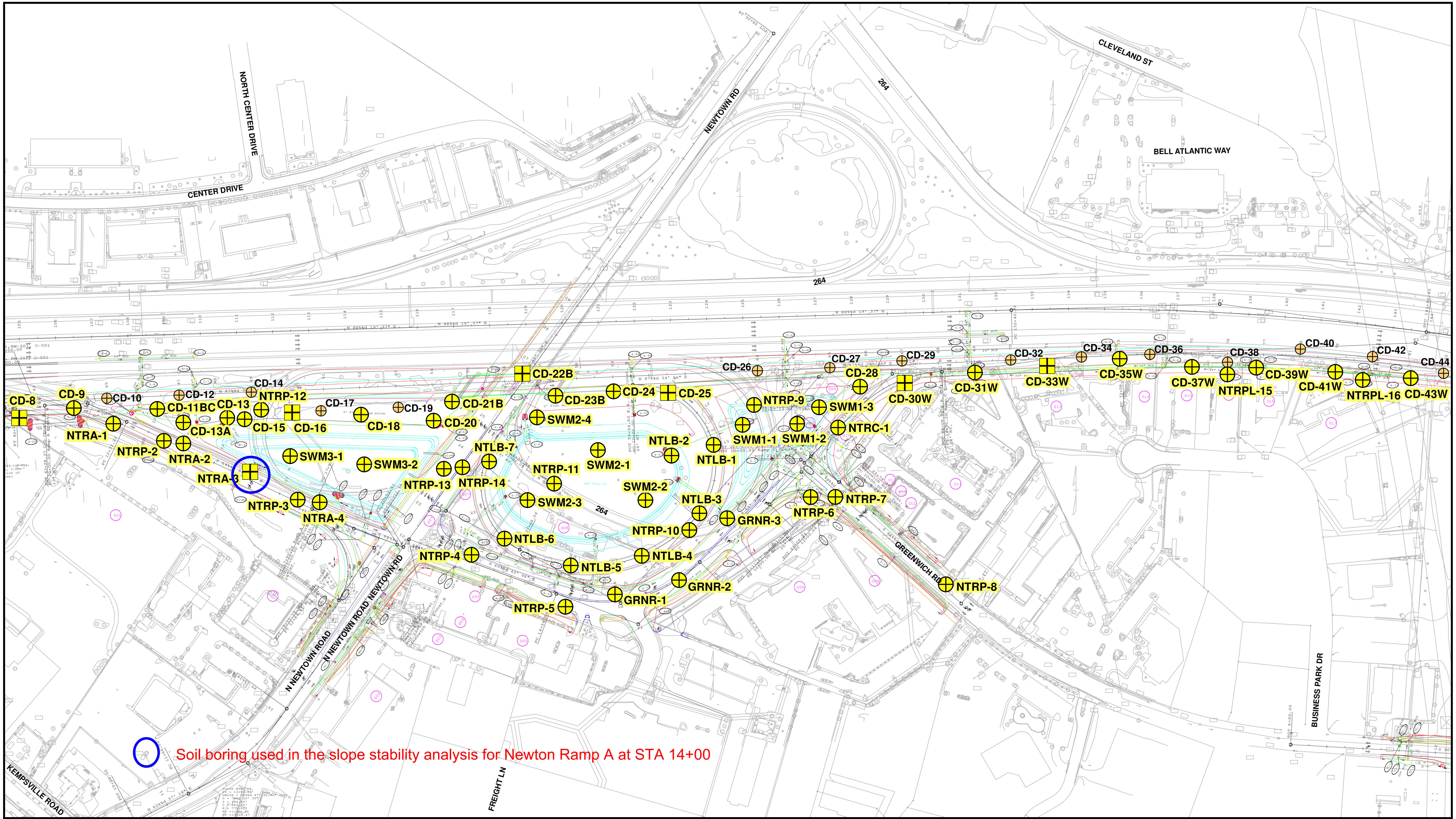
EB-17B
GS El. 16.3 ft
Nkt = 16
Nkt = 18
Nkt = 20
UU EB-16B EB-19B
Elevation (ft)
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
0
1000
2000
3000
4000
5000
6000
Su (psf)


NTRA-3
GS El. 13.9 ft
Elevation (ft)
20
10
0
-10
-20
-30
-40
-50
0
1000
2000
3000
4000
5000
6000
Su (psf)
Nkt = 16
Nkt = 18
Nkt = 20
● UU CD-10 CD-17 CD-21B CD-23B

Appendix B:

Slope Stability Outputs

Slope Stability Analysis at
STATION 14+00



Soil boring used in the slope stability analysis for Newton Ramp A at STA 14+00

N

0 125 250 Feet

⊕ SPT Exploration Locations

⊕ PSA I-264 CD Borings

⊞ CPT Exploration Locations

Prepared by: HDR

Date: November 2011

VDOT Virginia Department of Transportation

Project 0264-134-102
City of Virginia Beach

Project Study Area
Newtown

Drawing 2:
Exploration Location Plan

CONE PENETROMETER TEST LOG

Virginia Department of Transportation

PROJECT #: 0264-134-102

LOCATION: Va Beach: PSA Newtown

NTRA-3

PAGE 1 OF 1

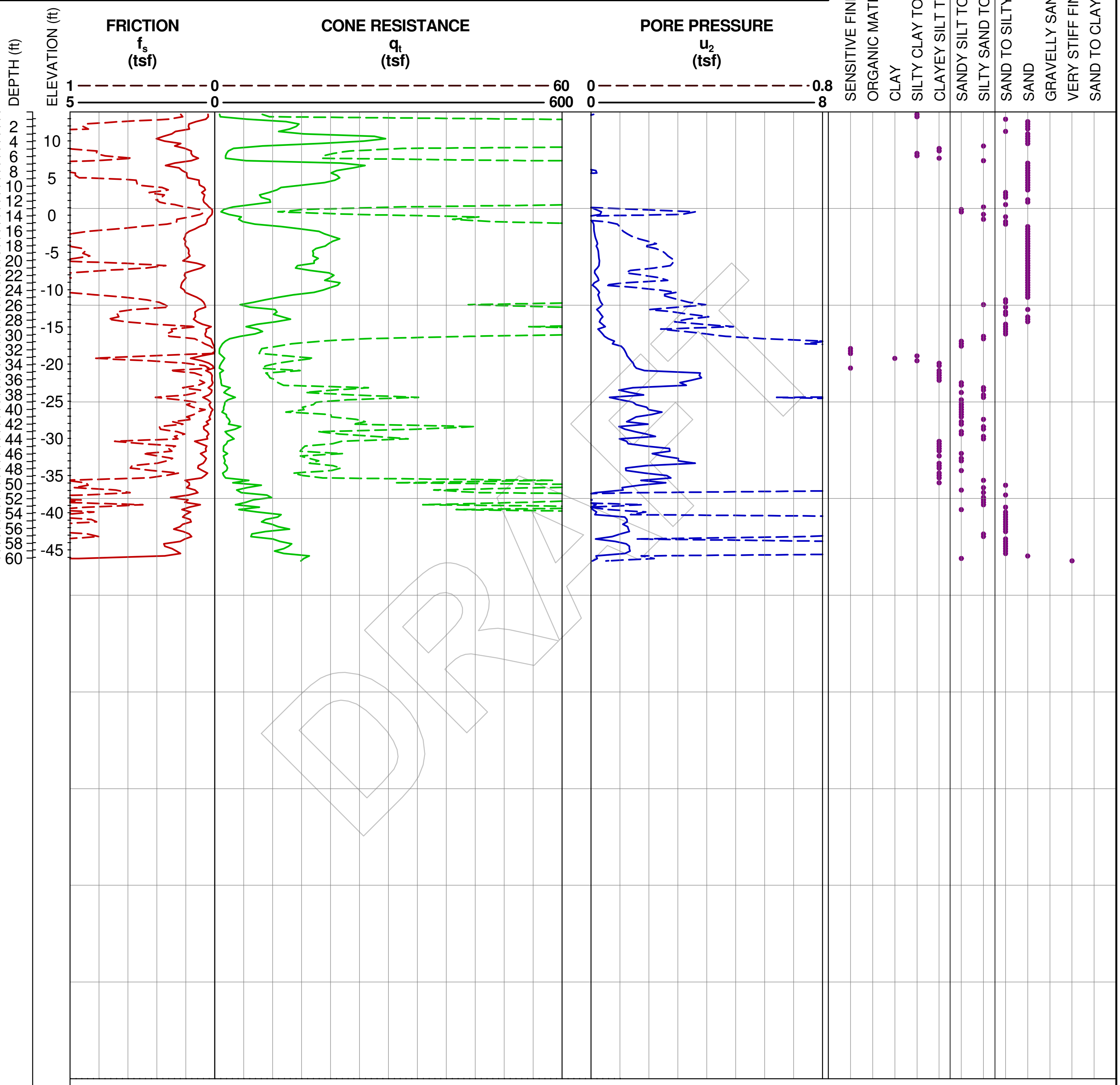
STATION: 16+00
OFFSET: 20 ft LT
LATITUDE: 36.844863° N
LONGITUDE: 76.186010° W
SURFACE ELEVATION: 13.9
COORD. DATUM: NAD 83
BENCHMARK LOCATION:

DRILLER: Ron Stewart/MAD
CONE TYPE: Hogentogler Elec. Sub. Cone
CONE SIZE: 10 sq. cm
CONE ID No.: DSG1031

DATE(S) DRILLED:
01/20/11 - 01/20/11

LOGGER: HDR

SOIL BEHAVIOR TYPE *



* Campanella and Robertson (1983) Friction Ratio correlation

REMARKS:
REFERENCE BASELINE: NEWTOWN RD. OFF-RAMP A CONST.

PAGE 1 OF 1

NTRA-3

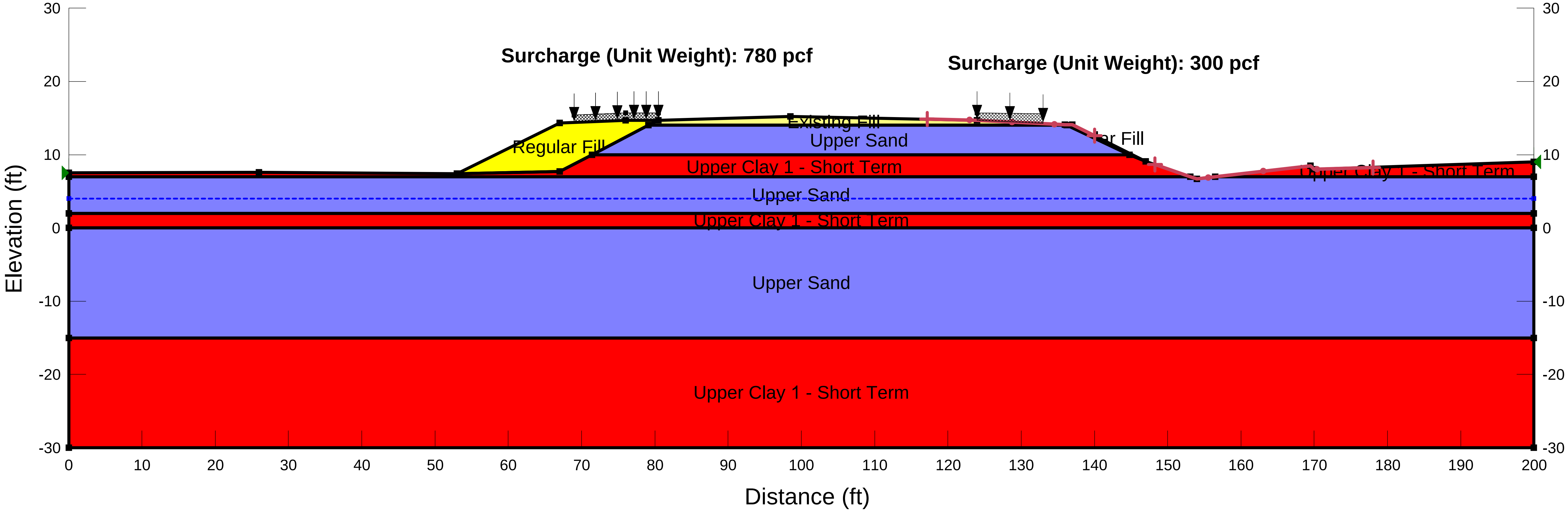
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Newtown Ramp A
Analysis Location: Sta. 14+00
GER Used for Soil Parameters: PSA Newtown
Borings Used for Profile: NTRA-3 (CPT)

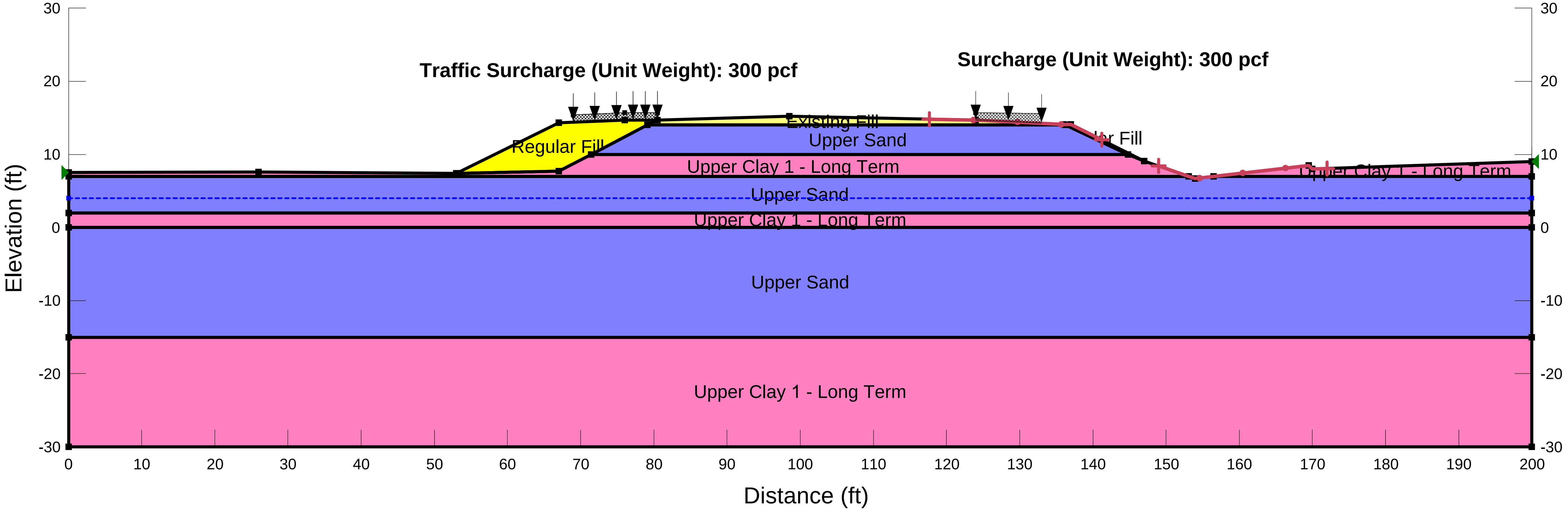


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 50 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 50 psf Phi: 23 ° Piezometric Line: 1

Newtown Ramp A
Analysis Location: Sta. 14+00
GER Used for Soil Parameters: PSA Newtown
Borings Used for Profile: NTRA-3 (CPT)

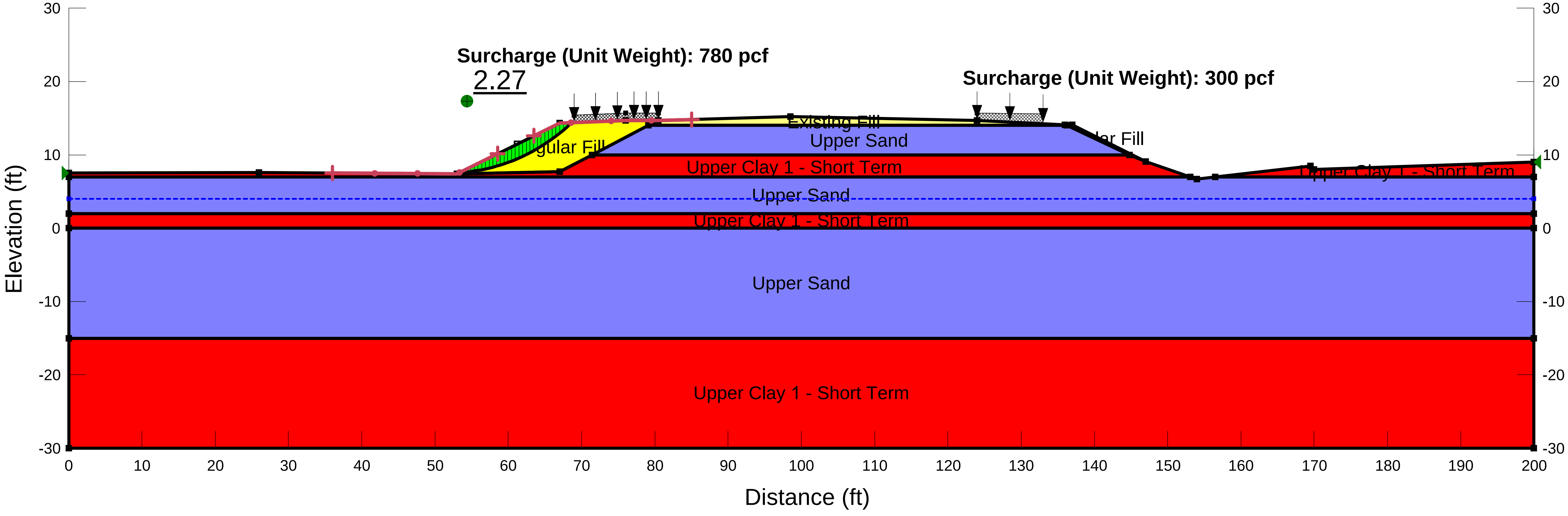


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Newtown Ramp A
Analysis Location: Sta. 14+00
GER Used for Soil Parameters: PSA Newtown
Borings Used for Profile: NTRA-3 (CPT)

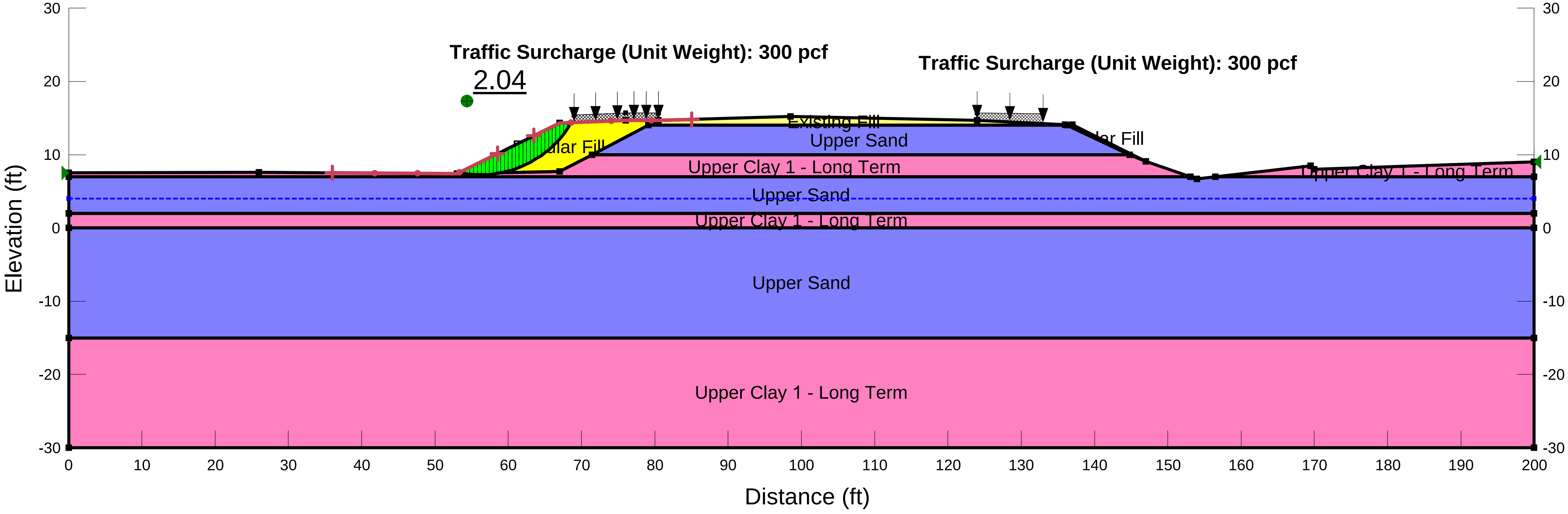


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Upper Clay 1 - Long Term	Unit Weight: 112 pcf	Cohesion: 50 psf	Phi: 23 °	Piezometric Line: 1
Name: Upper Clay 2 - Long Term	Unit Weight: 112 pcf	Cohesion: 50 psf	Phi: 23 °	Piezometric Line: 1

Newtown Ramp A
Analysis Location: Sta. 14+00
GER Used for Soil Parameters: PSA Newtown
Borings Used for Profile: NTRA-3 (CPT)



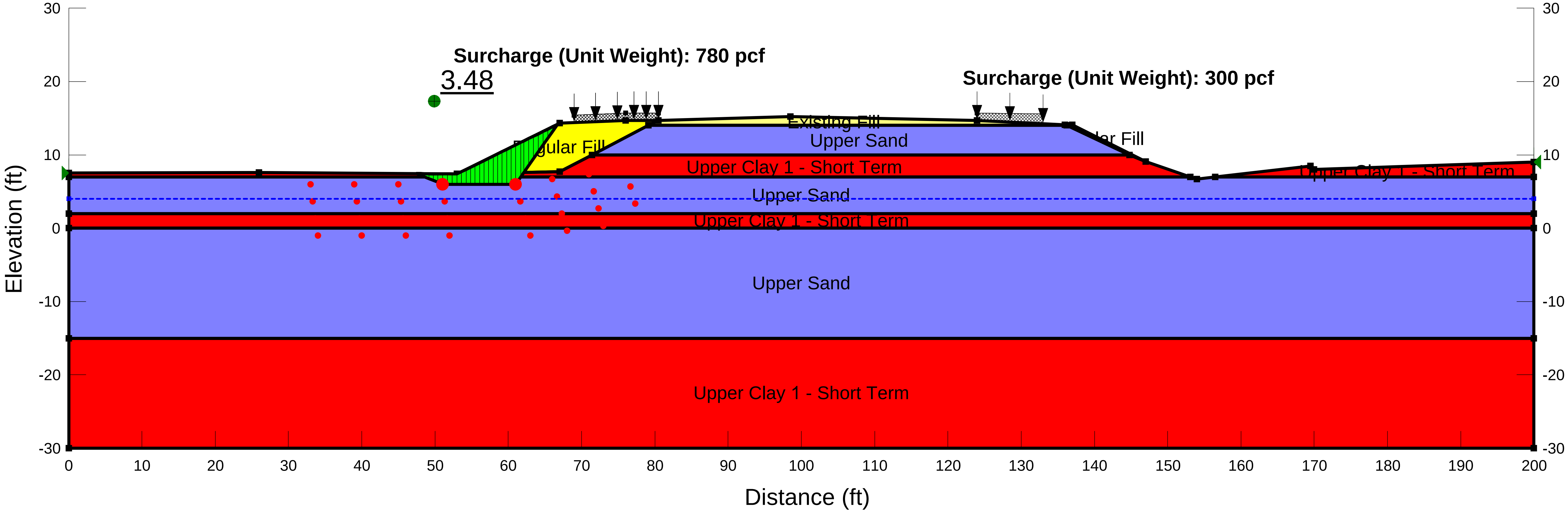
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Short Term Global Stability Analysis

Name: Existing Fill   Unit Weight: 125 pcf   Cohesion: 50 psf   Phi: 32 °   Piezometric Line: 1
Name: Regular Fill   Unit Weight: 130 pcf   Cohesion: 50 psf   Phi: 34 °   Piezometric Line: 1
Name: Upper Sand   Unit Weight: 115 pcf   Cohesion: 50 psf   Phi: 32 °   Piezometric Line: 1
Name: Upper Clay 1 - Short Term   Unit Weight: 112 pcf   Cohesion Spatial Fn: Upper Clay   Phi: 0 °   Piezometric Line: 1
Name: Upper Clay 2 - Short Term   Unit Weight: 112 pcf   Cohesion Spatial Fn: Upper Clay   Phi: 0 °   Piezometric Line: 1

Newtown Ramp A
Analysis Location: Sta. 14+00
GER Used for Soil Parameters: PSA Newtown
Borings Used for Profile: NTRA-3 (CPT)

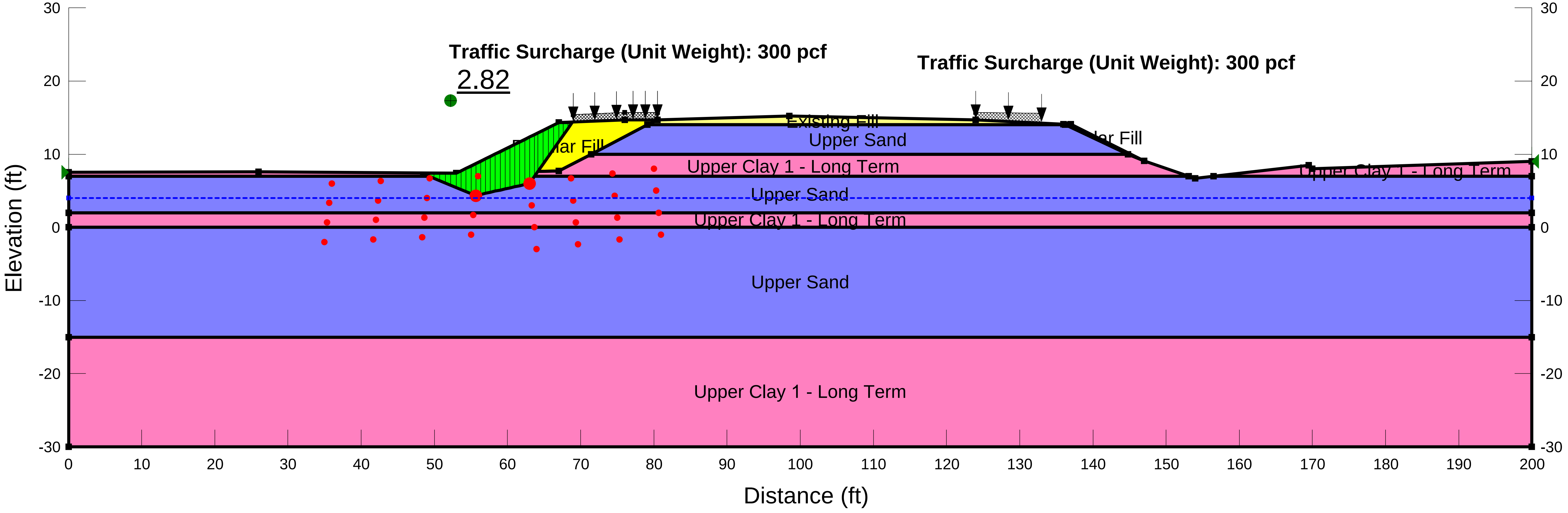


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 50 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 50 psf Phi: 23 ° Piezometric Line: 1

Long Term Global Stability Analysis

Newtown Ramp A
Analysis Location: Sta. 14+00
GER Used for Soil Parameters: PSA Newtown
Borings Used for Profile: NTRA-3 (CPT)

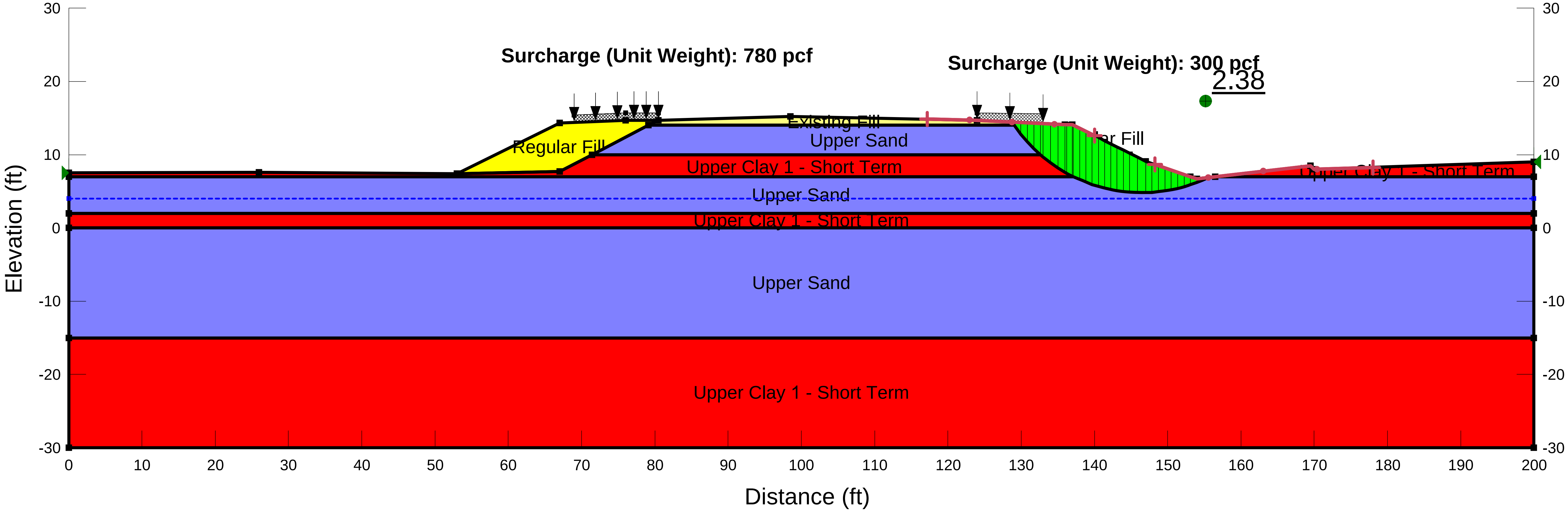


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Newtown Ramp A
Analysis Location: Sta. 14+00
GER Used for Soil Parameters: PSA Newtown
Borings Used for Profile: NTRA-3 (CPT)



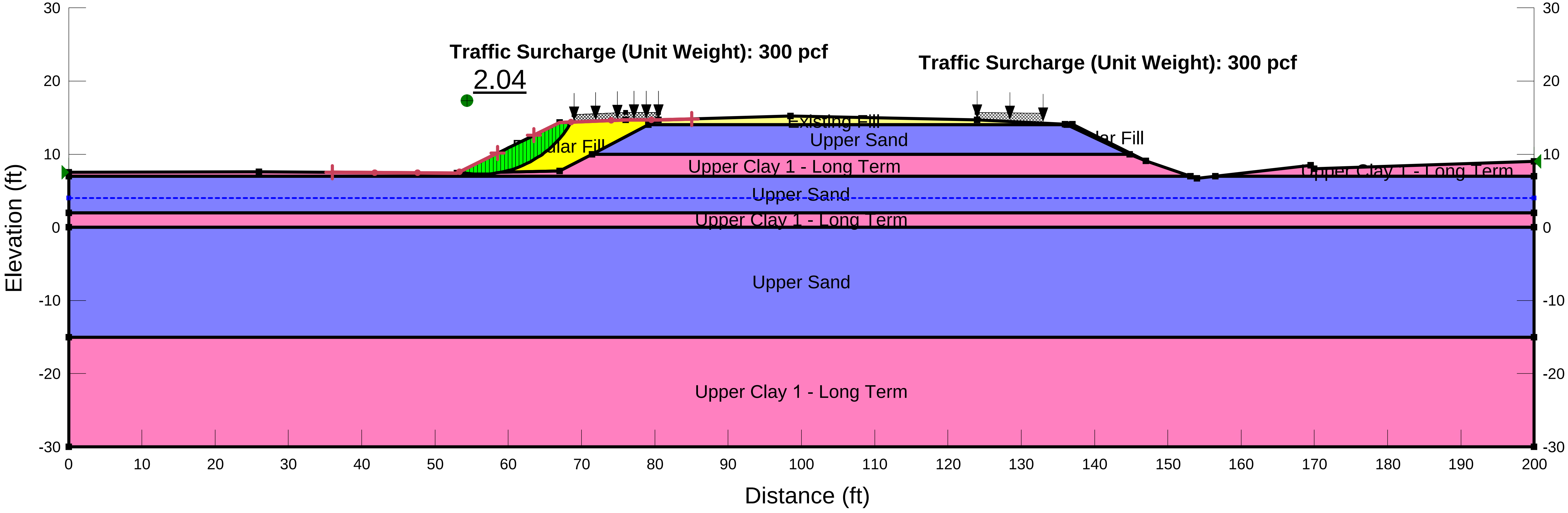
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 50 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 50 psf Phi: 23 ° Piezometric Line: 1

Newtown Ramp A
Analysis Location: Sta. 14+00
GER Used for Soil Parameters: PSA Newtown
Borings Used for Profile: NTRA-3 (CPT)



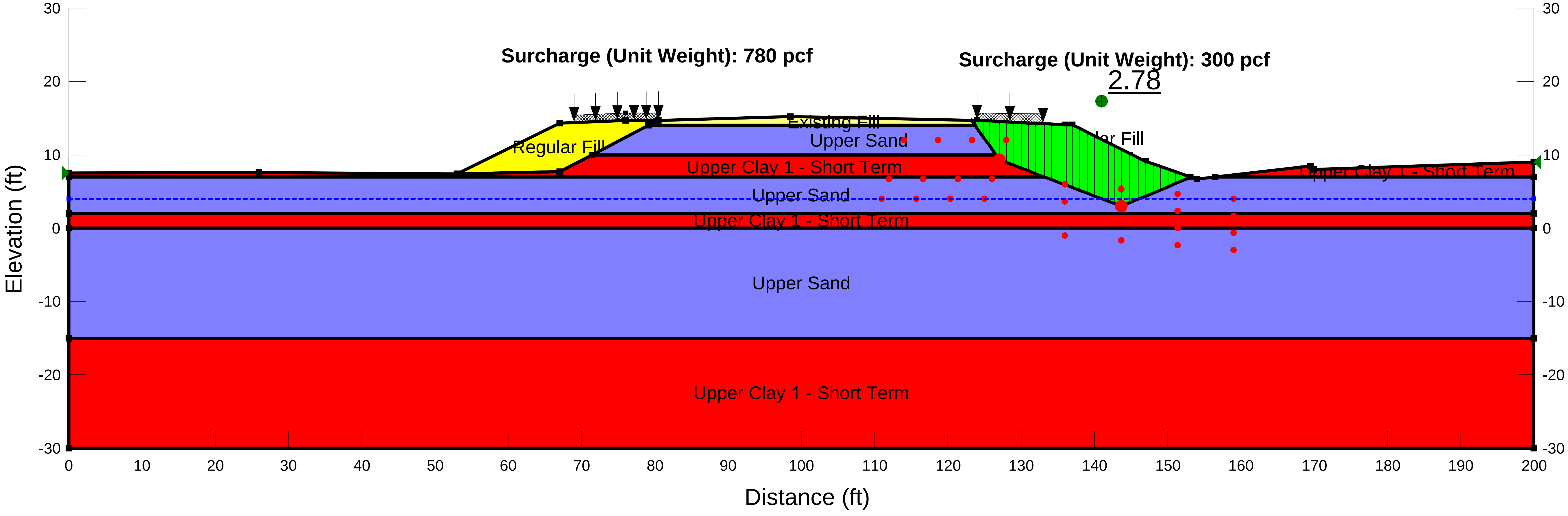
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Newtown Ramp A
Analysis Location: Sta. 14+00
GER Used for Soil Parameters: PSA Newtown
Borings Used for Profile: NTRA-3 (CPT)

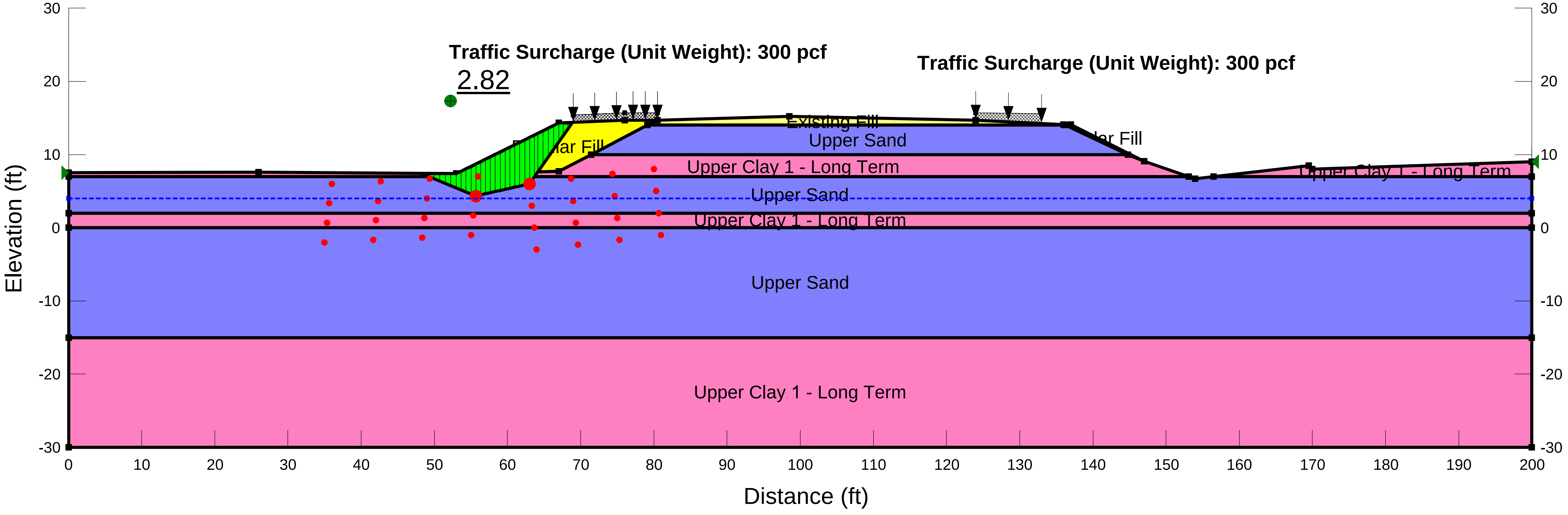


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

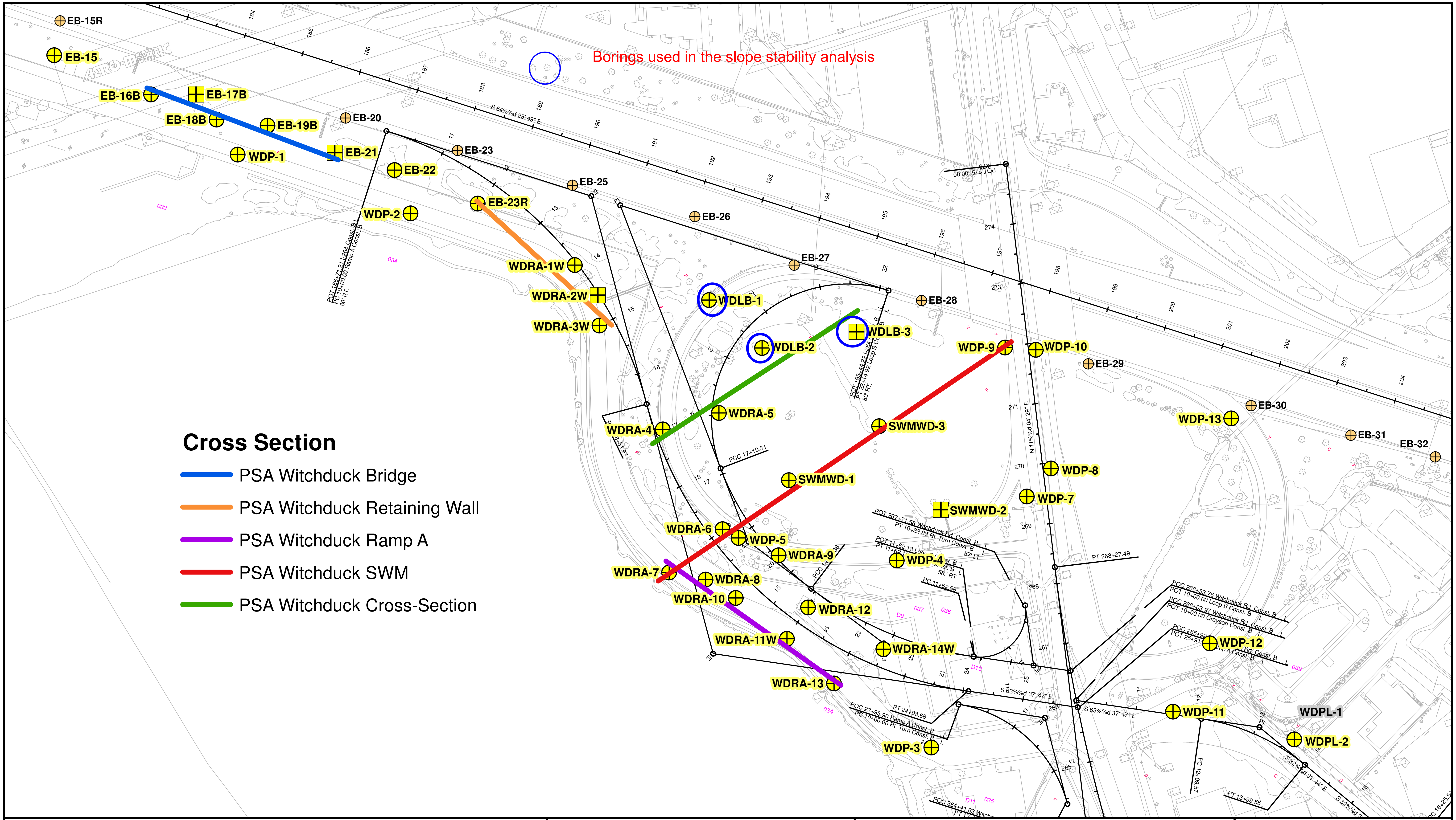
Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 50 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 50 psf Phi: 23 ° Piezometric Line: 1

Newtown Ramp A
Analysis Location: Sta. 14+00
GER Used for Soil Parameters: PSA Newtown
Borings Used for Profile: NTRA-3 (CPT)



Slope Stability Analysis at

STATION 17+50



N

0 75 150 Feet

Scale: 1" = 150'

⊕ SPT Exploration

⊞ CPT Exploration

⊕ PSA I-264 CD Borings

Prepared by: HDR Date: February 13, 2013

VDOT Virginia Department of Transportation

Project 0264-134-102

City of Virginia Beach

Project Study Area
Witchduck

Drawing 4: Subsurface Cross Section Locations

CONE PENETROMETER TEST LOG

VDOT Virginia Department of Transportation

PROJECT #: 0264-134-102

LOCATION: VA Beach: PSA Witchduck

WDLB-3

PAGE 1 OF 1

STATION: 21+69

OFFSET: 78 ft RT

LATITUDE: 36.838513° N

LONGITUDE: 76.160156° W

SURFACE ELEVATION: 11.7

COORD. DATUM: NAD 83

BENCHMARK LOCATION:

DRILLER: Ron Stewart/MAD

DATE(S) DRILLED:
01/17/11 - 01/17/11

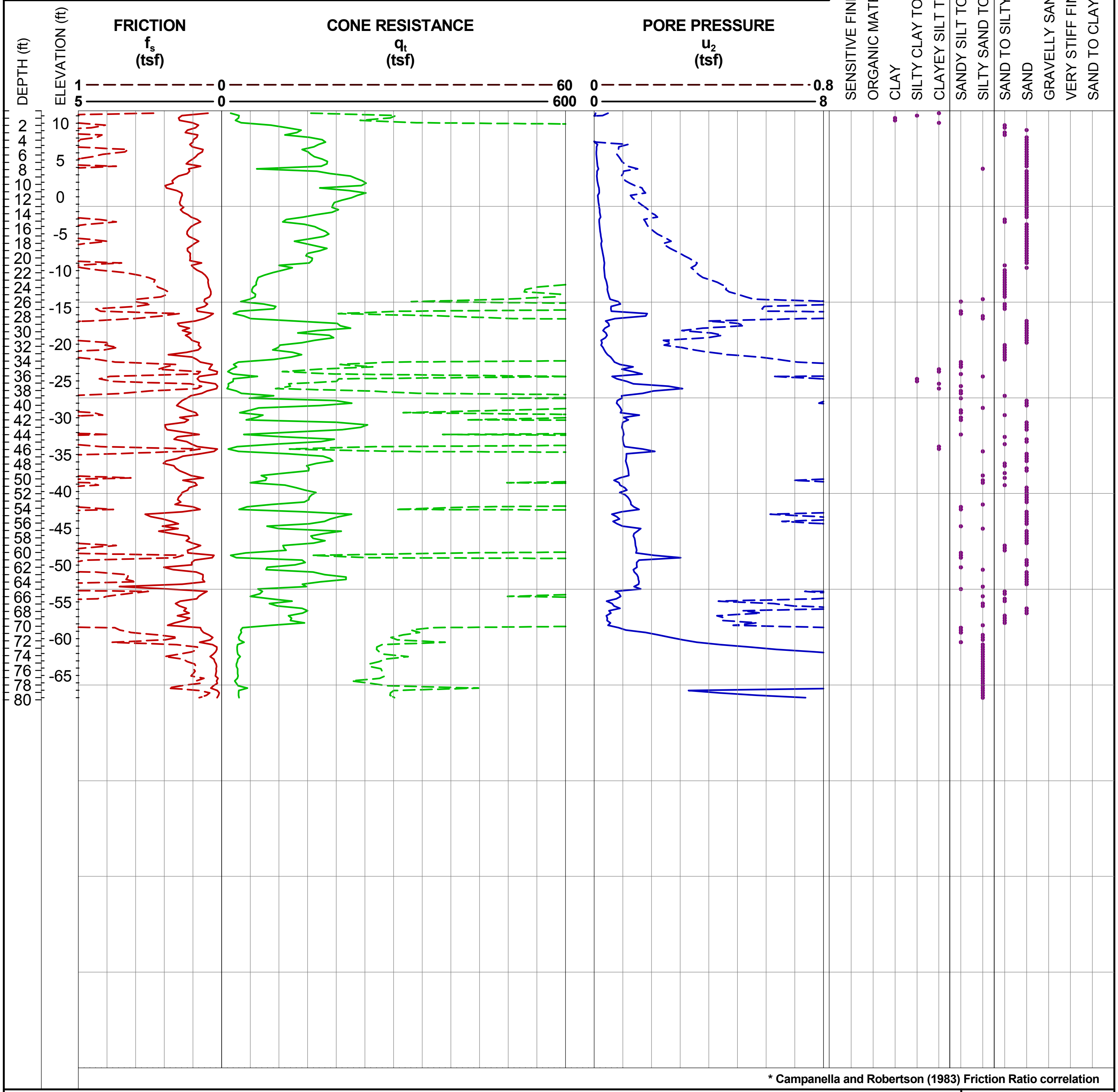
CONE TYPE: Hogentogler Elec. Sub. Cone

CONE SIZE: 10 sq. cm

CONE ID No.: DSG1031

LOGGER: HDR

SOIL BEHAVIOR TYPE*



* Campanella and Robertson (1983) Friction Ratio correlation

REMARKS: REFERENCE BASELINE: LOOP B

PAGE 1 OF 1

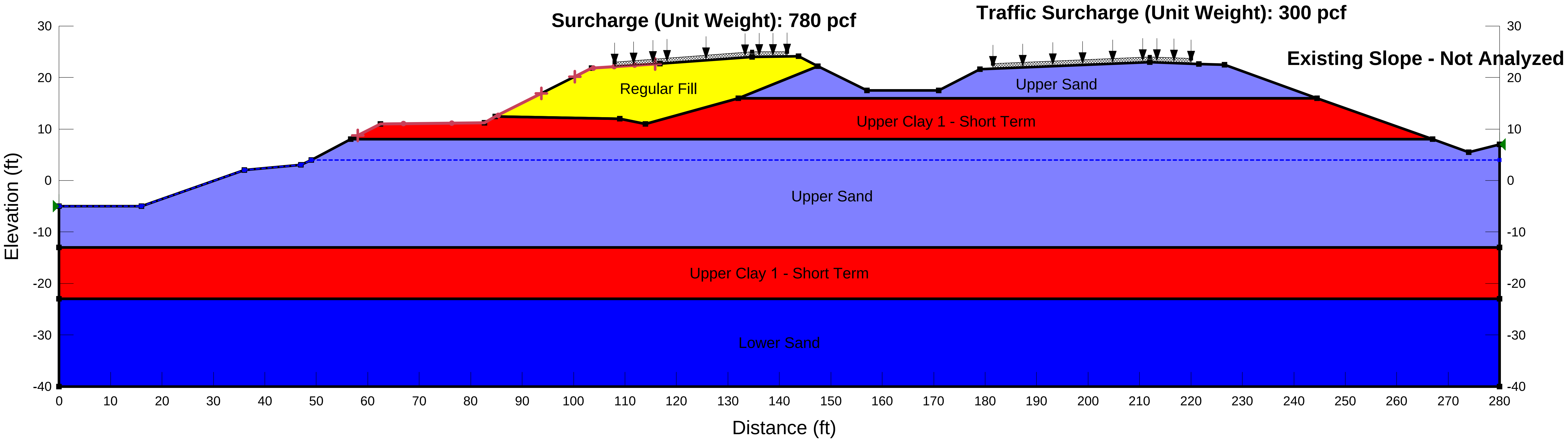
WDLB-3

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 28 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Short Term Global Stability Analysis

Witchduck Ramp A
Analysis Location: Sta. 17+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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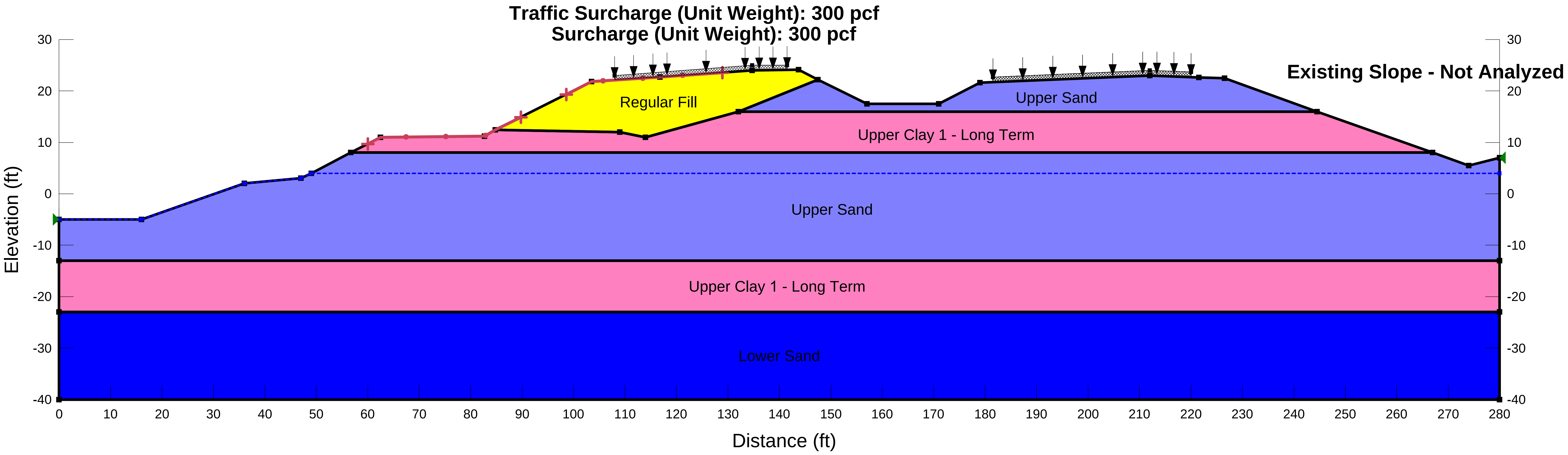
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

Long Term Global Stability Analysis

Witchduck Ramp A
Analysis Location: Sta. 17+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Short Term Global Stability Analysis

Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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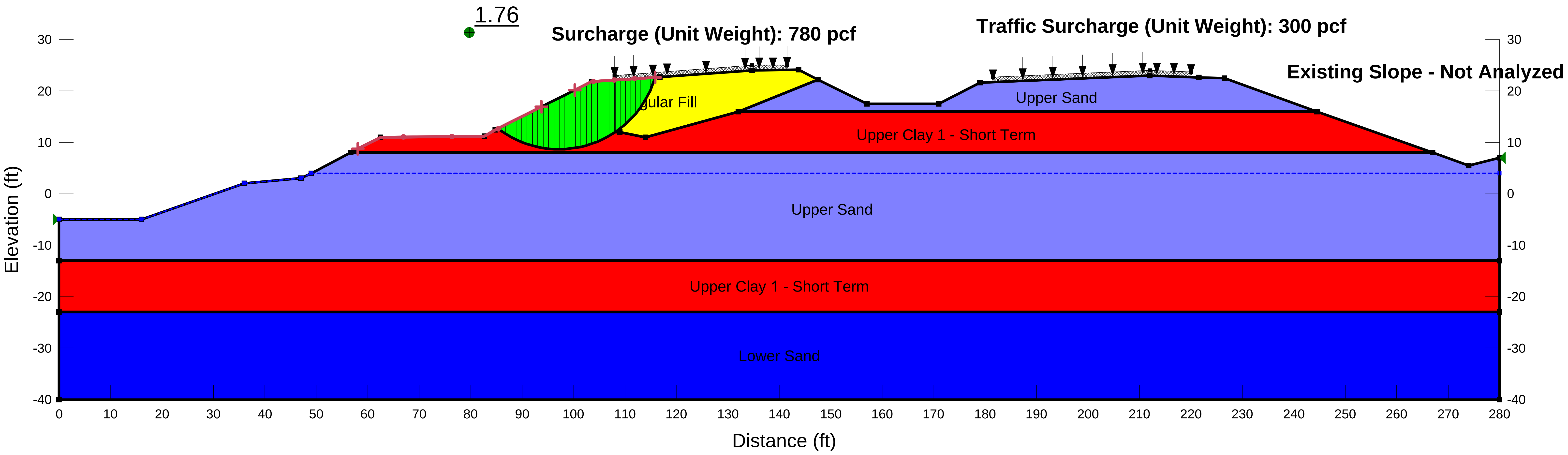
Witchduck Ramp A
Analysis Location: Sta. 17+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
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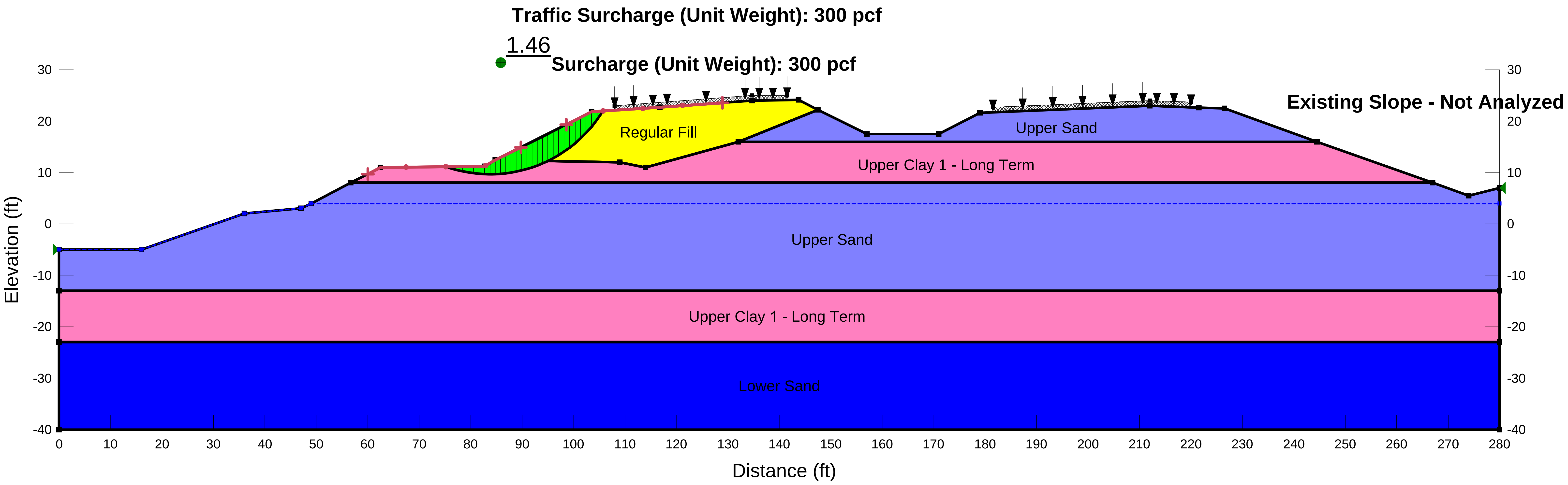
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

Long Term Global Stability Analysis

Witchduck Ramp A
Analysis Location: Sta. 17+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
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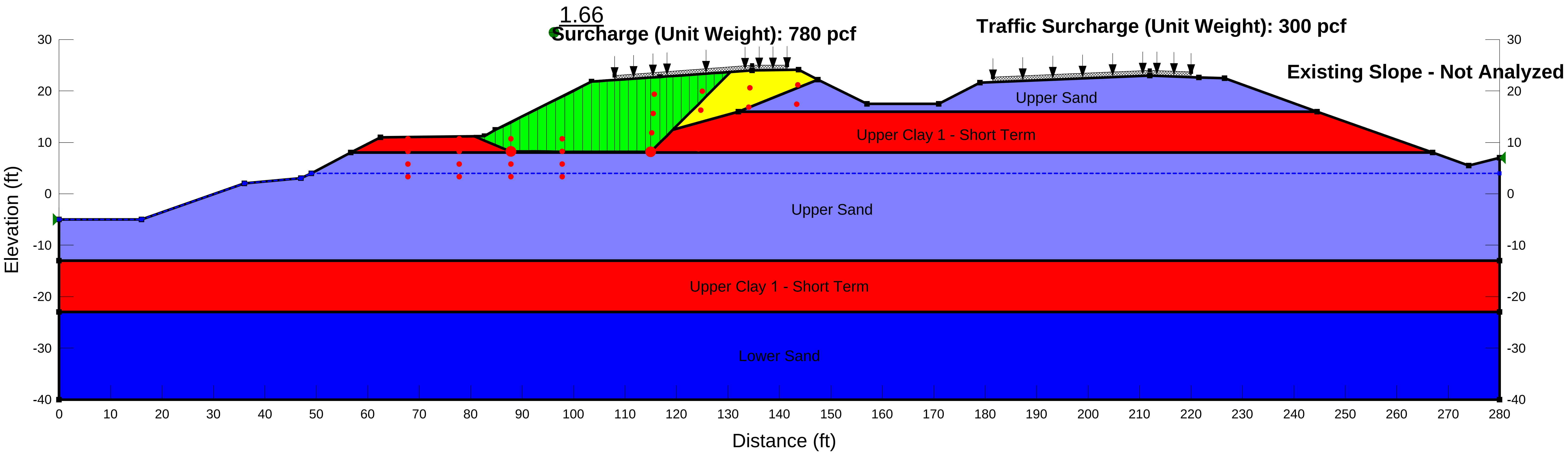
Short Term Global Stability Analysis

Witchduck Ramp A
Analysis Location: Sta. 17+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3



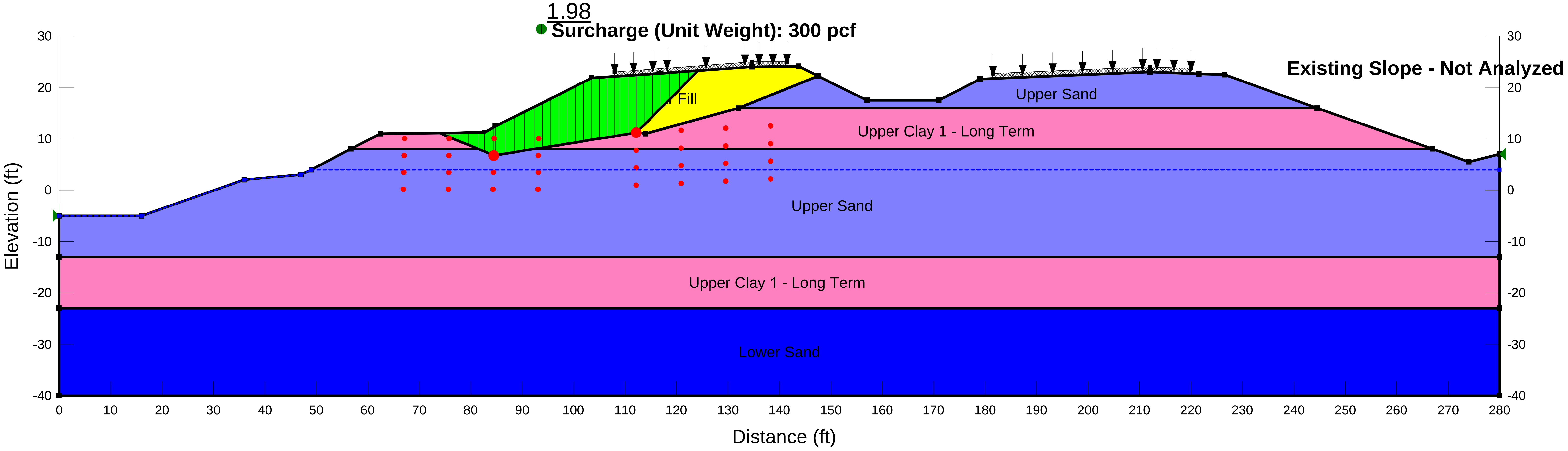
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 50 psf	Phi: 28 °	Piezometric Line: 1
Name: Lower Sand	Unit Weight: 125 pcf	Cohesion: 0 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Clay 1 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1
Name: Upper Clay 2 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1

Long Term Global Stability Analysis

Witchduck Ramp A
Analysis Location: Sta. 17+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Short Term Global Stability Analysis

Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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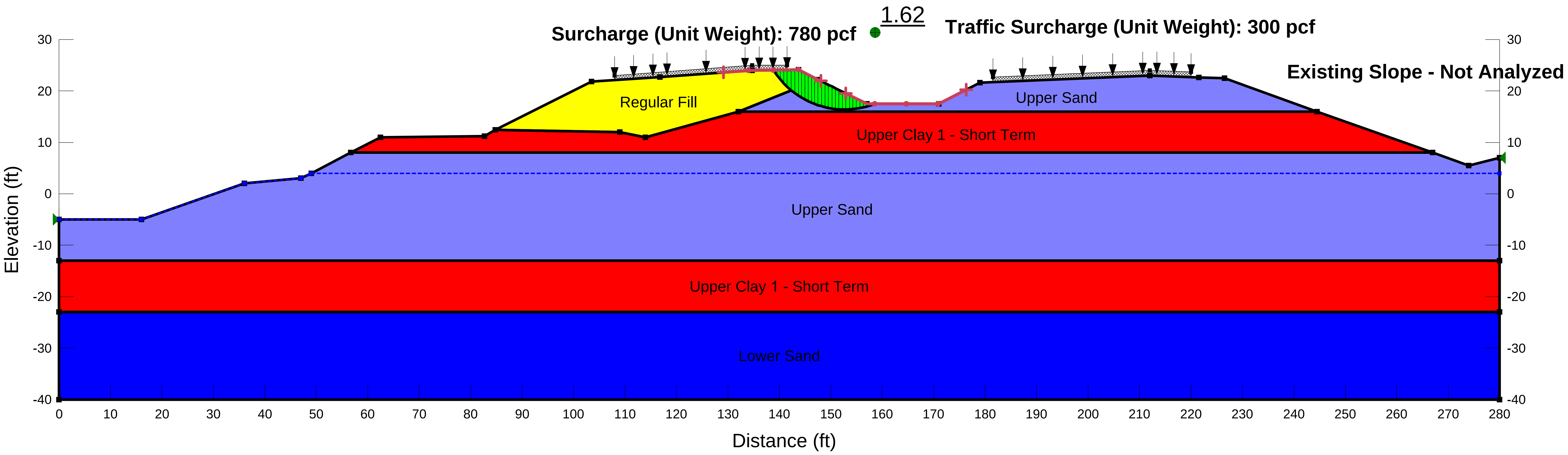
Witchduck Ramp A
Analysis Location: Sta. 17+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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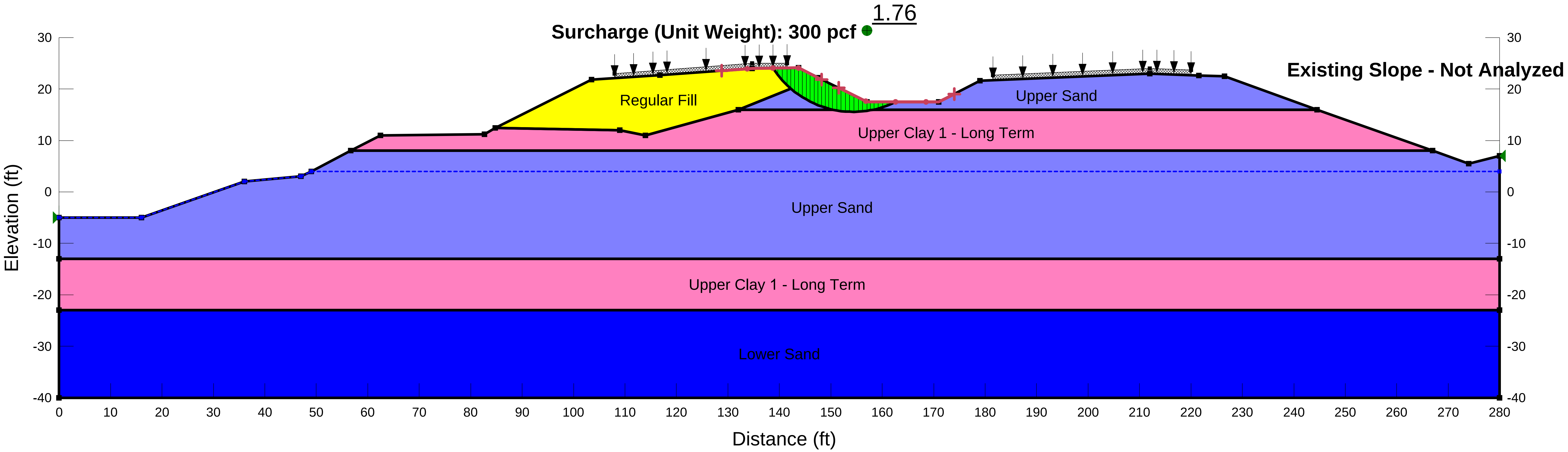
Long Term Global Stability Analysis

Witchduck Ramp A
Analysis Location: Sta. 17+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Short Term Global Stability Analysis

Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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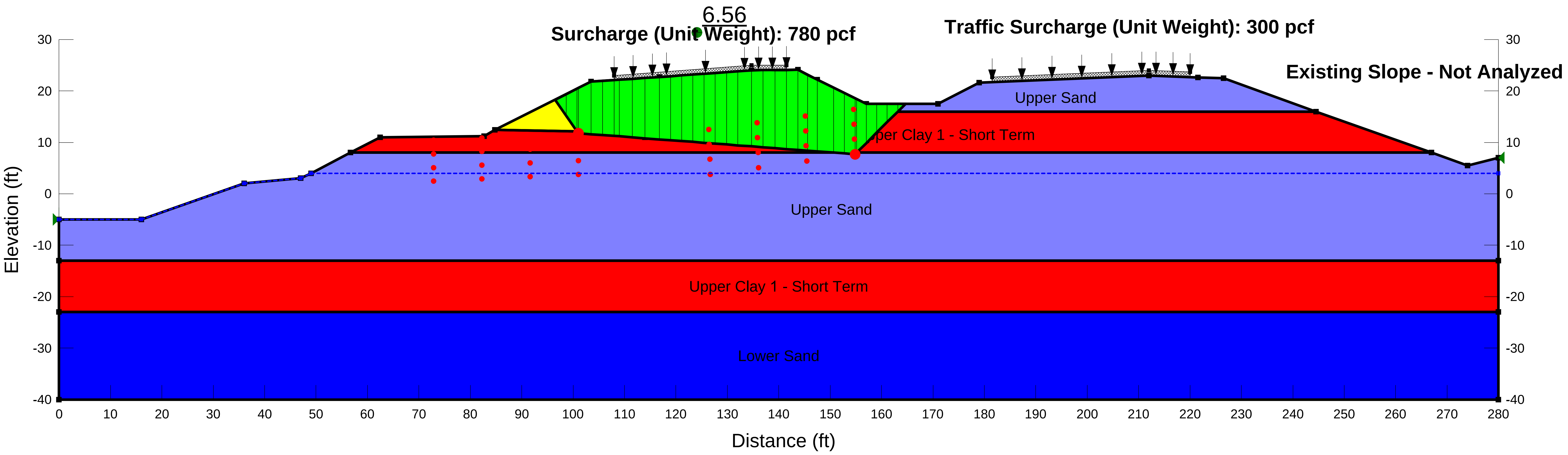
Witchduck Ramp A
Analysis Location: Sta. 17+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
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Long Term Global Stability Analysis

Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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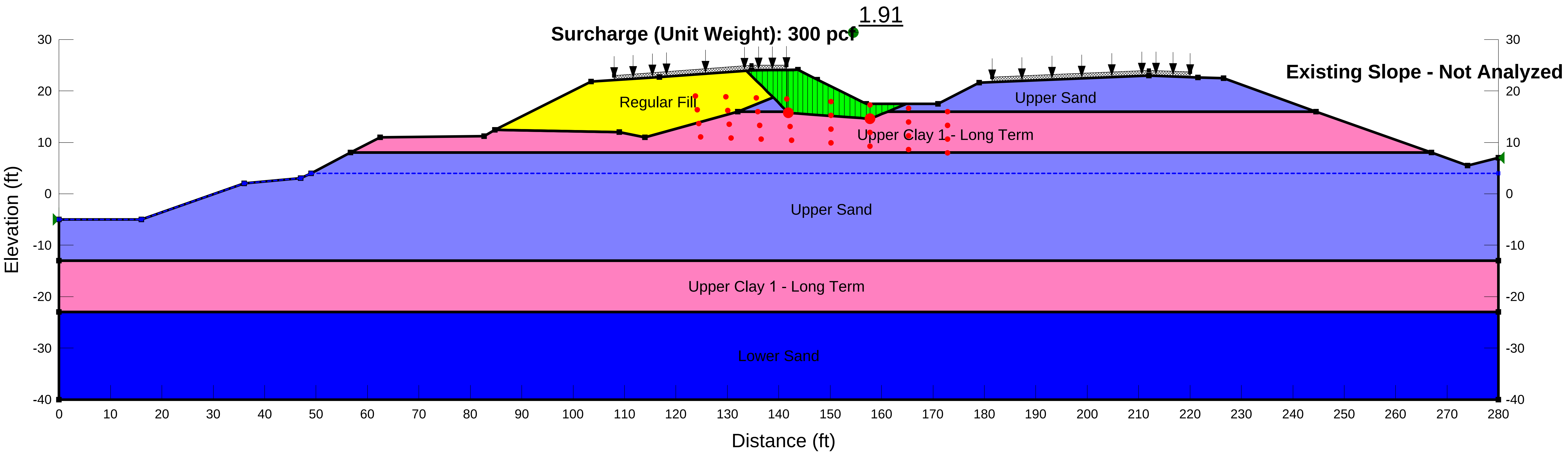
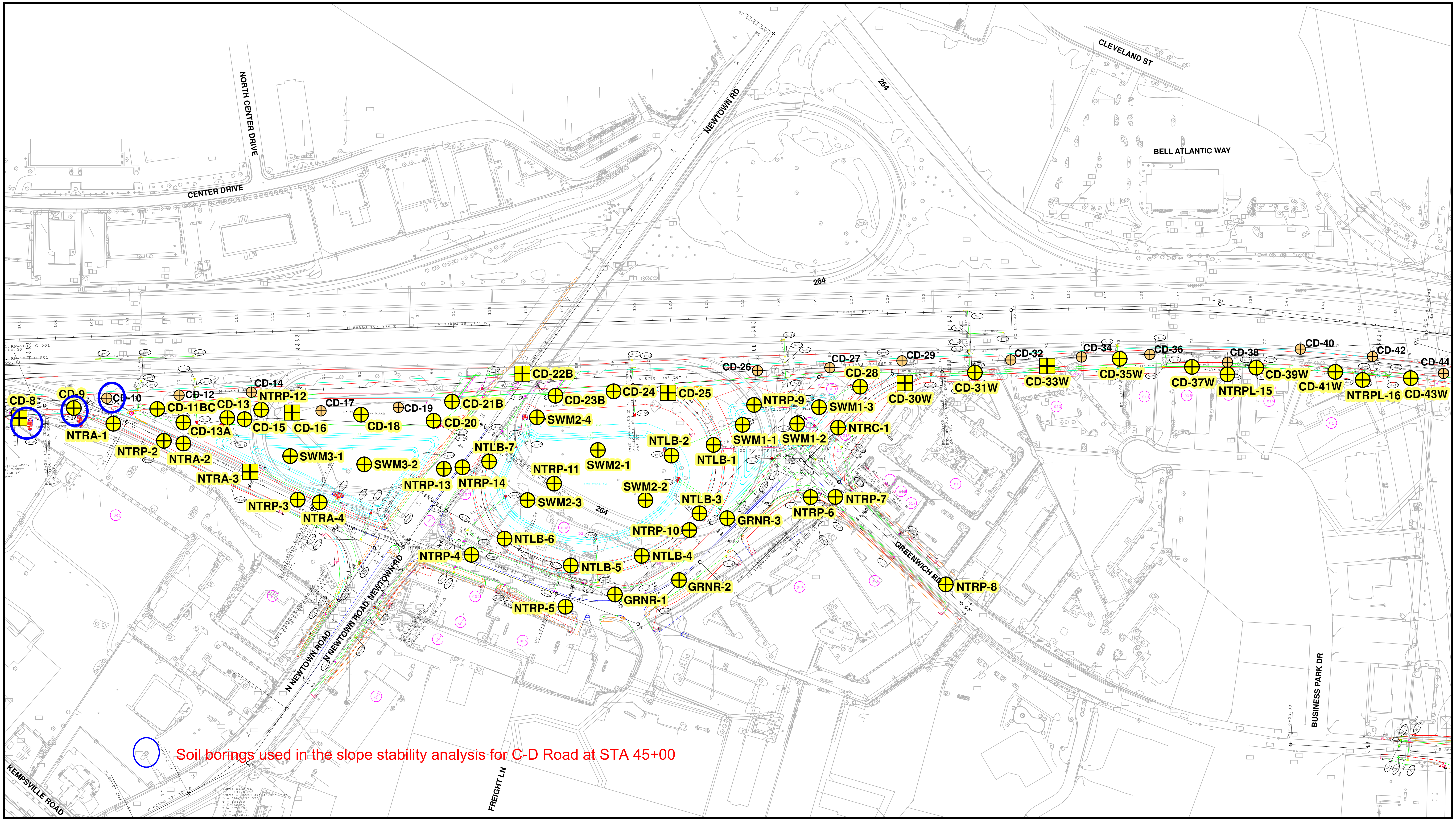
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

Witchduck Ramp A
Analysis Location: Sta. 17+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3



Slope Stability Analysis at
STATION 45+00



Soil borings used in the slope stability analysis for C-D Road at STA 45+00

N

0 125 250 Feet

⊕ SPT Exploration Locations

⊕ PSA I-264 CD Borings

⊞ CPT Exploration Locations

Prepared by: HDR

Date: November 2011

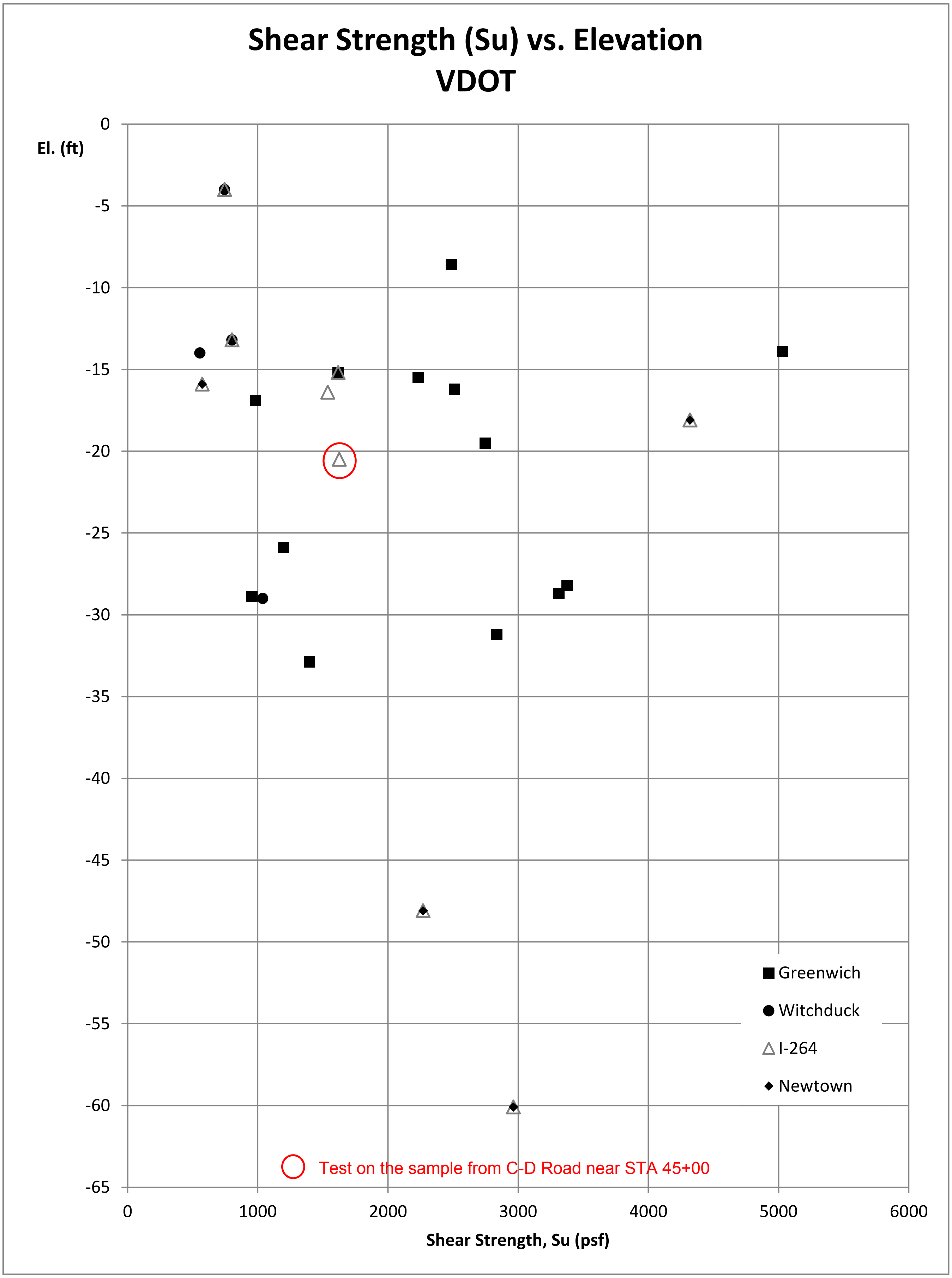
VDOT Virginia Department of Transportation

Project 0264-134-102

City of Virginia Beach

Project Study Area
Newtown

Drawing 2:
Exploration Location Plan



Shear Strength (Su) vs. Elevation
VDOT

○ Test on the sample from C-D Road near STA 45+00

CONE PENETROMETER TEST LOG

VDOT
Virginia Department of Transportation

PROJECT #: 0264-134-102
LOCATION: Va Beach: PSA Newtown

CD-08
PAGE 1 OF 1

STATION: 42+56
LATITUDE: 36.845313° N
SURFACE ELEVATION: 10.4
BENCHMARK LOCATION:

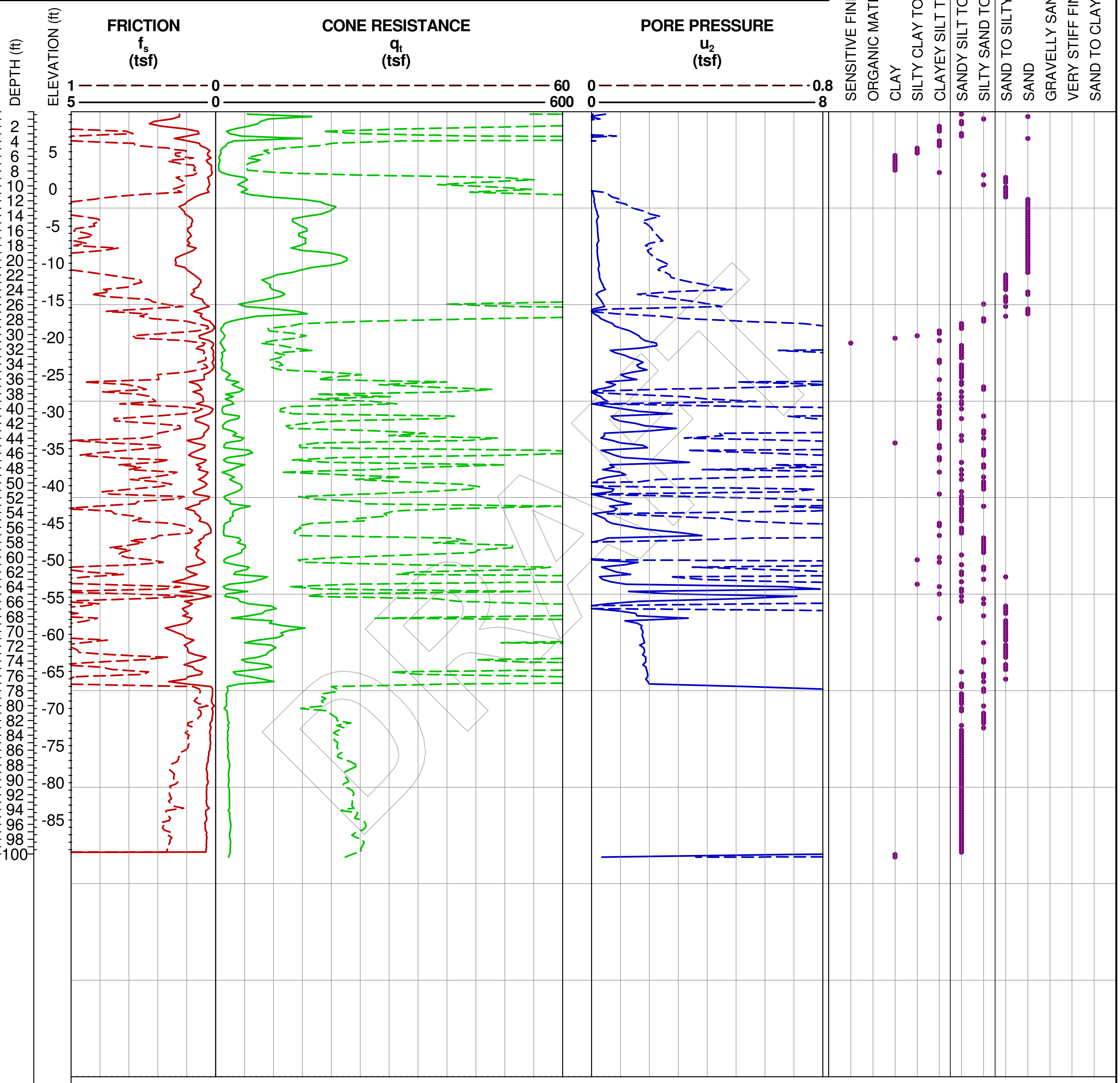
OFFSET: 44 ft RT
LONGITUDE: 76.188177° W
COORD. DATUM: NAD 83

DRILLER: Ron Stewart/MAD
CONE TYPE: Hogentogler Elec. Sub. Cone
CONE SIZE: 10 sq. cm
CONE ID No.: DSG1031

DATE(S) DRILLED:
01/21/11 - 01/21/11

LOGGER: HDR

SOIL BEHAVIOR TYPE*



* Campanella and Robertson (1983) Friction Ratio correlation

REMARKS:
REFERENCE BASELINE: C-D CONST.

PAGE 1 OF 1
CD-08

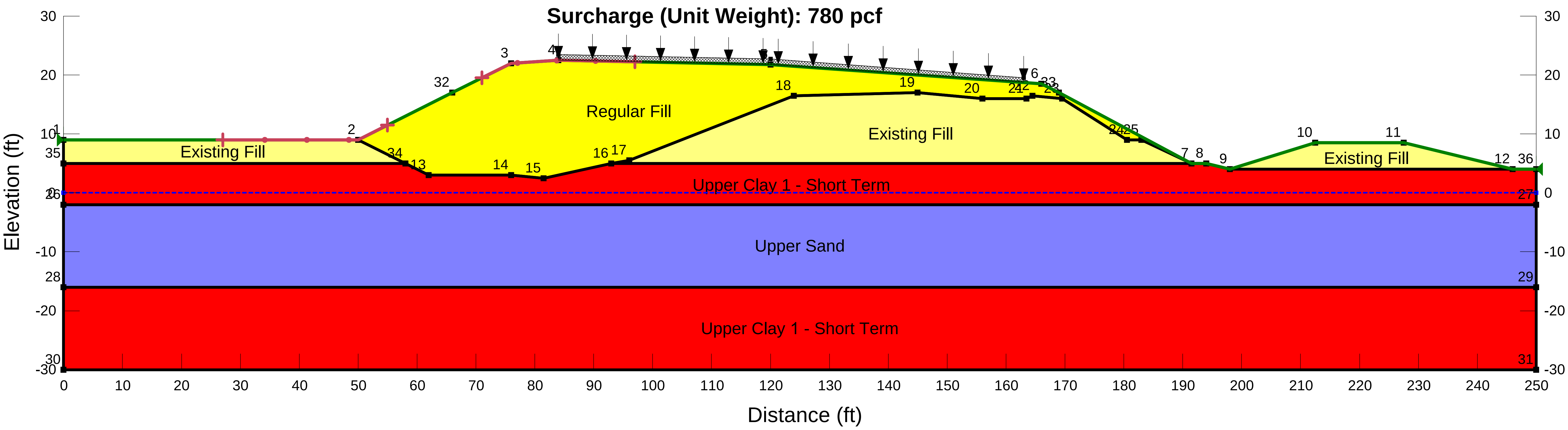
CPT_LOG:NEWTOWN CPT LOGS.GPJ:8.2.004:101609:2/21/11

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 45+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-9, CD-10, CD-8 (CPT)



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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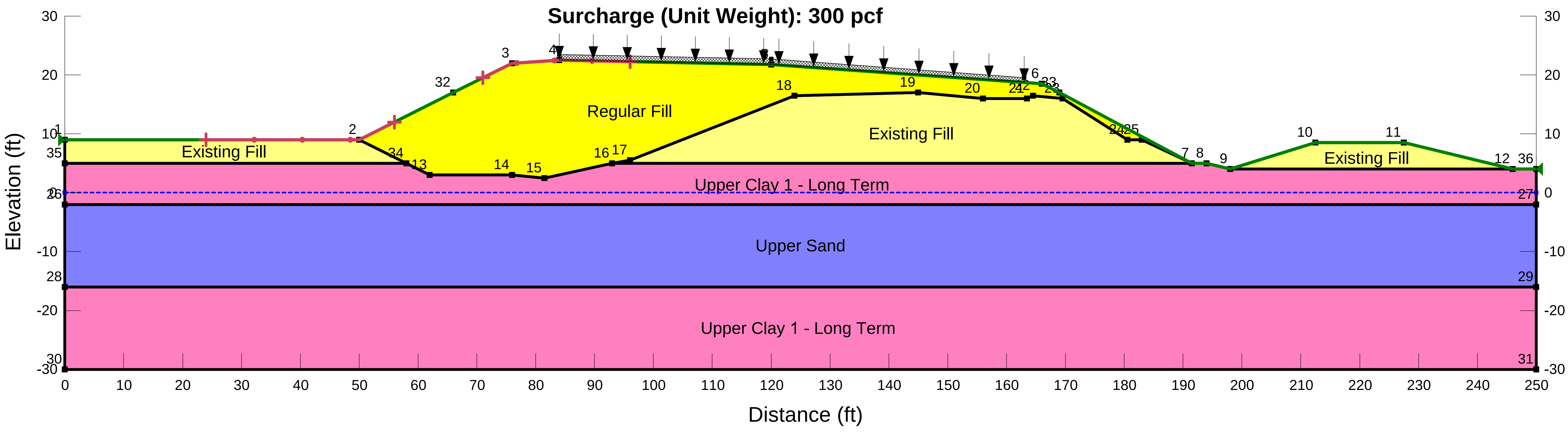
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 45+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-9, CD-10, CD-8 (CPT)



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
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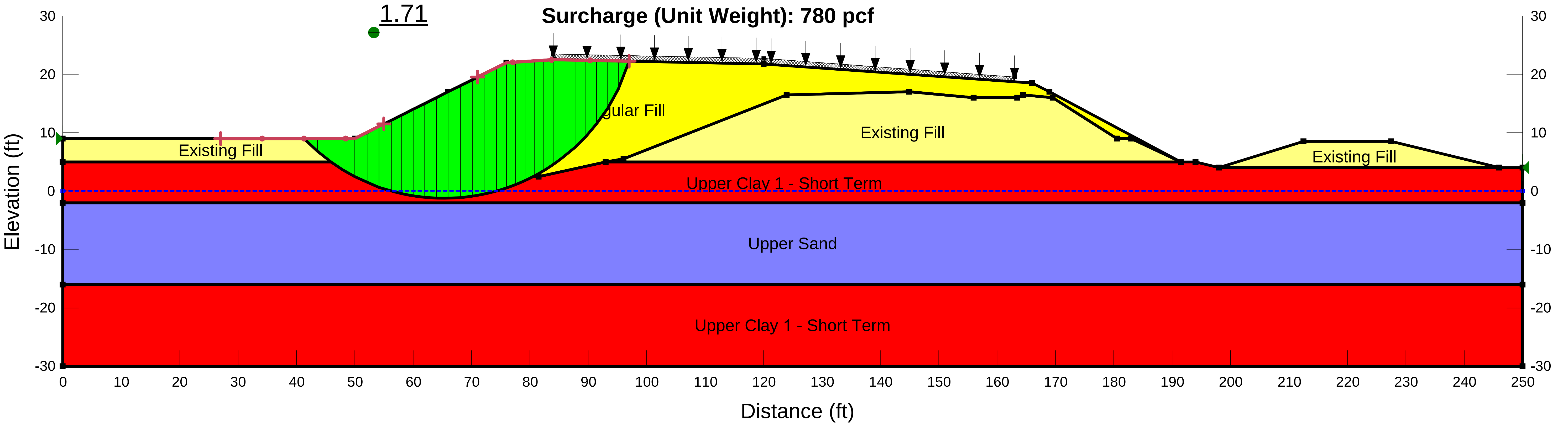
I-264 C-D Road
Analysis Location: Sta. 45+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-9, CD-10, CD-8 (CPT)



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

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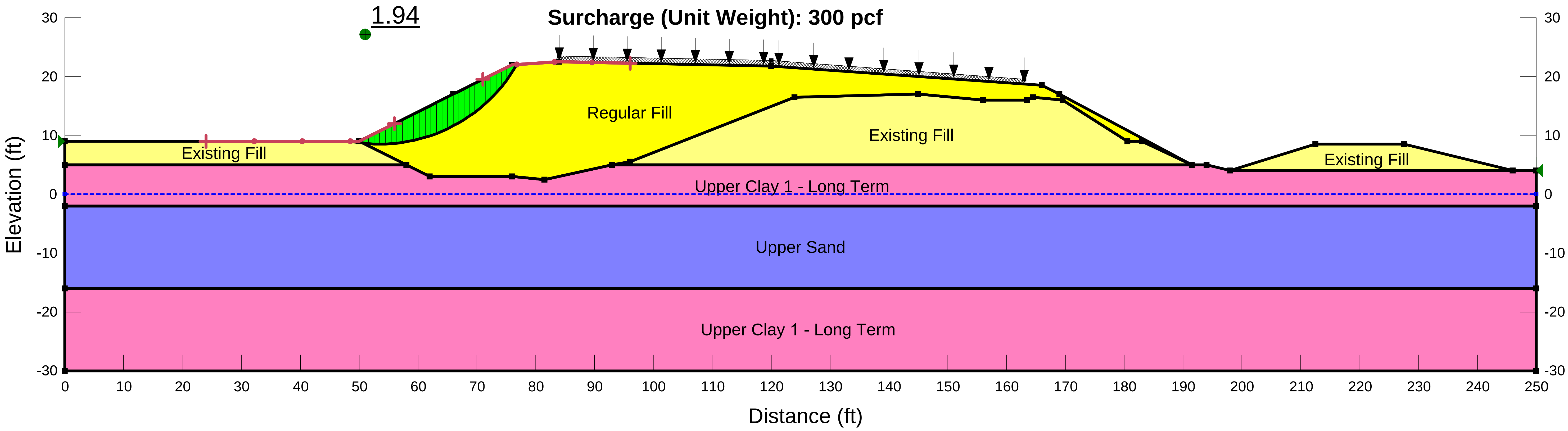
Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 45+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-9, CD-10, CD-8 (CPT)



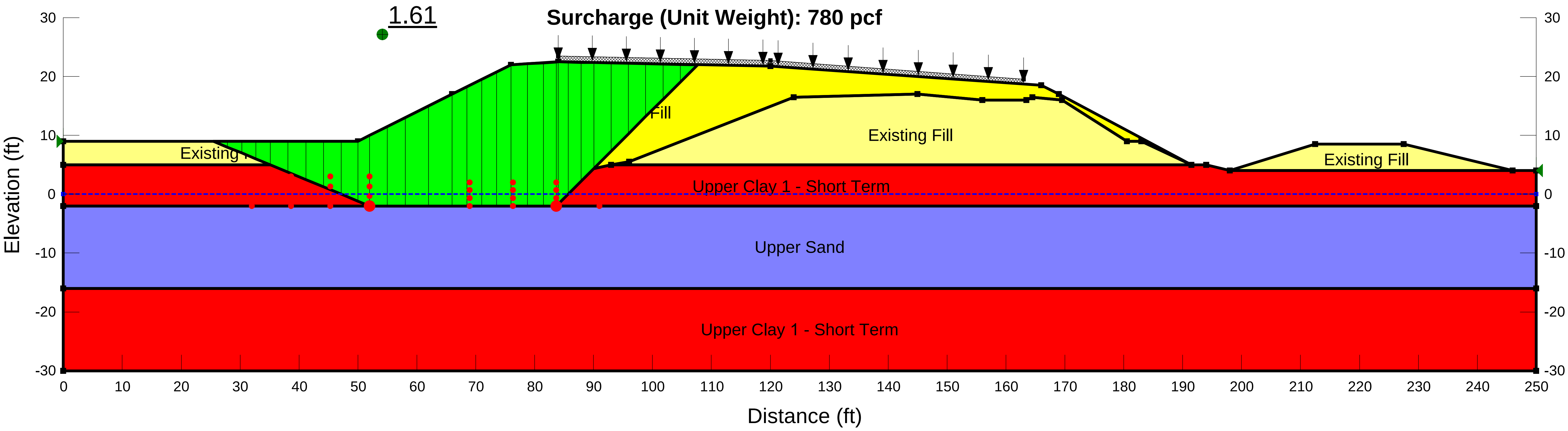
AECOM

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill   Unit Weight: 125 pcf   Cohesion: 50 psf   Phi: 32 °   Piezometric Line: 1
Name: Regular Fill   Unit Weight: 130 pcf   Cohesion: 50 psf   Phi: 34 °   Piezometric Line: 1
Name: Upper Sand   Unit Weight: 115 pcf   Cohesion: 0 psf   Phi: 30 °   Piezometric Line: 1
Name: Upper Clay 1 - Short Term   Unit Weight: 112 pcf   Cohesion Spatial Fn: Upper Clay   Phi: 0 °   Piezometric Line: 1
Name: Upper Clay 2 - Short Term   Unit Weight: 112 pcf   Cohesion Spatial Fn: Upper Clay   Phi: 0 °   Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 45+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-9, CD-10, CD-8 (CPT)

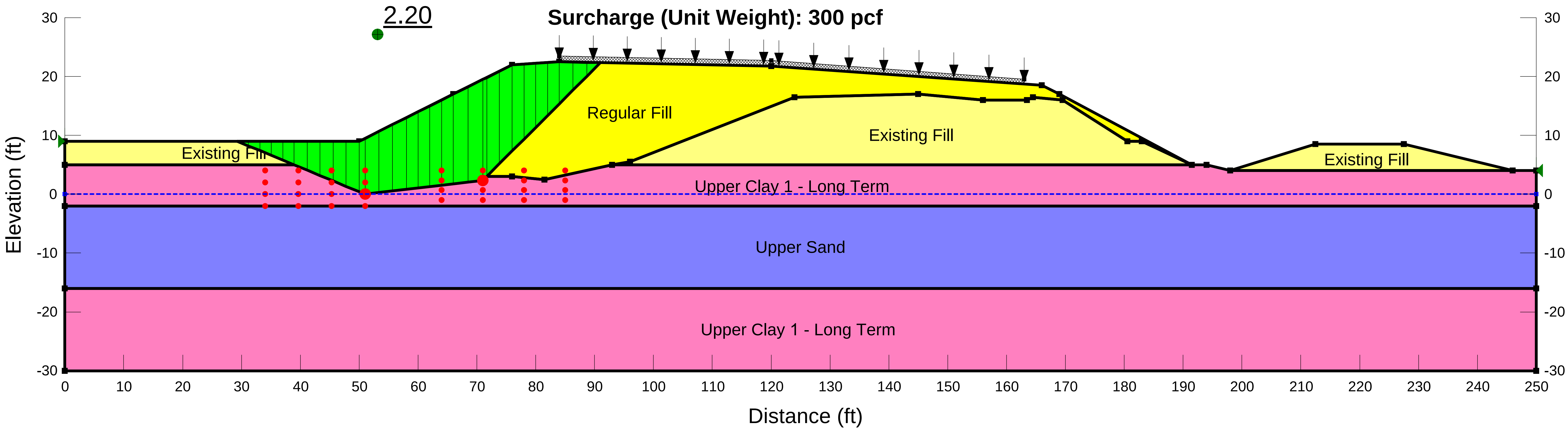


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

Name: Existing Fill   Unit Weight: 125 pcf   Cohesion: 50 psf   Phi: 32 °   Piezometric Line: 1
Name: Regular Fill   Unit Weight: 130 pcf   Cohesion: 50 psf   Phi: 34 °   Piezometric Line: 1
Name: Upper Sand   Unit Weight: 115 pcf   Cohesion: 0 psf   Phi: 30 °   Piezometric Line: 1
Name: Upper Clay 1 - Long Term   Unit Weight: 112 pcf   Cohesion: 0 psf   Phi: 23 °   Piezometric Line: 1
Name: Upper Clay 2 - Long Term   Unit Weight: 112 pcf   Cohesion: 0 psf   Phi: 23 °   Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 45+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-9, CD-10, CD-8 (CPT)



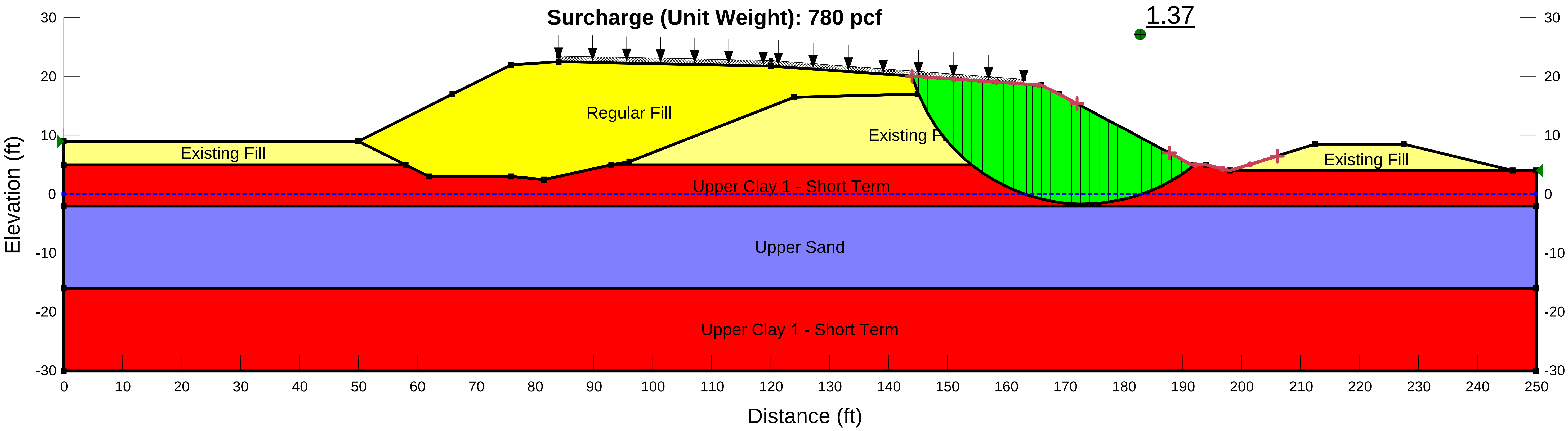
AECOM

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 45+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-9, CD-10, CD-8 (CPT)



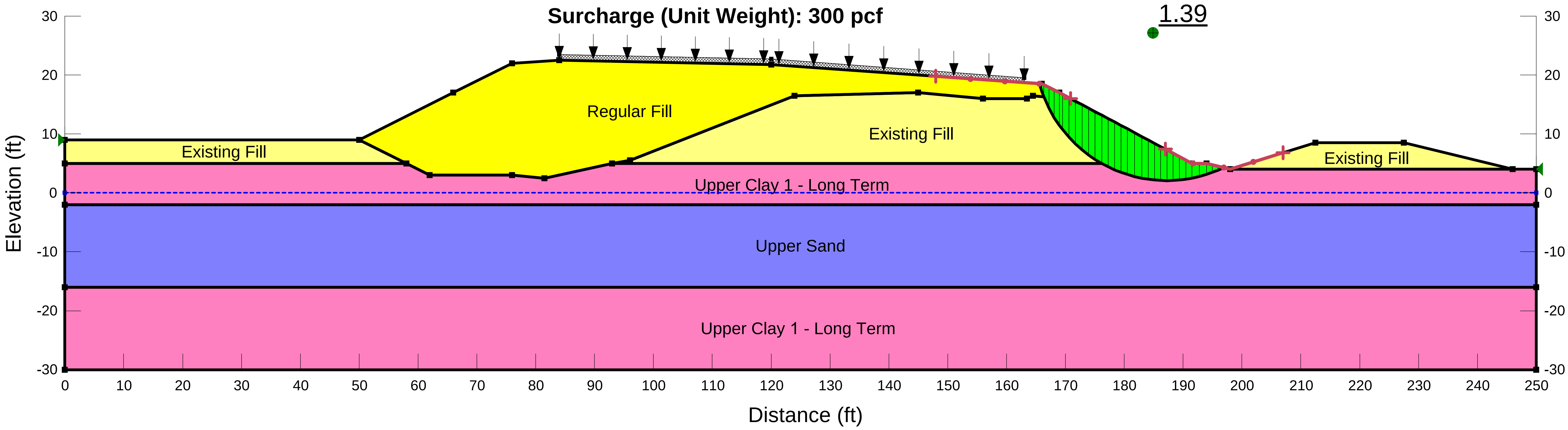
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

Name: Existing Fill   Unit Weight: 125 pcf   Cohesion: 50 psf   Phi: 32 °   Piezometric Line: 1
Name: Regular Fill   Unit Weight: 130 pcf   Cohesion: 50 psf   Phi: 34 °   Piezometric Line: 1
Name: Upper Sand   Unit Weight: 115 pcf   Cohesion: 0 psf   Phi: 30 °   Piezometric Line: 1
Name: Upper Clay 1 - Long Term   Unit Weight: 112 pcf   Cohesion: 0 psf   Phi: 23 °   Piezometric Line: 1
Name: Upper Clay 2 - Long Term   Unit Weight: 112 pcf   Cohesion: 0 psf   Phi: 23 °   Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 45+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-9, CD-10, CD-8 (CPT)



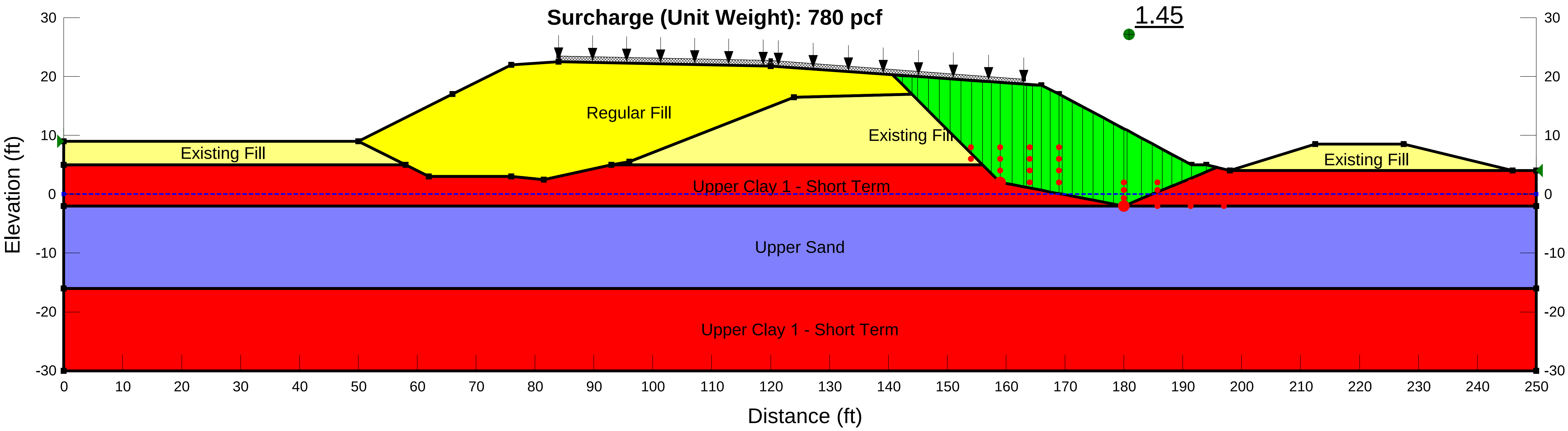
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 45+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-9, CD-10, CD-8 (CPT)

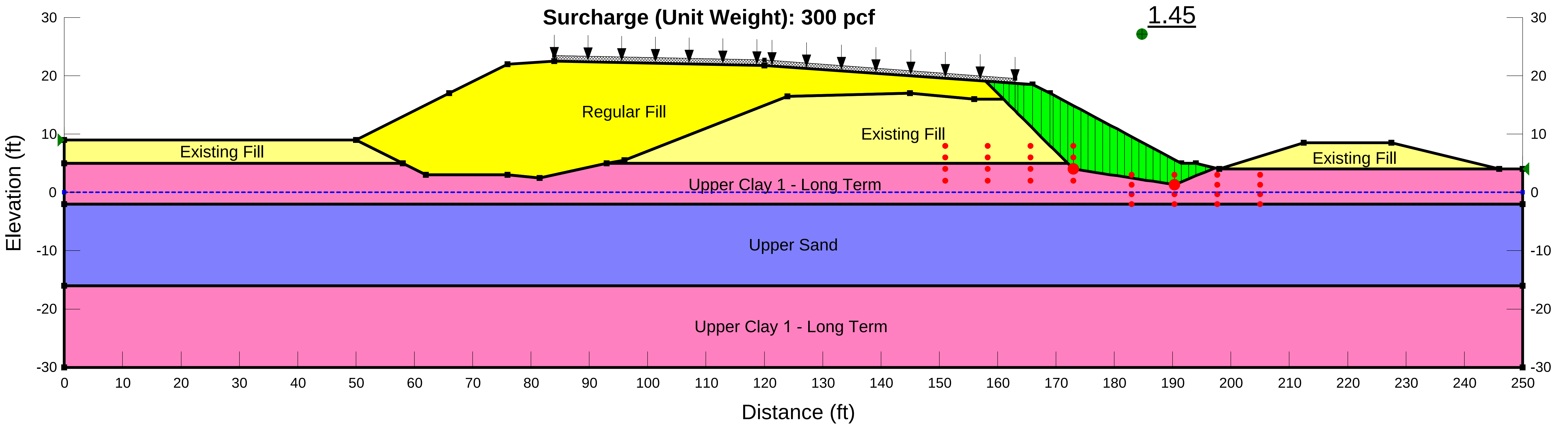


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

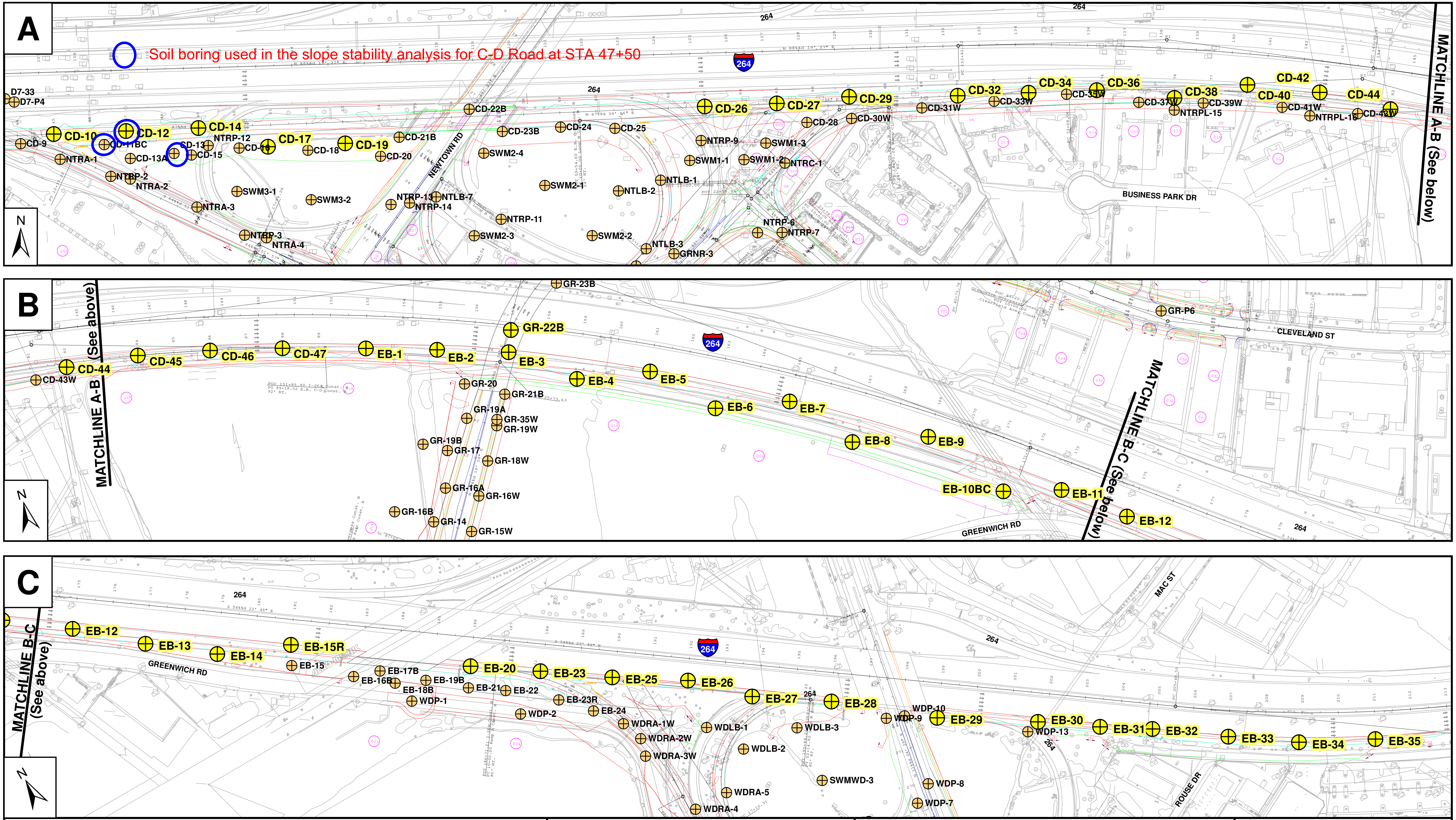
Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 45+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-9, CD-10, CD-8 (CPT)



Slope Stability Analysis at
STATION 47+50



0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

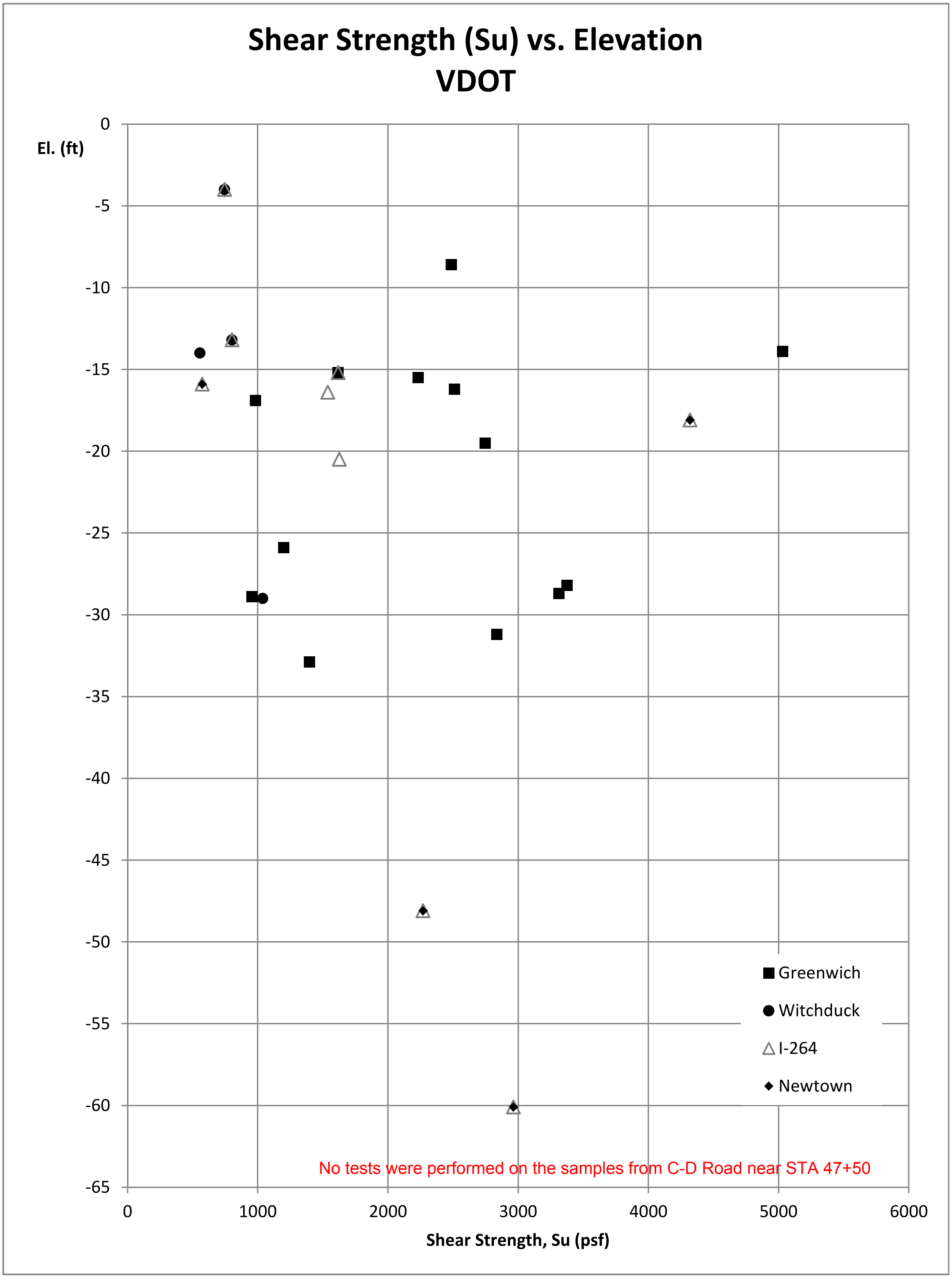
VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan


Shear Strength (Su) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
1000
2000
3000
4000
5000
6000
Shear Strength, Su (psf)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown
No tests were performed on the samples from C-D Road near STA 47+50

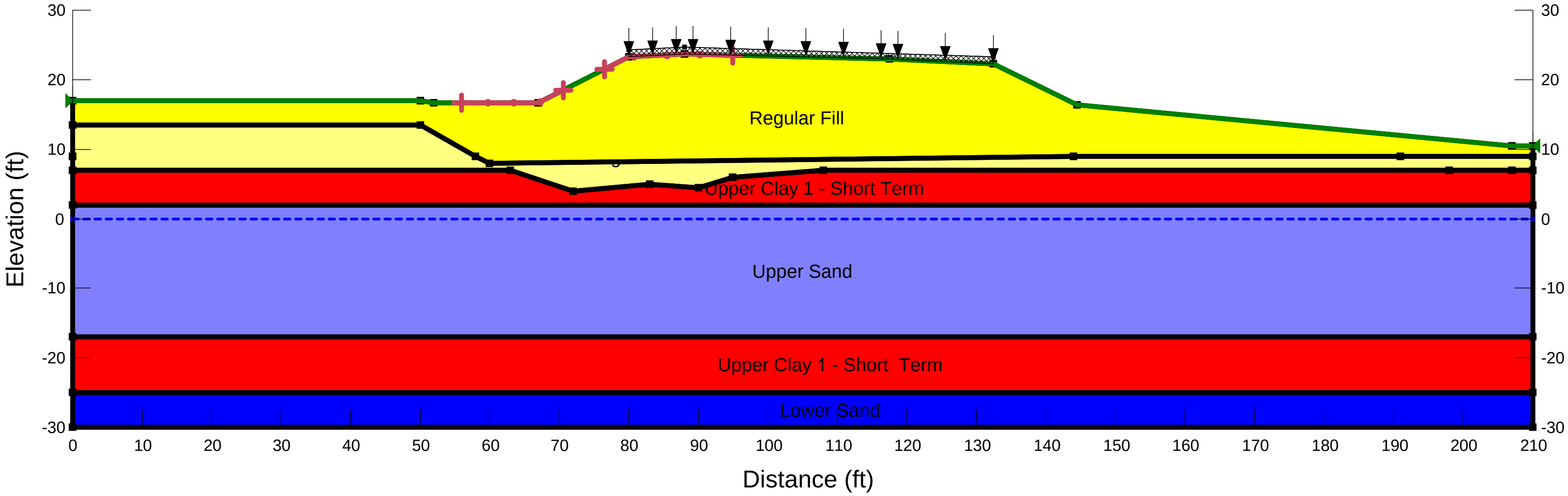
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 47+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-12, CD-11BC, CD-13

Surcharge (Unit Weight): 780 pcf



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method
Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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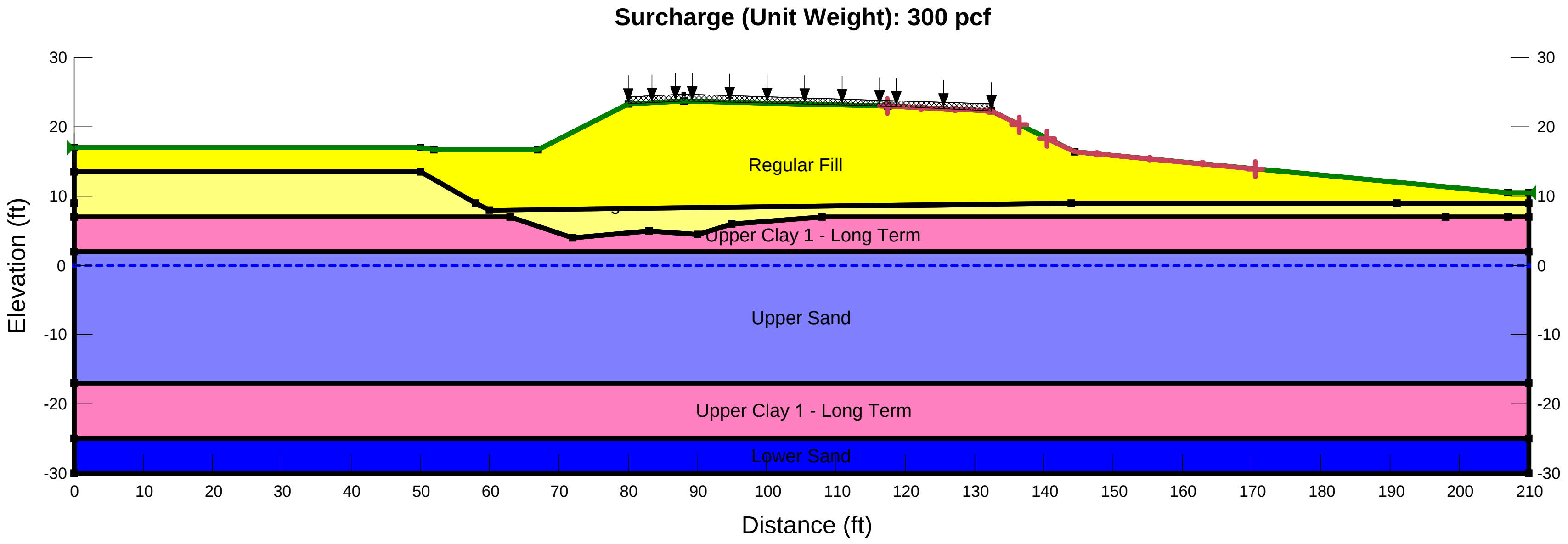
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

AECOM

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 47+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-12, CD-11BC, CD-13



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method
Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
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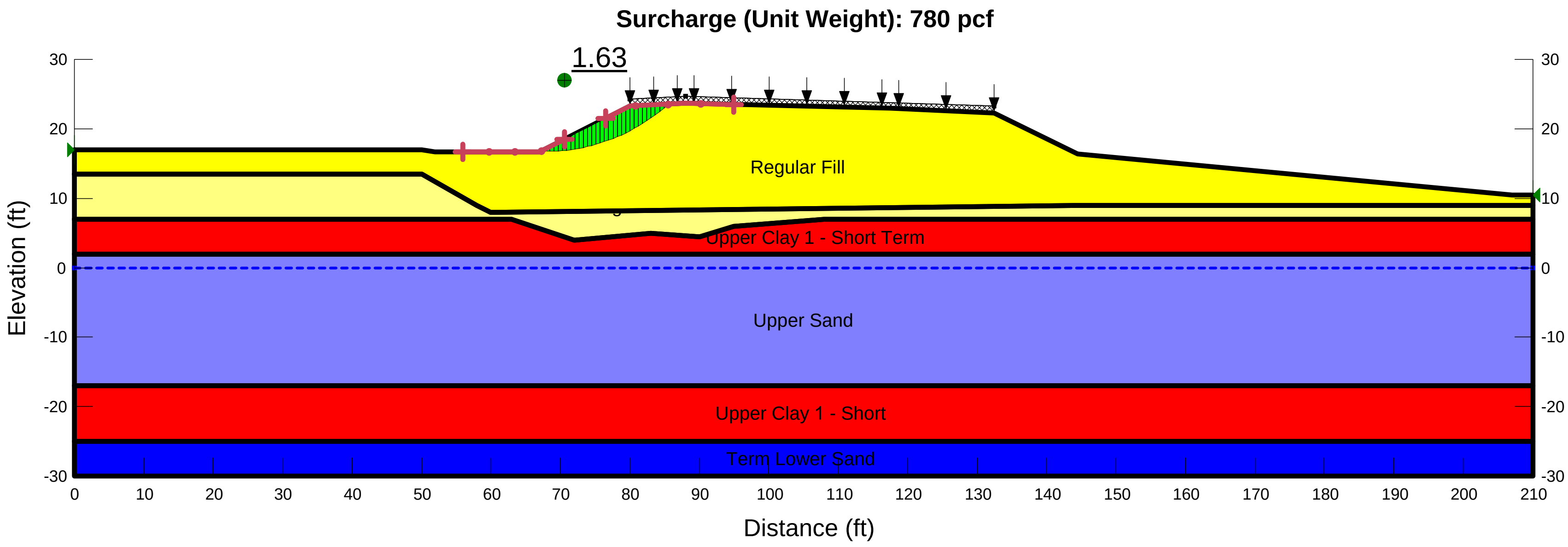
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 47+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-12, CD-11BC, CD-13



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
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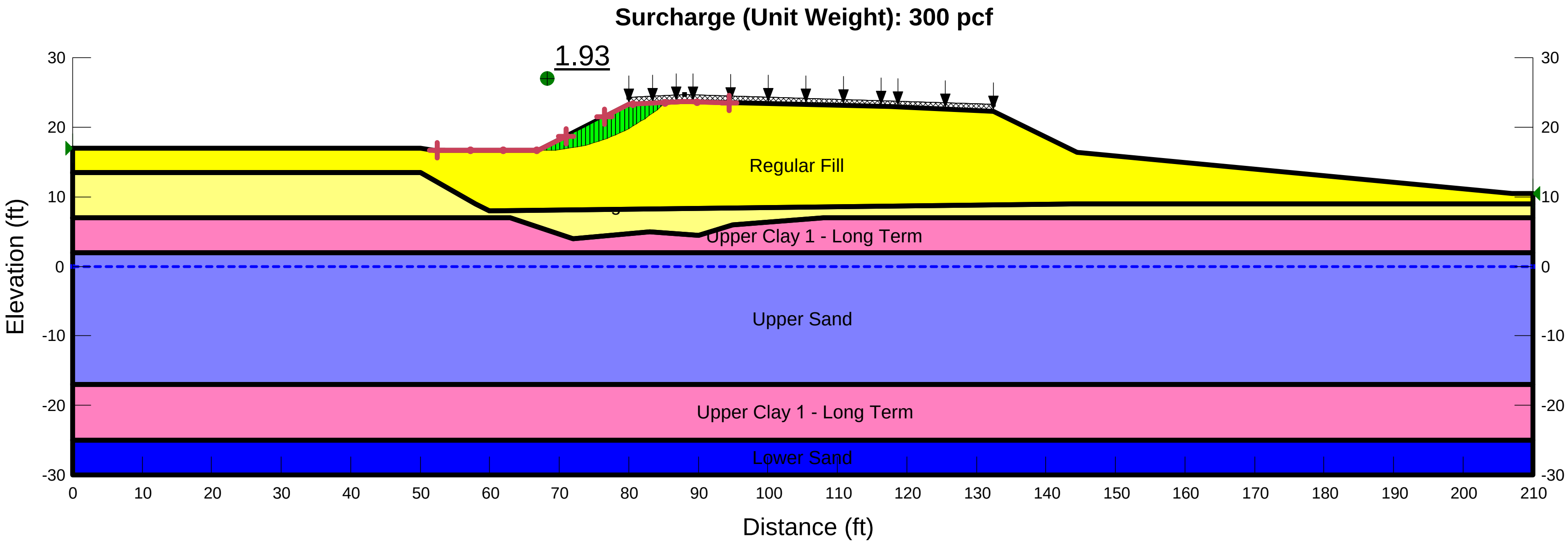
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

AECOM

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 47+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-12, CD-11BC, CD-13



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method
Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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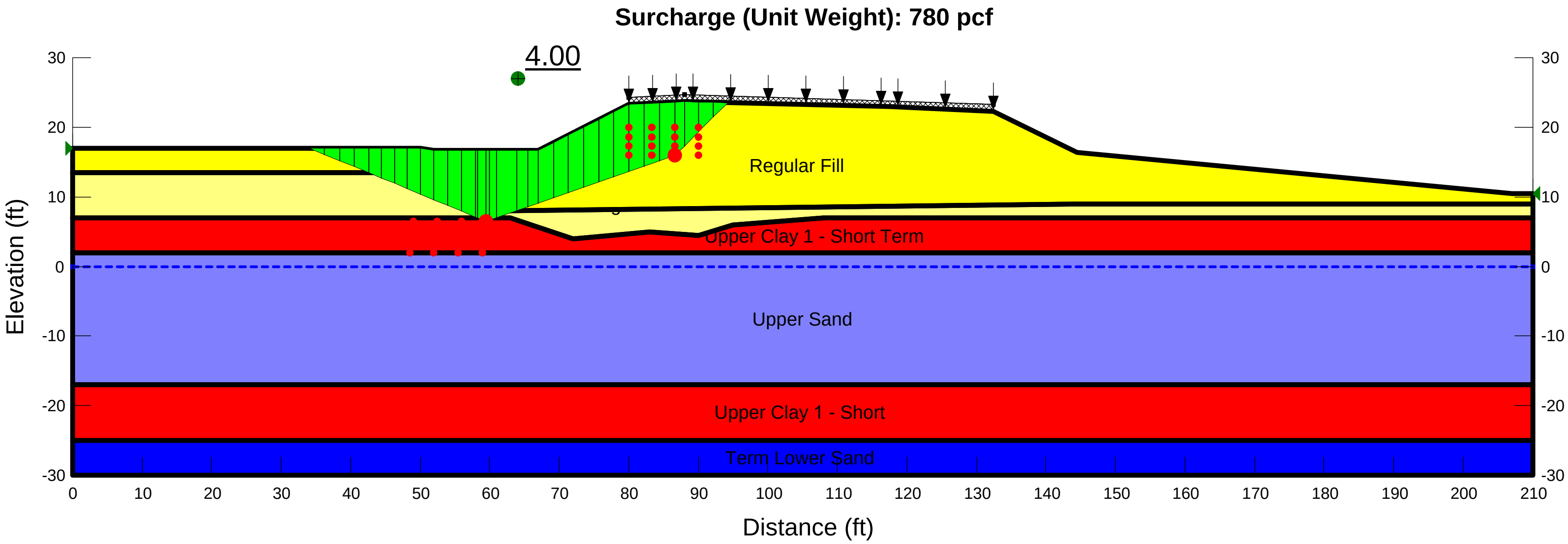
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

AECOM

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 47+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-12, CD-11BC, CD-13

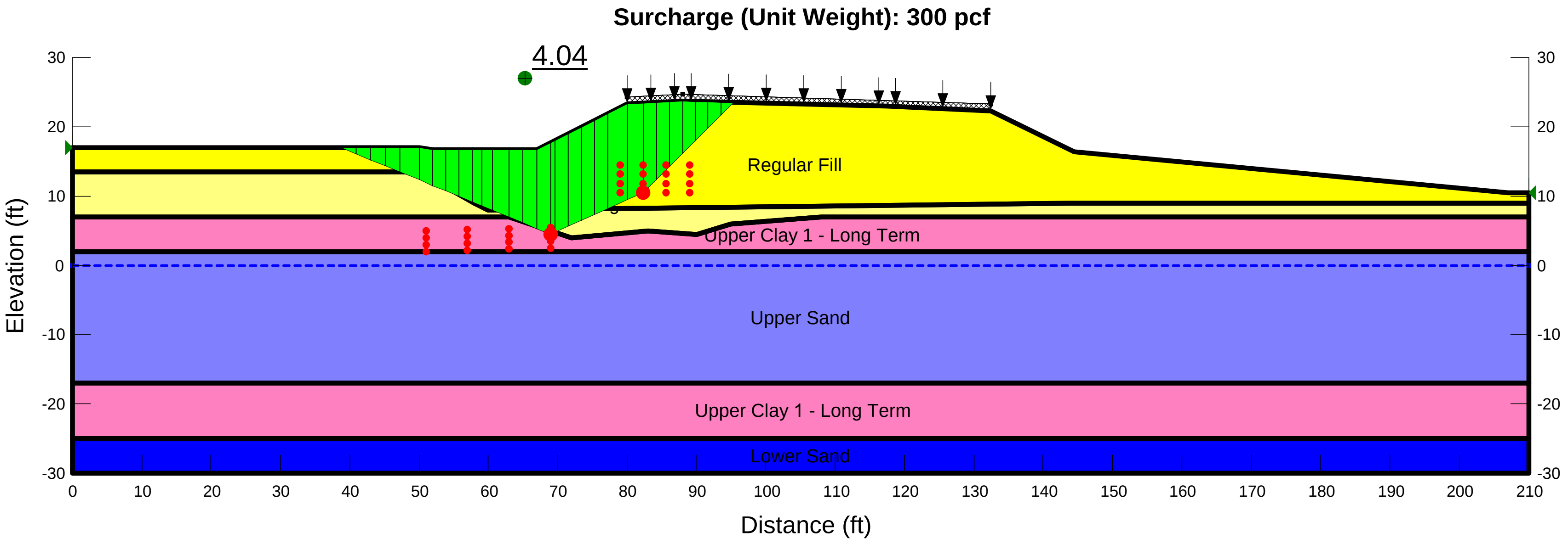


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 47+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-12, CD-11BC, CD-13



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method
Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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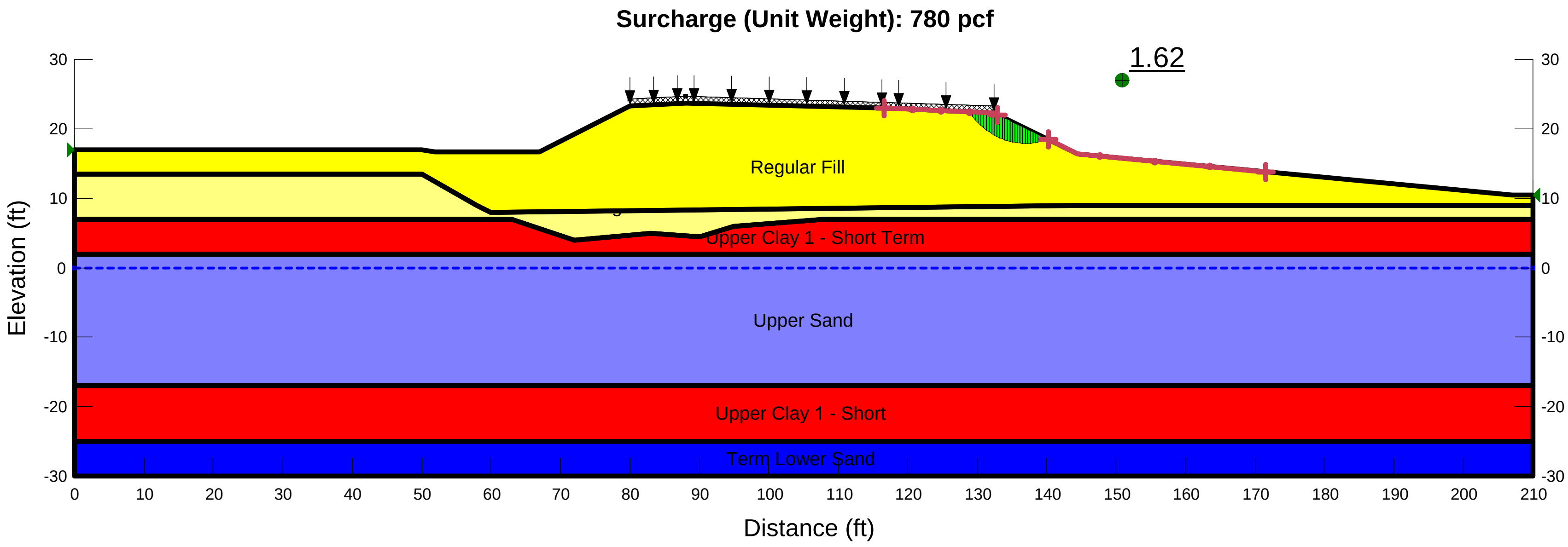
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 47+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-12, CD-11BC, CD-13



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
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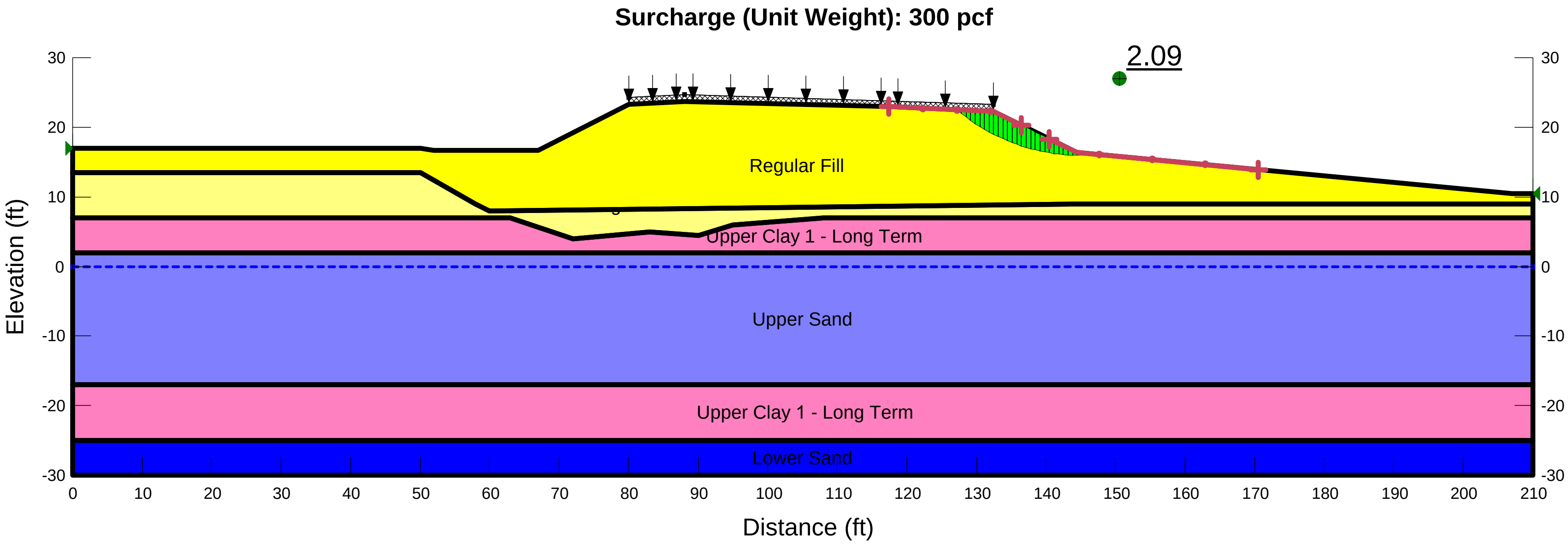
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

AECOM

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 47+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-12, CD-11BC, CD-13



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method
Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
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Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
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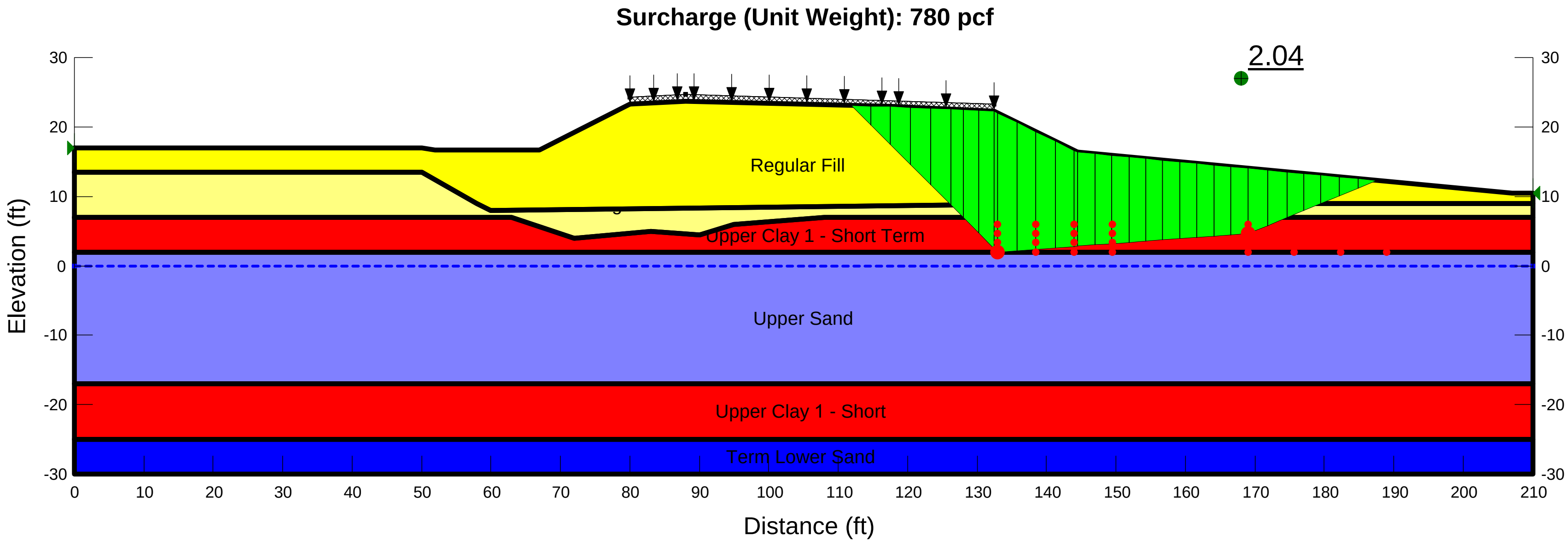
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

AECOM

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 47+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-12, CD-11BC, CD-13



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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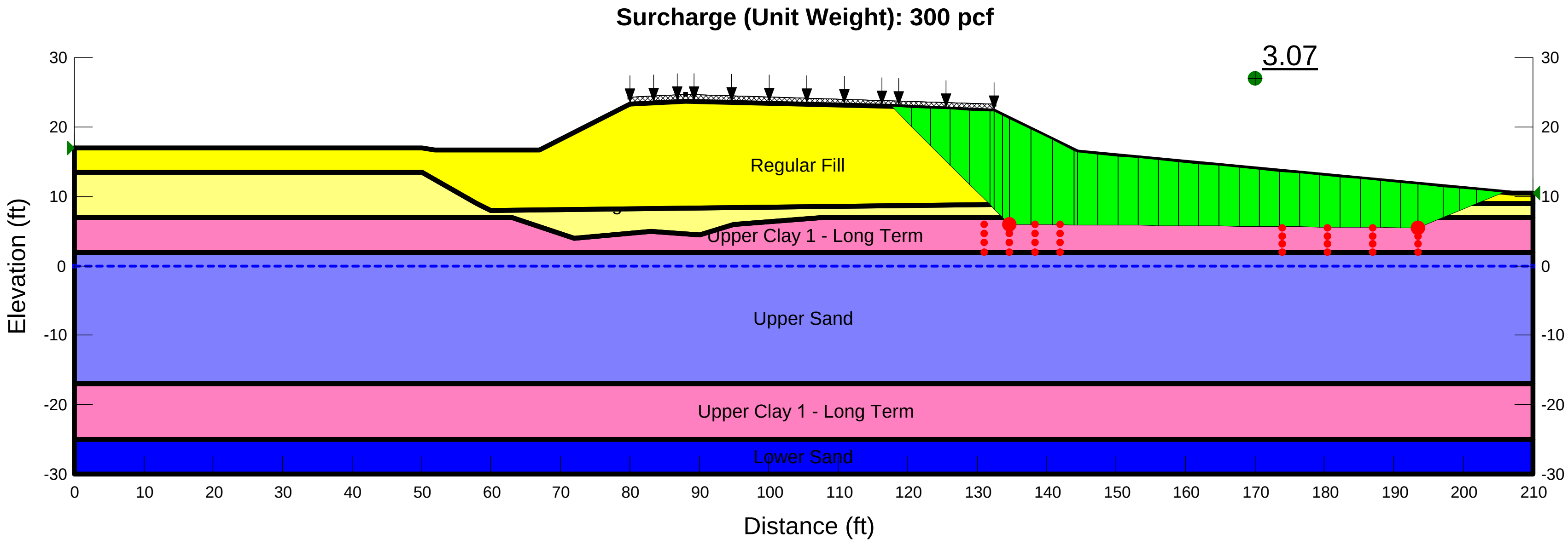
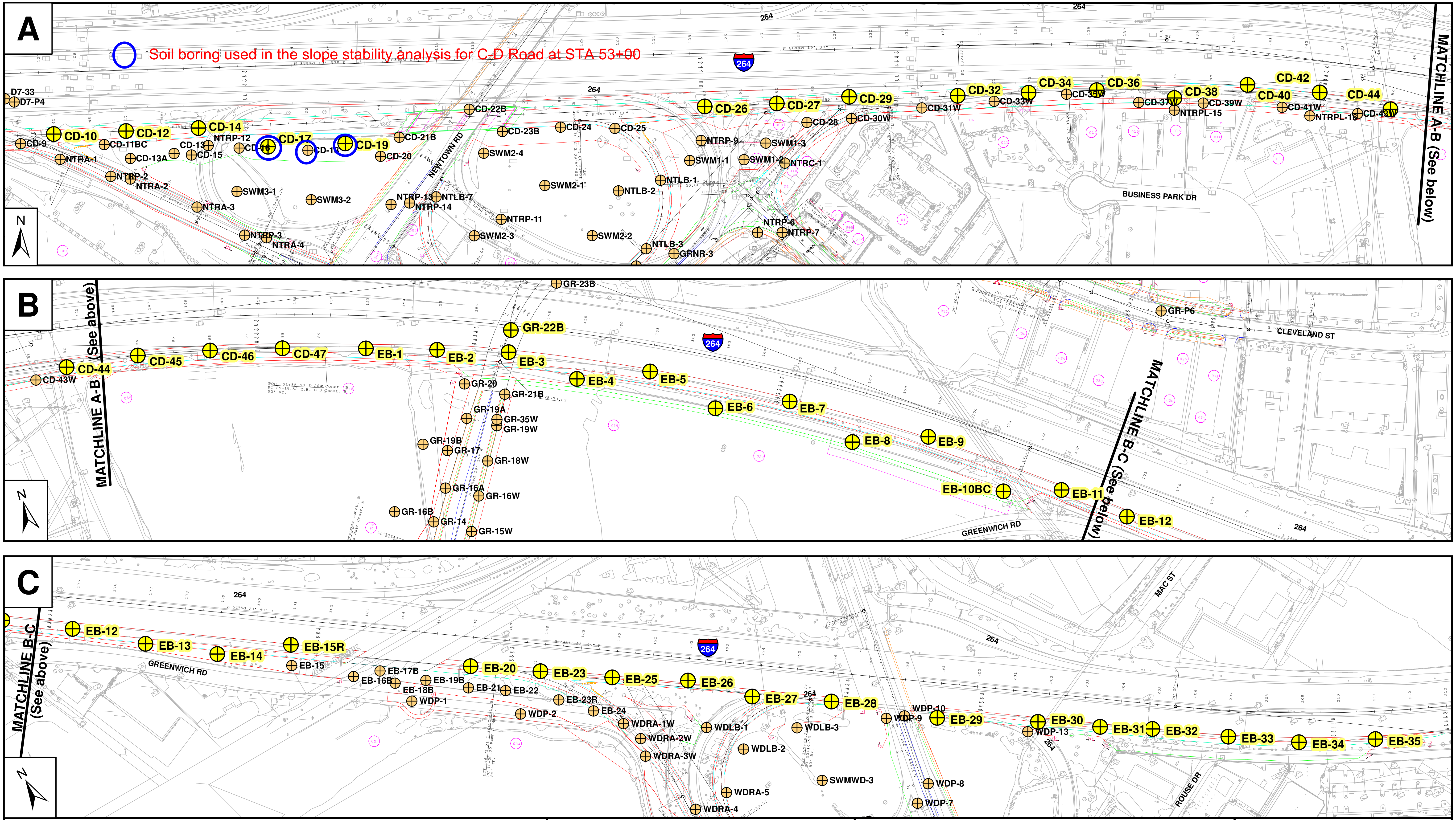
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 47+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-12, CD-11BC, CD-13



Slope Stability Analysis at
STATION 53+00



0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

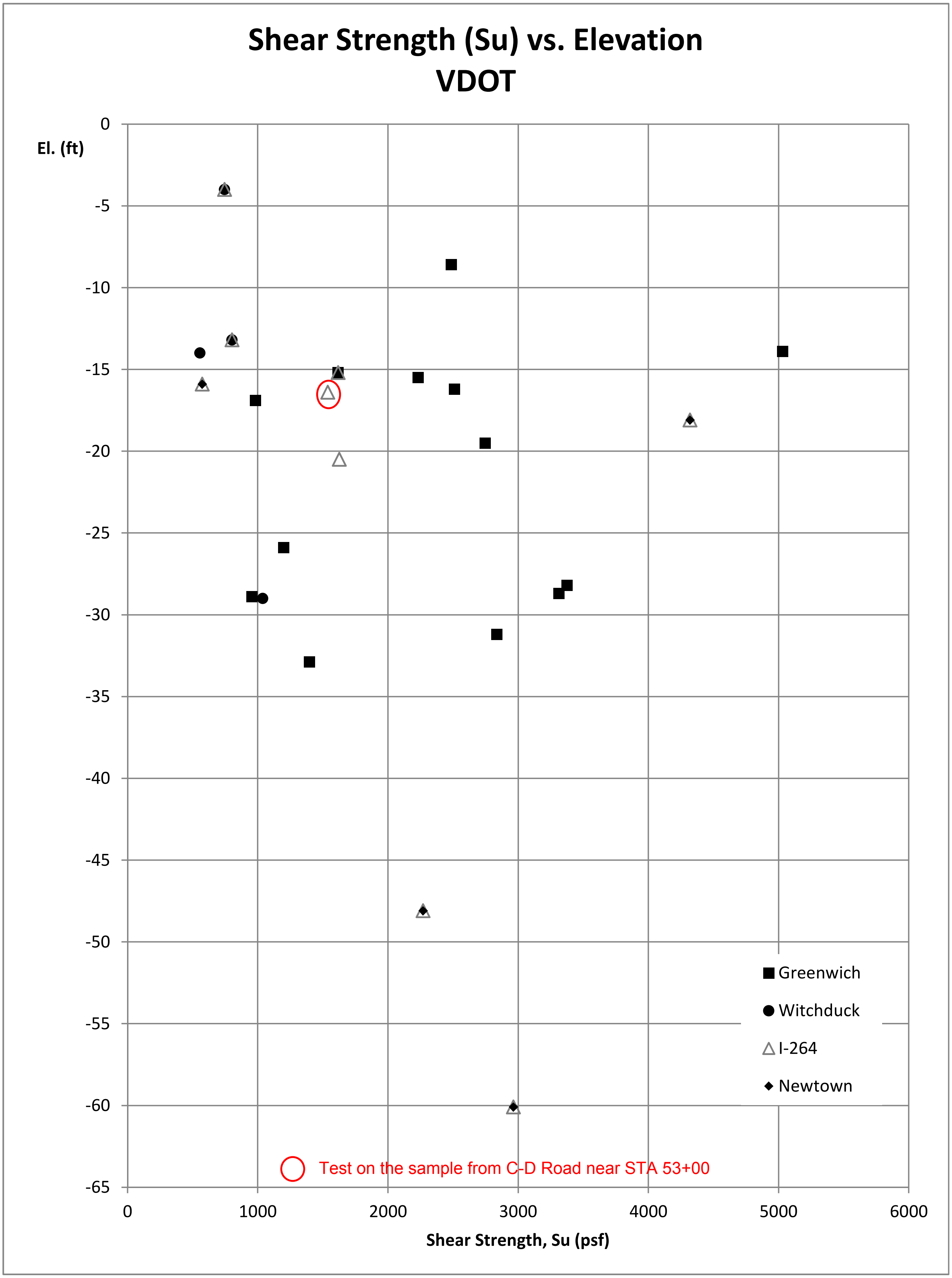
VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan


Shear Strength (Su) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
1000
2000
3000
4000
5000
6000
Shear Strength, Su (psf)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown
Test on the sample from C-D Road near STA 53+00

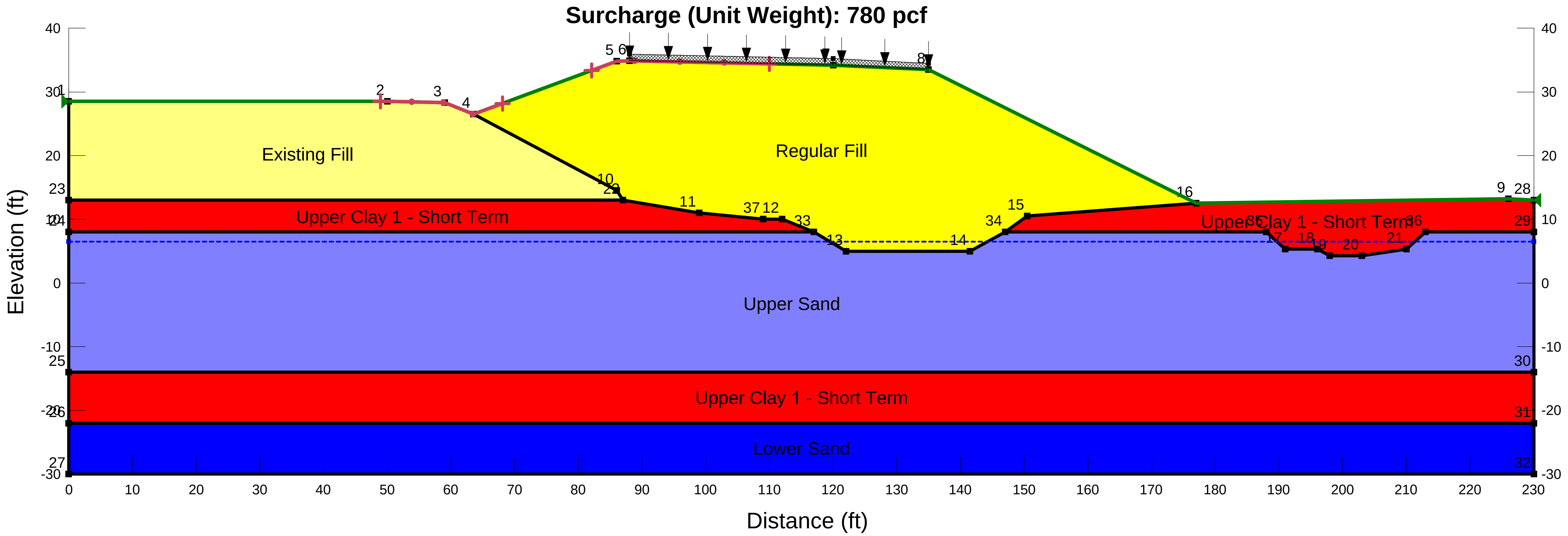
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Station 53+00 - Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Station 53+00 - Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 53+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-19, CD-18, CD-17

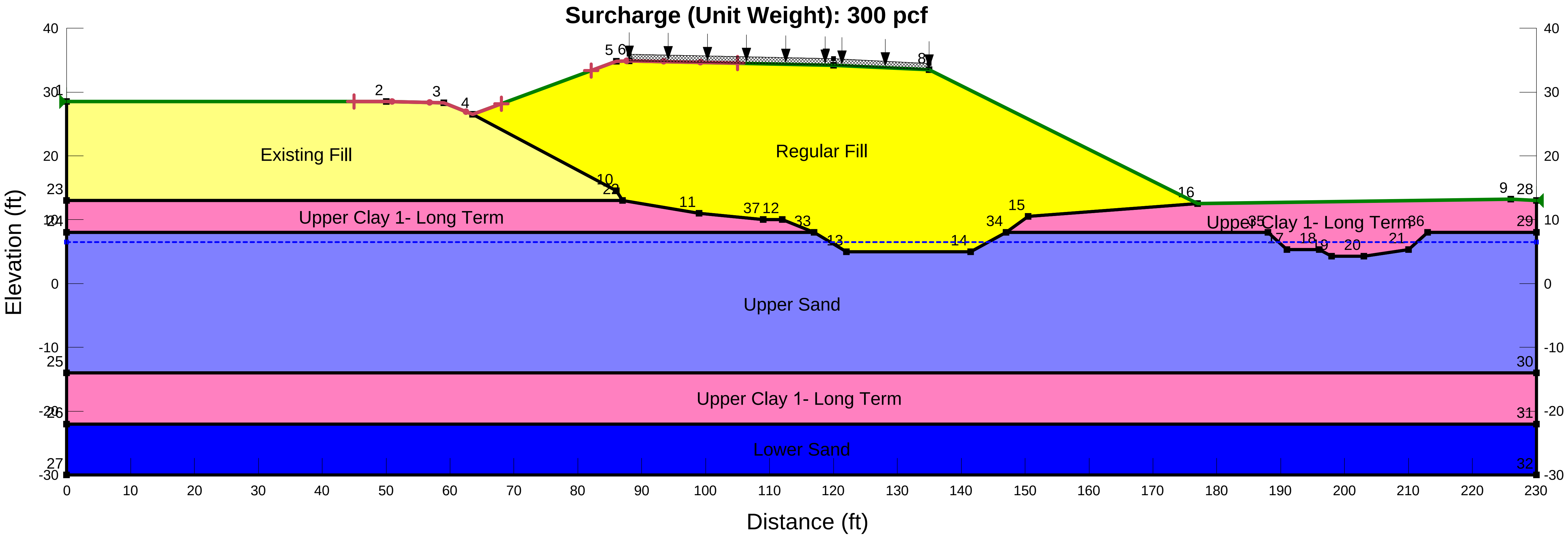


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1- Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2- Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 53+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-19, CD-18, CD-17

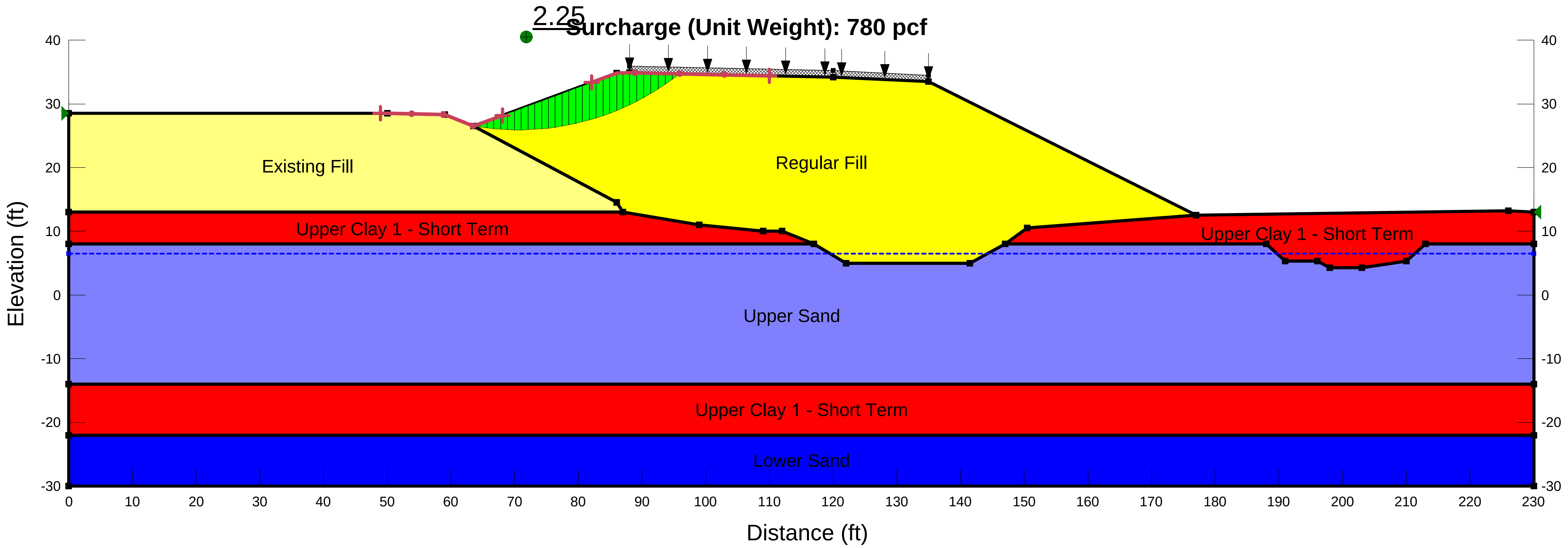


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Station 53+00 - Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Station 53+00 - Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 53+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-19, CD-18, CD-17

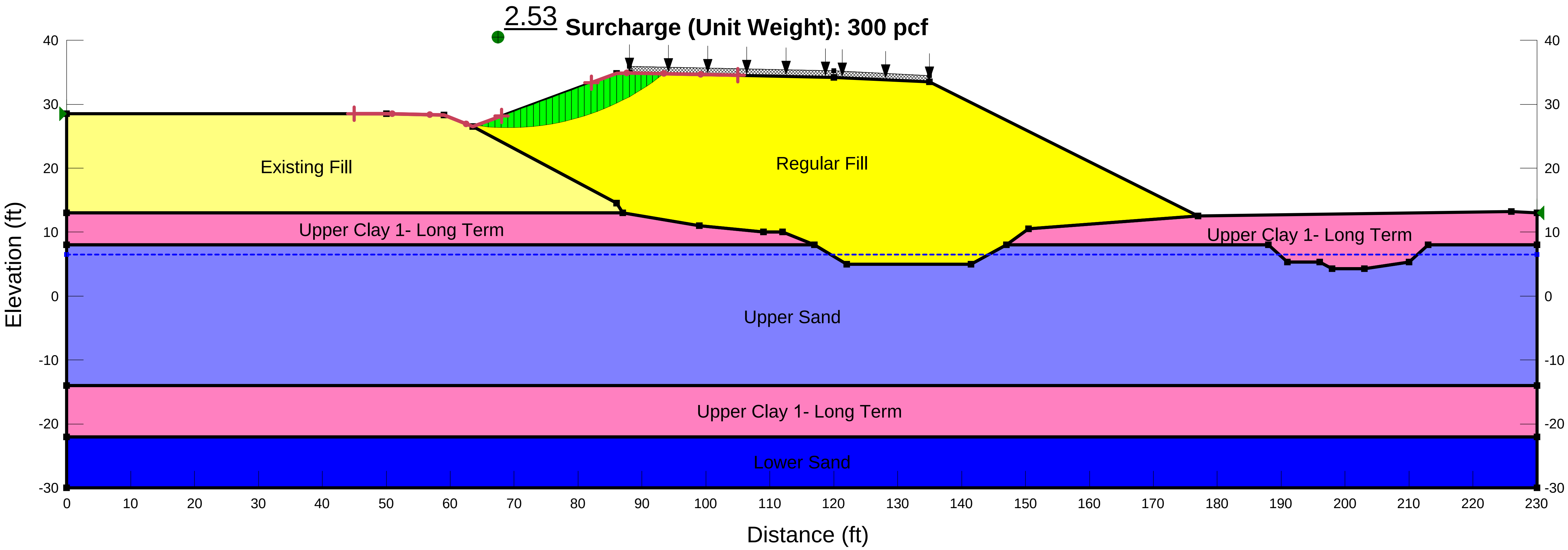


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1- Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2- Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 53+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-19, CD-18, CD-17

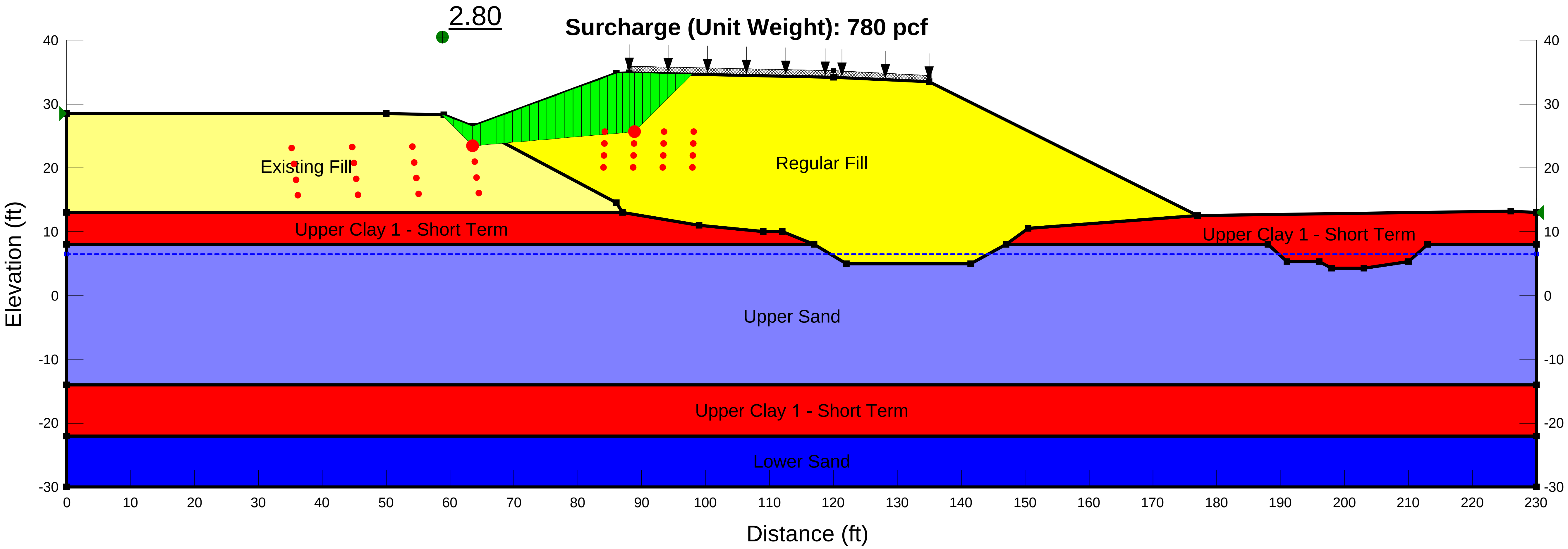


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 0 psf	Phi: 30 °	Piezometric Line: 1
Name: Lower Sand	Unit Weight: 125 pcf	Cohesion: 0 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Clay 1 - Short Term	Unit Weight: 112 pcf	Cohesion Spatial Fn: Station 53+00 - Upper Clay	Phi: 0 °	Piezometric Line: 1
Name: Upper Clay 2 - Short Term	Unit Weight: 112 pcf	Cohesion Spatial Fn: Station 53+00 - Upper Clay	Phi: 0 °	Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 53+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-19, CD-18, CD-17



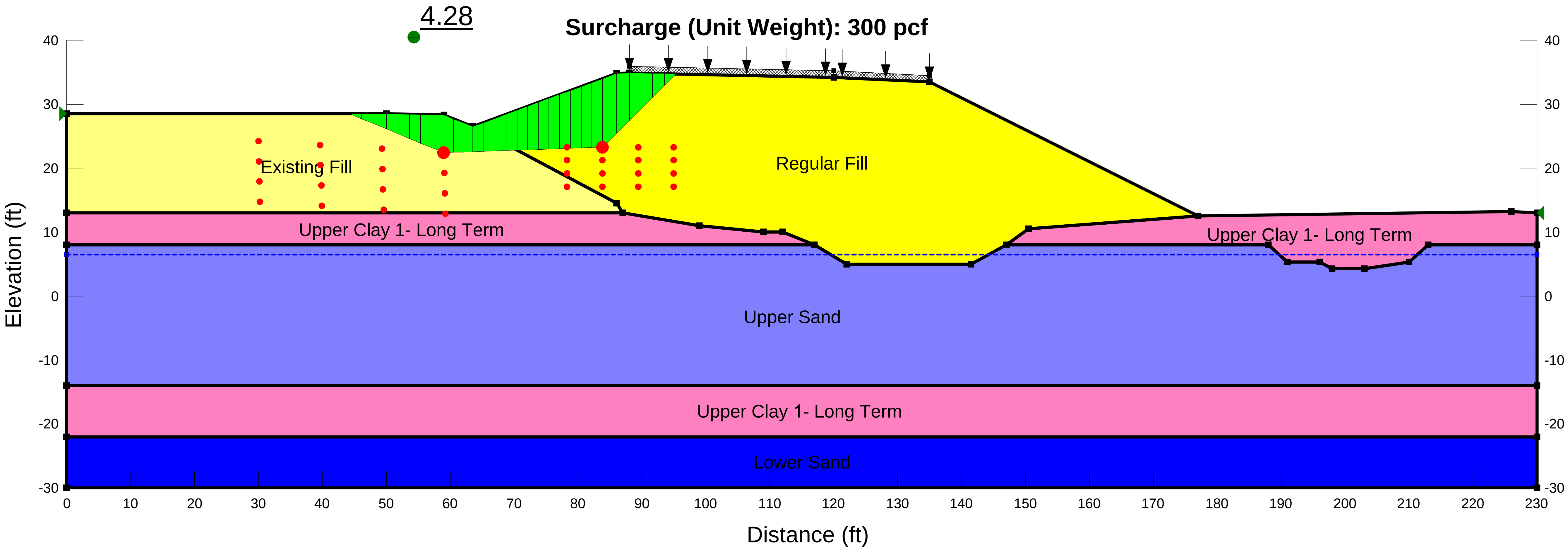
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1- Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2- Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 53+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-19, CD-18, CD-17



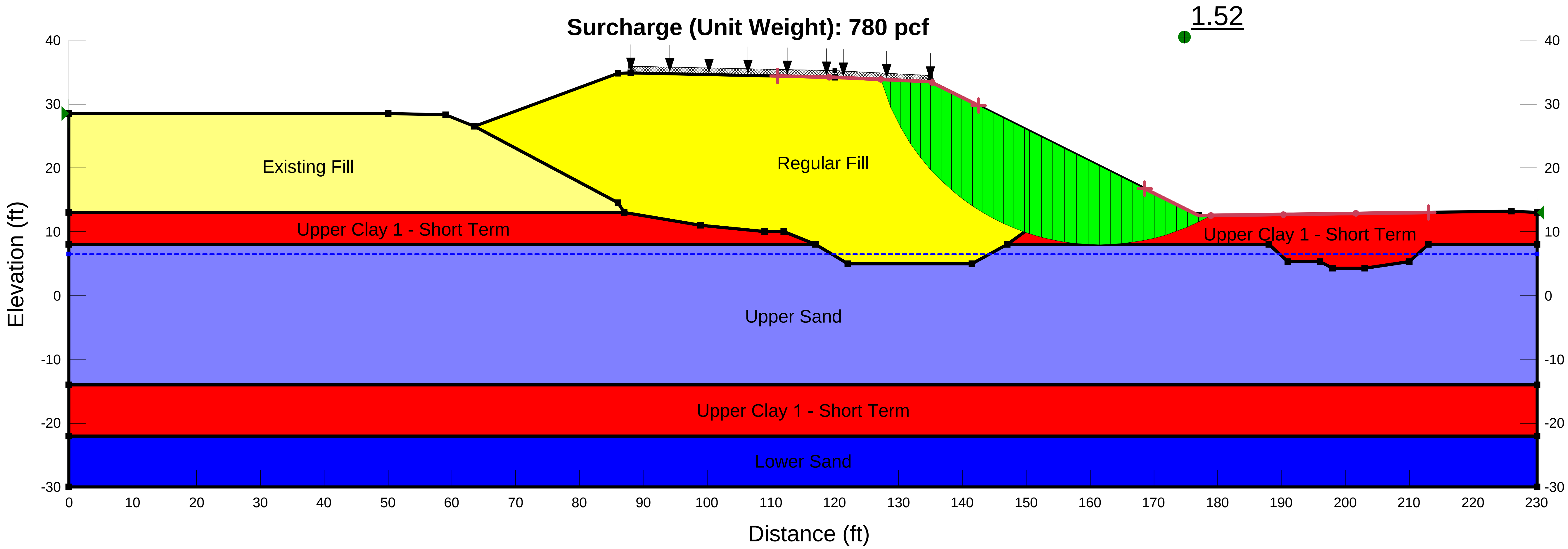
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Station 53+00 - Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Station 53+00 - Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 53+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-19, CD-18, CD-17



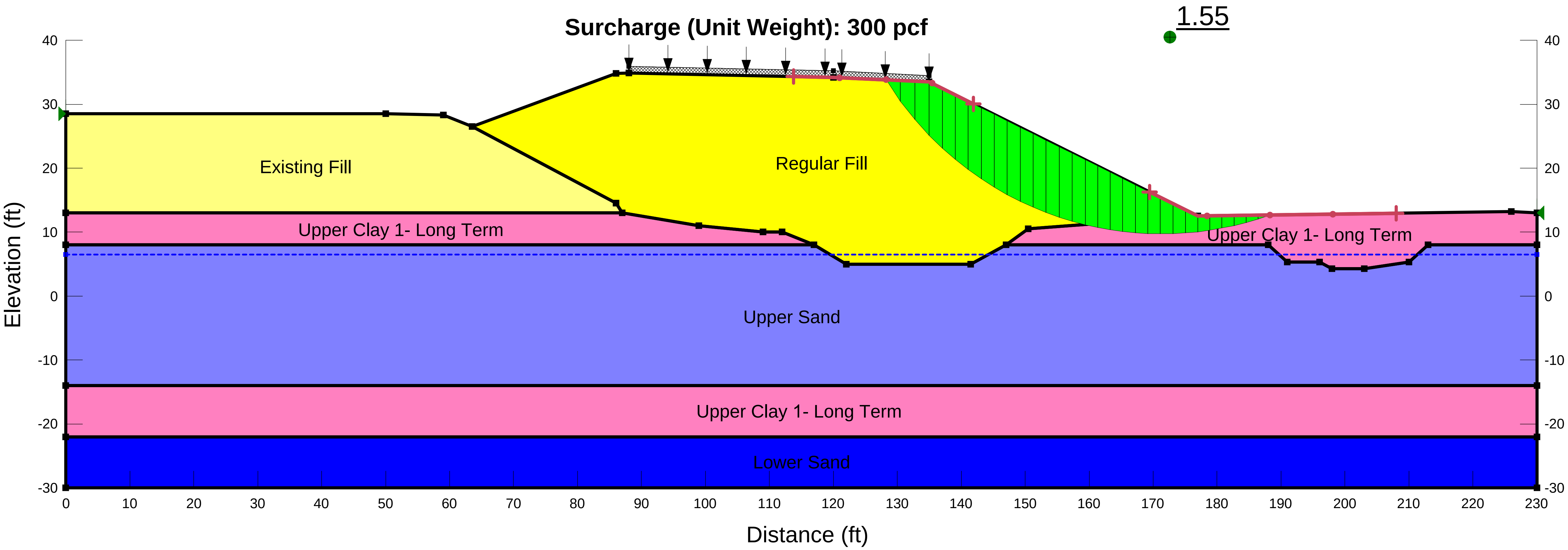
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1- Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2- Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 53+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-19, CD-18, CD-17



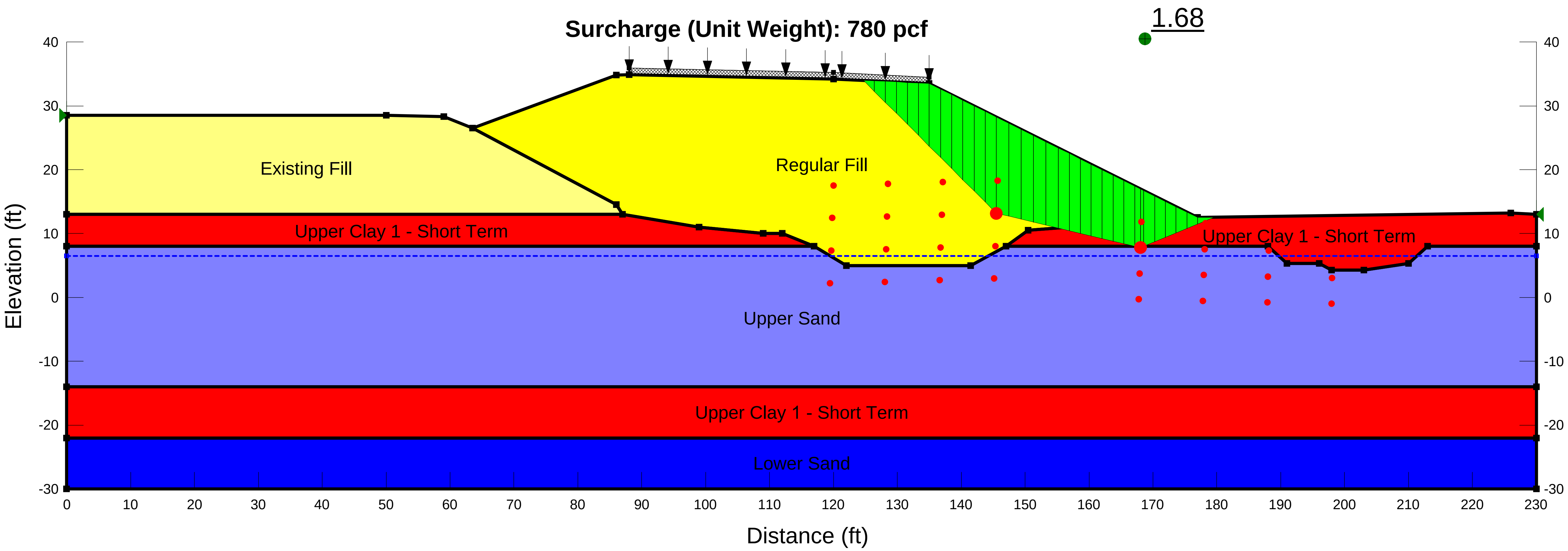
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Station 53+00 - Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Station 53+00 - Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 53+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-19, CD-18, CD-17



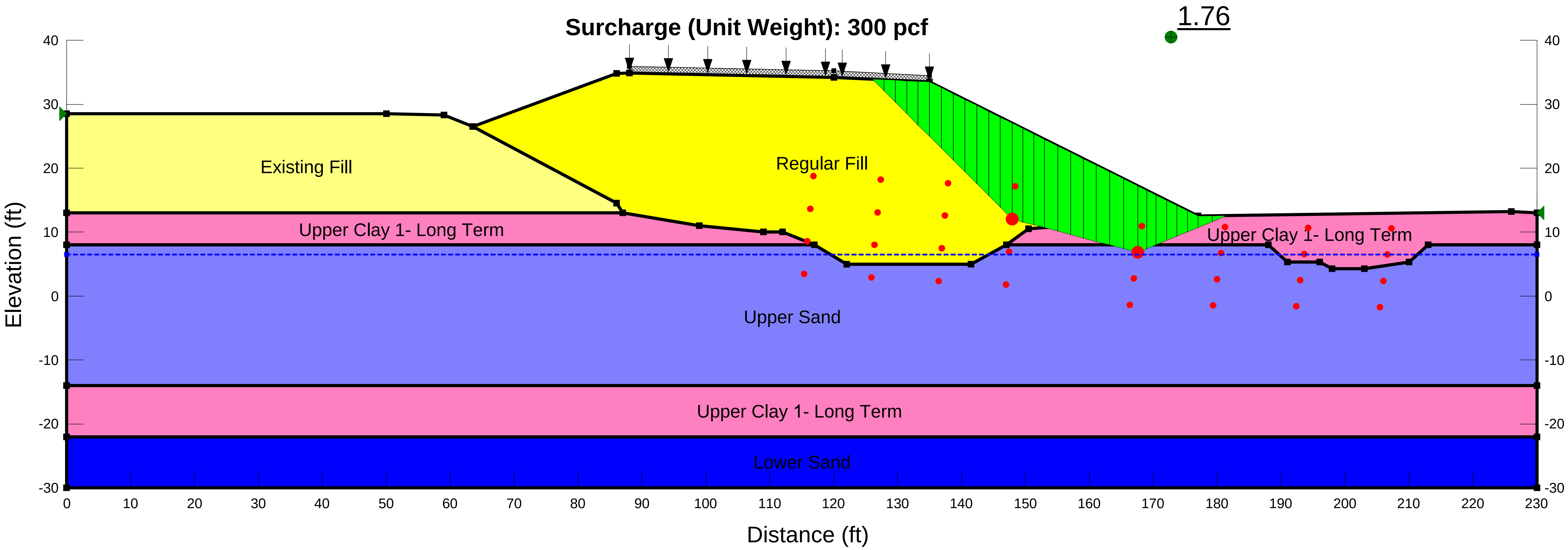
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

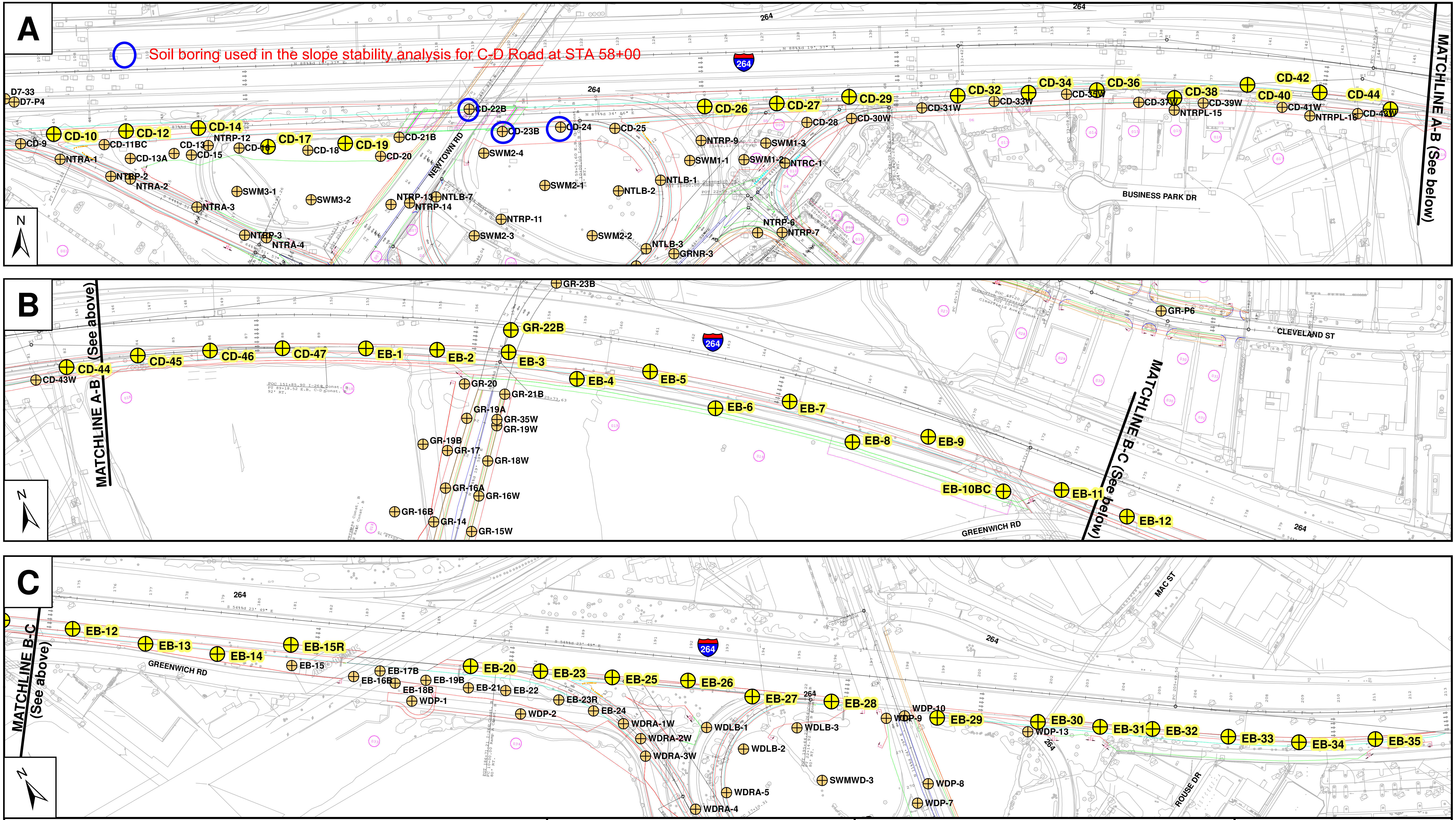
Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1- Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2- Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 53+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-19, CD-18, CD-17



Slope Stability Analysis at

STATION 58+00



0 125 250 Feet

⊕	SPT Exploration Locations
⊕	Borings in other PSAs

Prepared by: HDR

Date: November 2011

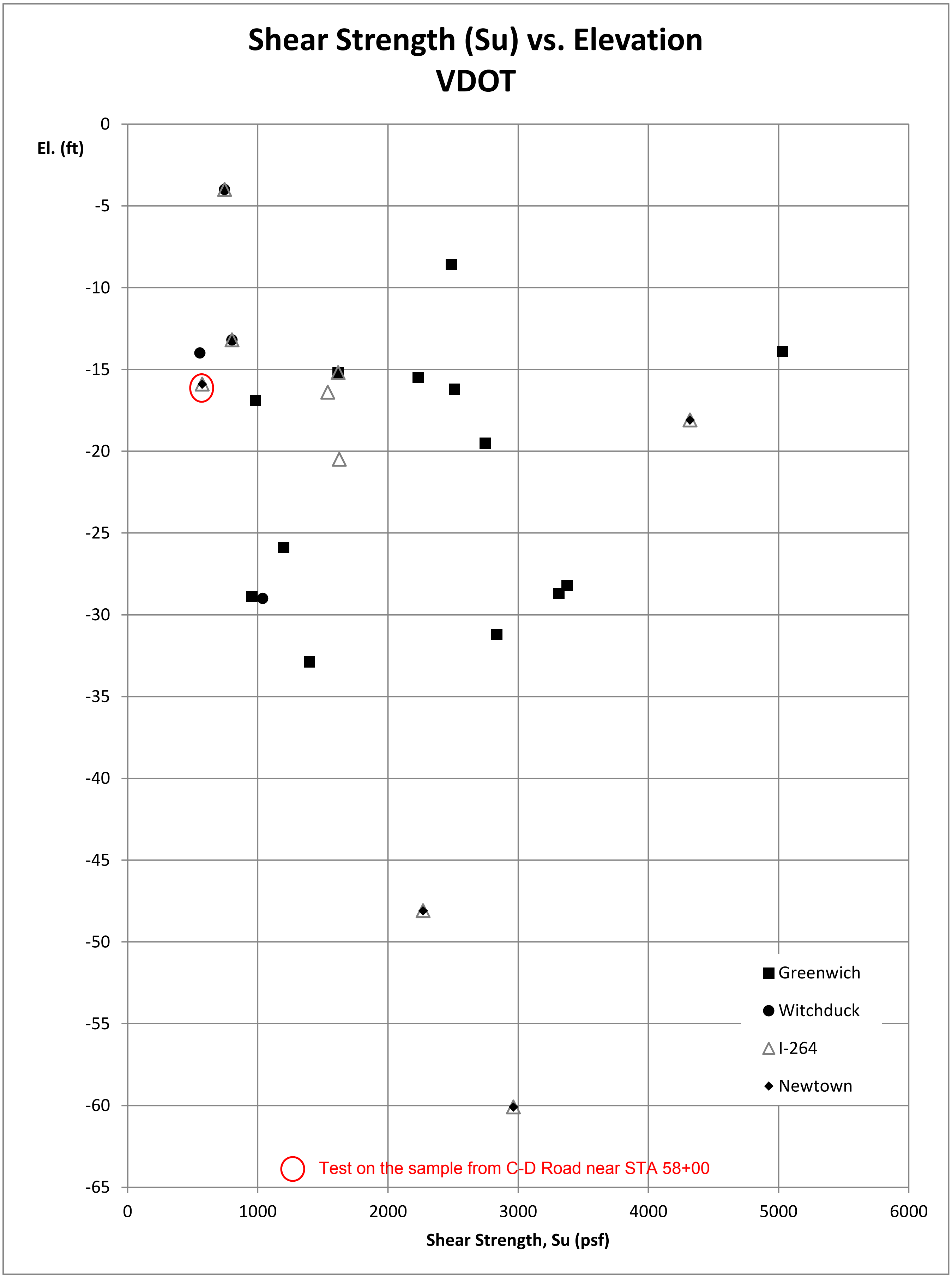
VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan


Shear Strength (Su) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
1000
2000
3000
4000
5000
6000
Shear Strength, Su (psf)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown
Test on the sample from C-D Road near STA 58+00

CONE PENETROMETER TEST LOG

Virginia Department of Transportation

PROJECT #: 0264-134-102
LOCATION: Va Beach: PSA Newtown

CD-22B
PAGE 1 OF 1

STATION: 56+20
LATITUDE: 36.845555° N
SURFACE ELEVATION: 12.5
BENCHMARK LOCATION:

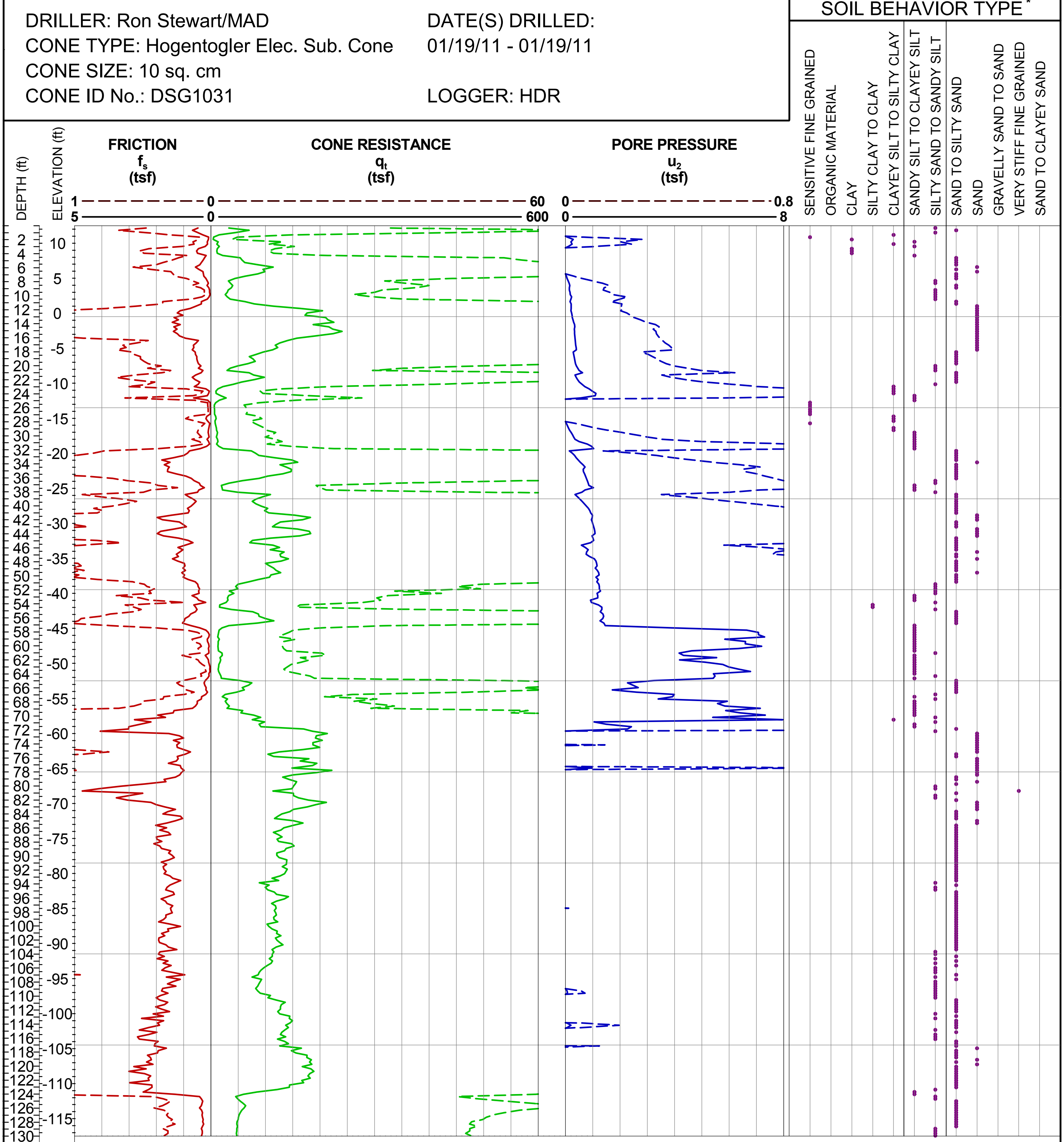
OFFSET: 20 ft LT
LONGITUDE: 76.183418° W
COORD. DATUM: NAD 83

DRILLER: Ron Stewart/MAD
CONE TYPE: Hogentogler Elec. Sub. Cone
CONE SIZE: 10 sq. cm
CONE ID No.: DSG1031

DATE(S) DRILLED:
01/19/11 - 01/19/11

LOGGER: HDR

SOIL BEHAVIOR TYPE *



* Campanella and Robertson (1983) Friction Ratio correlation

REMARKS: REFERENCE BASELINE: C-D CONST.

PAGE 1 OF 1
CD-22B

CPT_LOG:NEWTOWN CPT LOGS.GPJ:8.30.003:061810:1/27/13

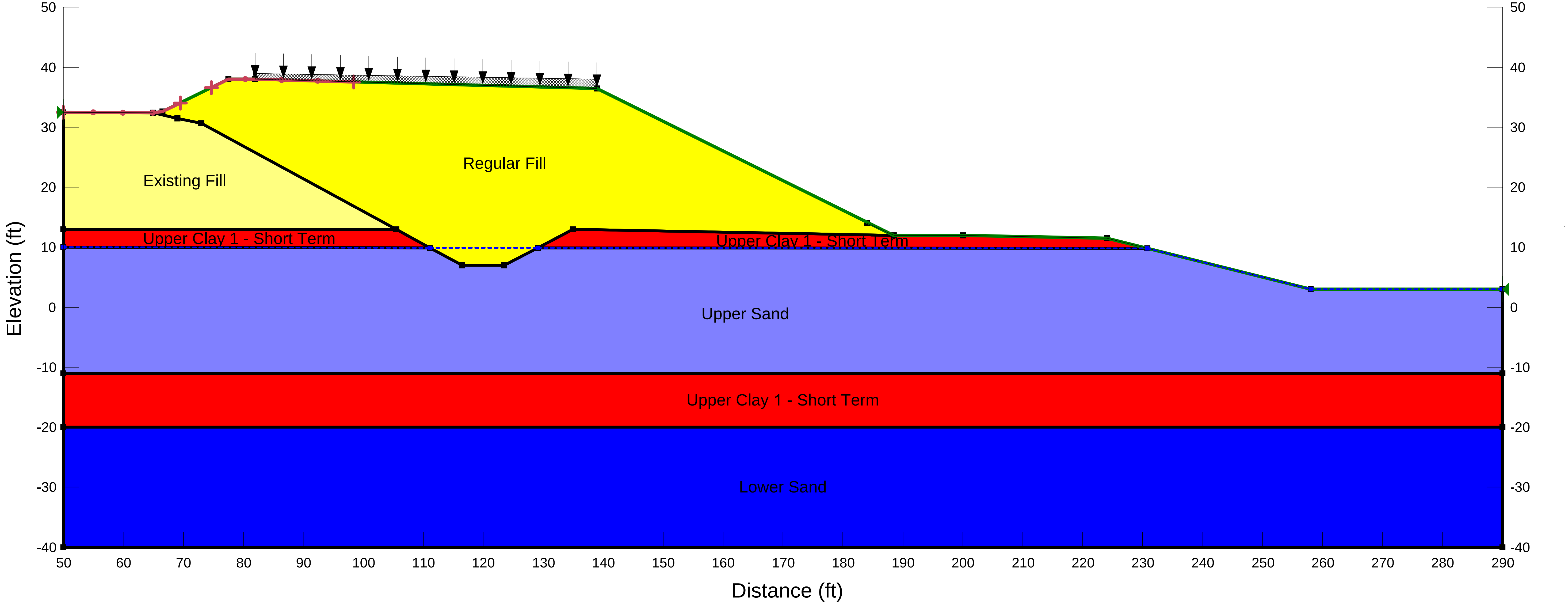
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

AECOM

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 58+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-22B (CPT), CD-23B, CD-24



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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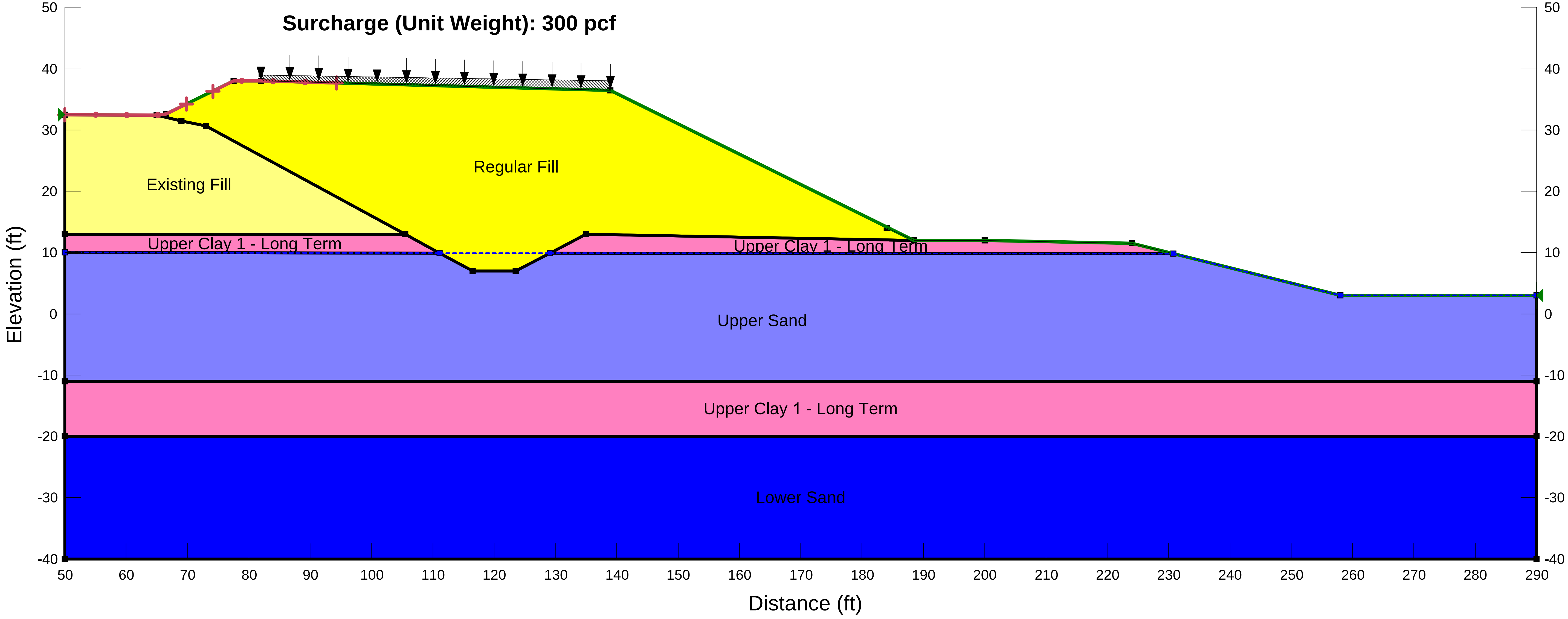
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 58+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-22B (CPT), CD-23B, CD-24

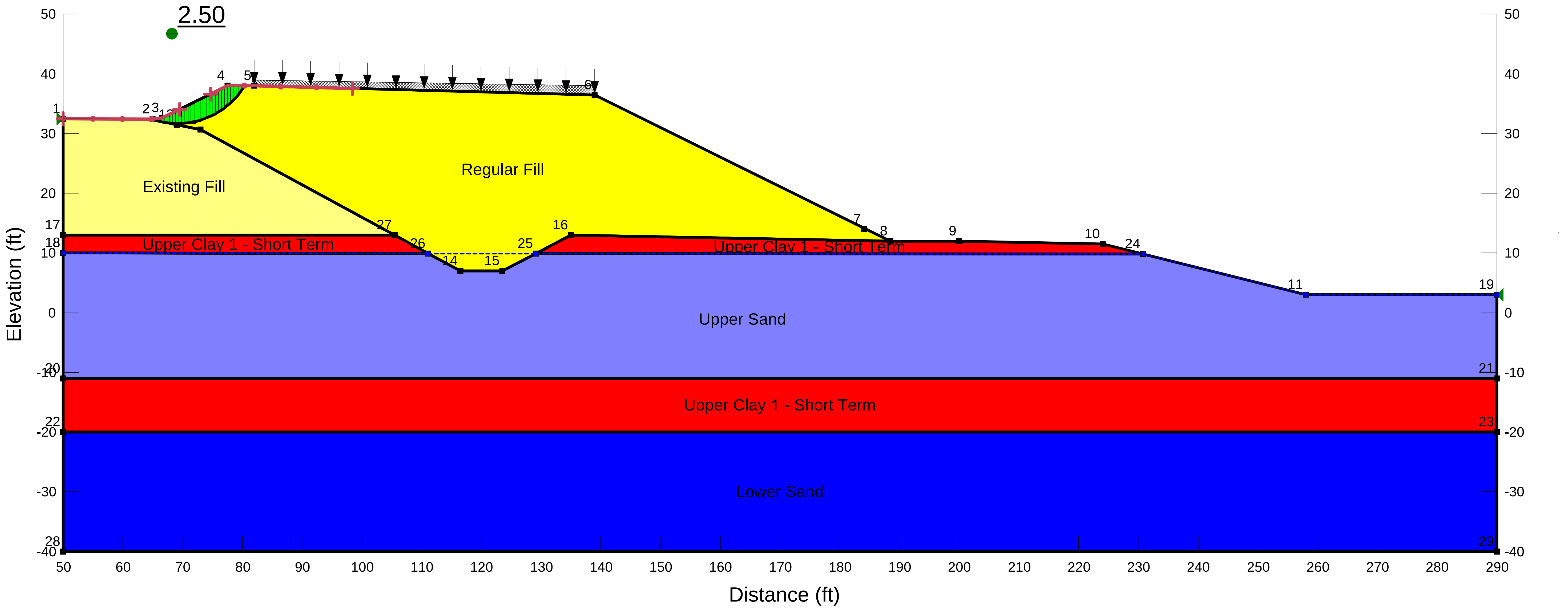


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 50 psf	Phi: 30 °	Piezometric Line: 1
Name: Lower Sand	Unit Weight: 125 pcf	Cohesion: 0 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Clay 1 - Short Term	Unit Weight: 112 pcf	Cohesion Spatial Fn: Upper Clay	Phi: 0 °	Piezometric Line: 1
Name: Upper Clay 2 - Short Term	Unit Weight: 112 pcf	Cohesion Spatial Fn: Upper Clay	Phi: 0 °	Piezometric Line: 1

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 58+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-22B (CPT), CD-23B, CD-24



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
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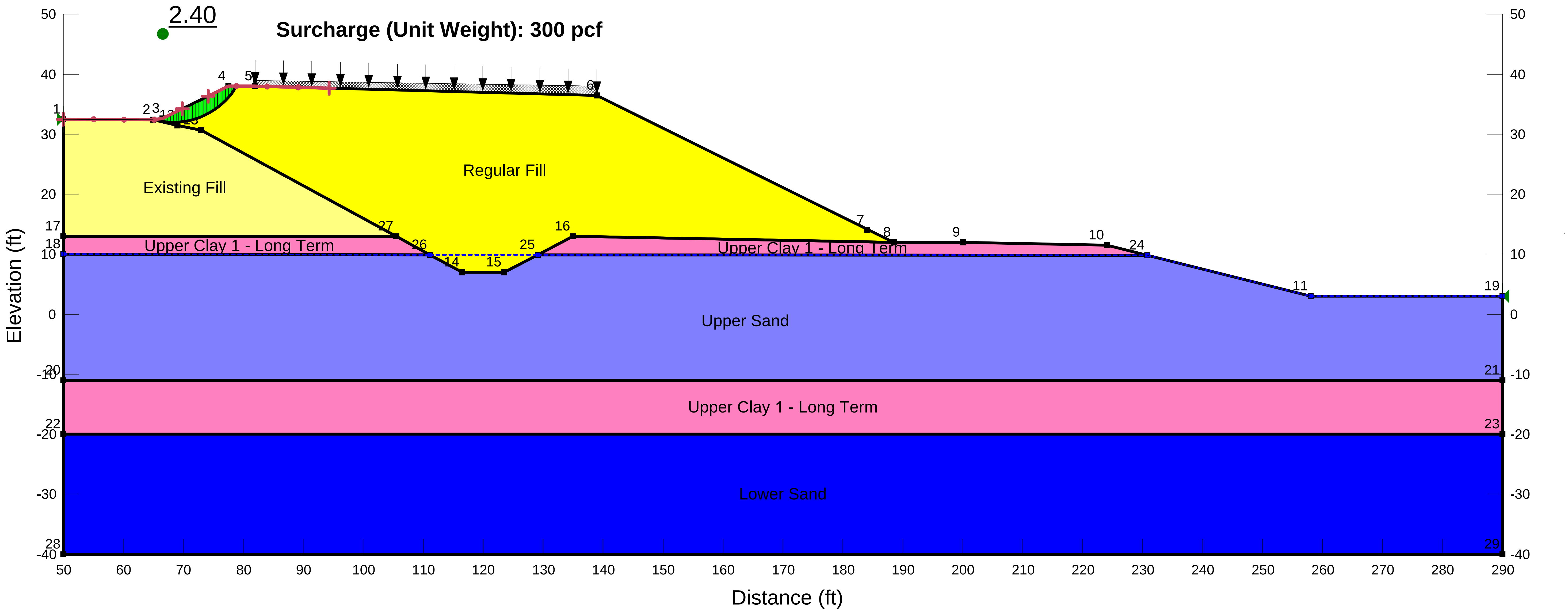
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 58+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-22B (CPT), CD-23B, CD-24



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
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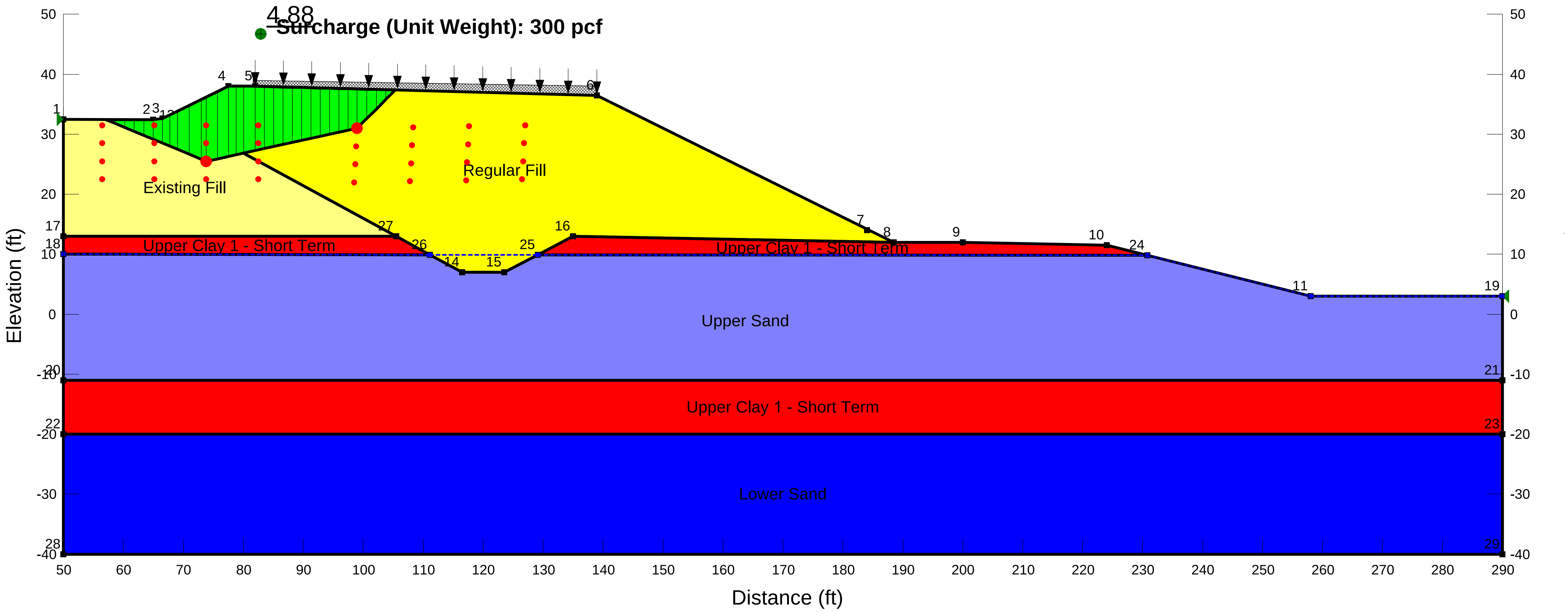
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

AECOM

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 58+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-22B (CPT), CD-23B, CD-24

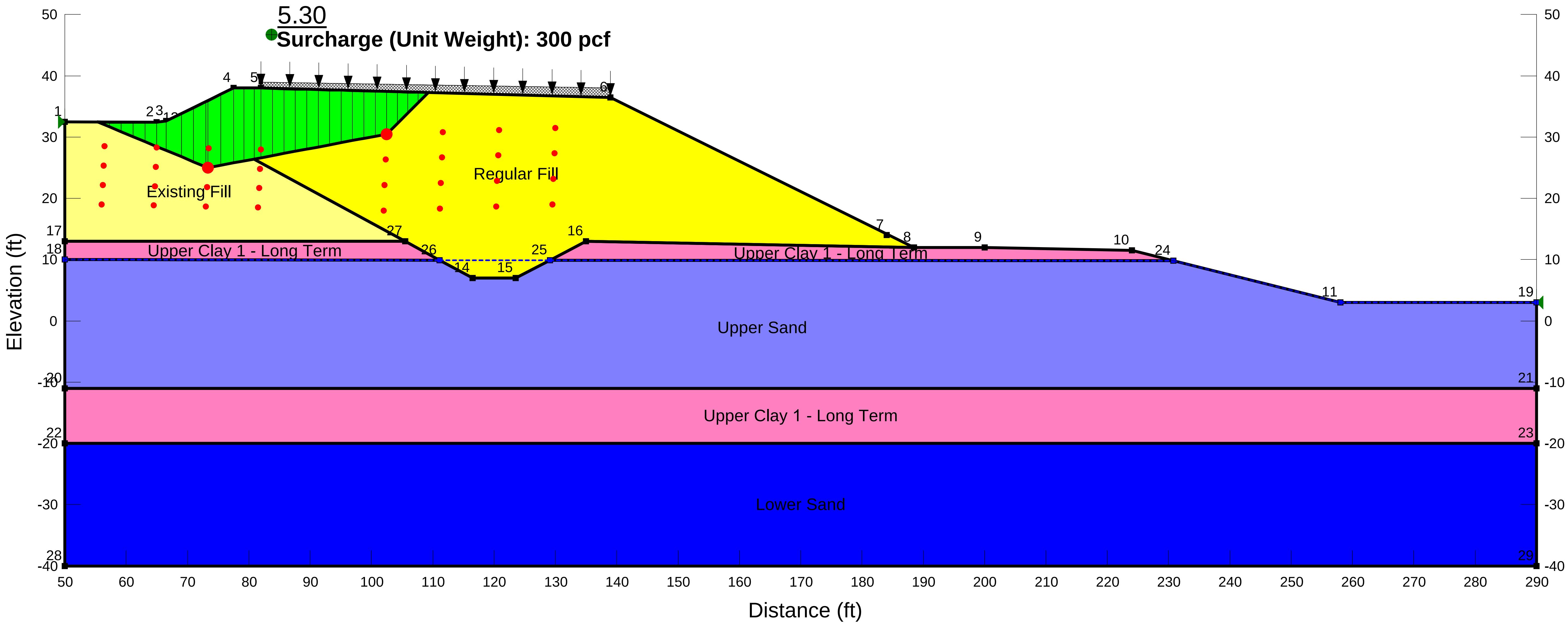


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 50 psf	Phi: 30 °	Piezometric Line: 1
Name: Lower Sand	Unit Weight: 125 pcf	Cohesion: 0 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Clay 1 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1
Name: Upper Clay 2 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 58+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-22B (CPT), CD-23B, CD-24

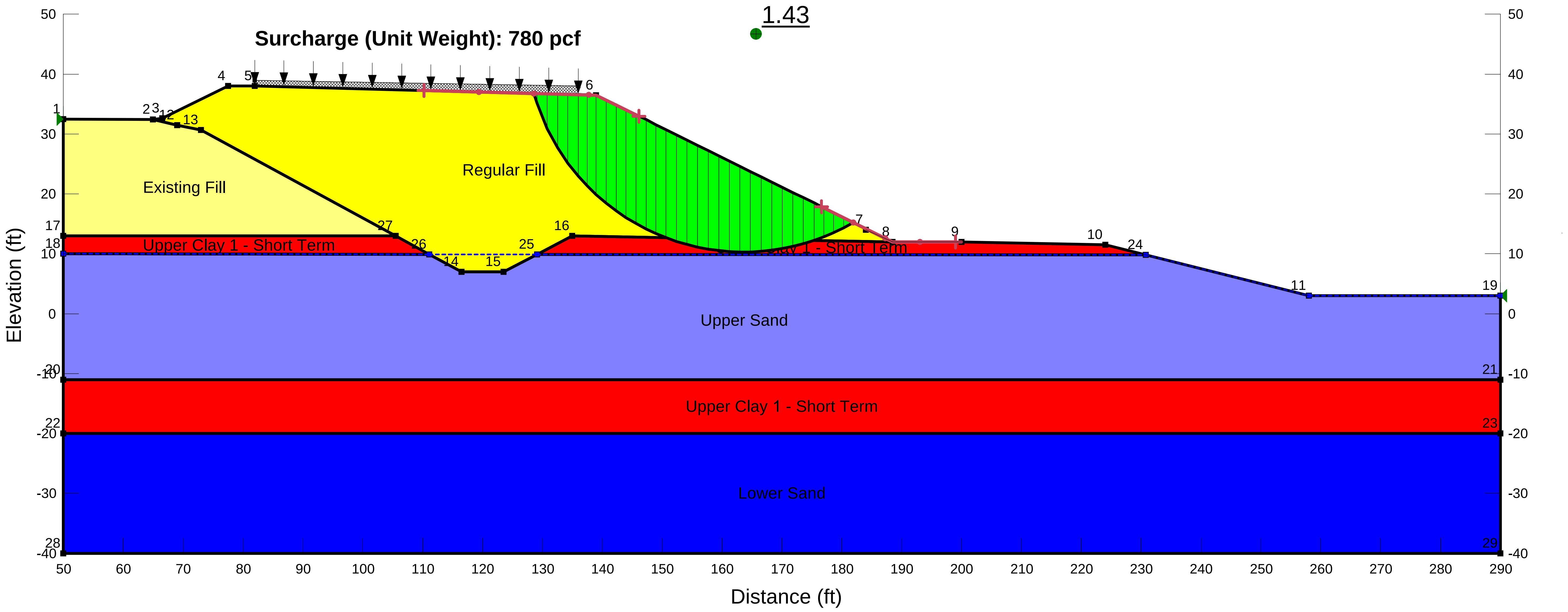


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Short Term Global Stability Analysis
RIGHT-1

I-264 C-D Road
Analysis Location: Sta. 58+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-22B (CPT), CD-23B, CD-24

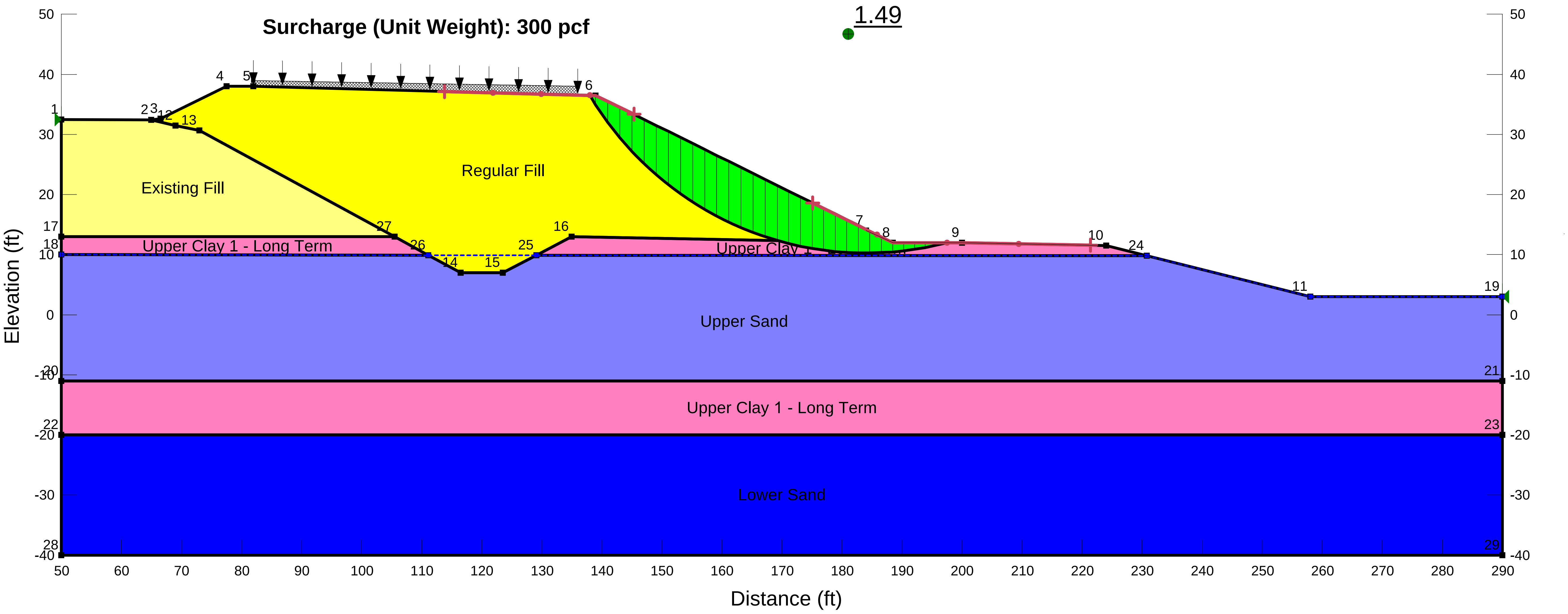


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 50 psf	Phi: 30 °	Piezometric Line: 1
Name: Lower Sand	Unit Weight: 125 pcf	Cohesion: 0 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Clay 1 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1
Name: Upper Clay 2 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1

Long Term Global Stability Analysis
RIGHT-1

I-264 C-D Road
Analysis Location: Sta. 58+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-22B (CPT), CD-23B, CD-24

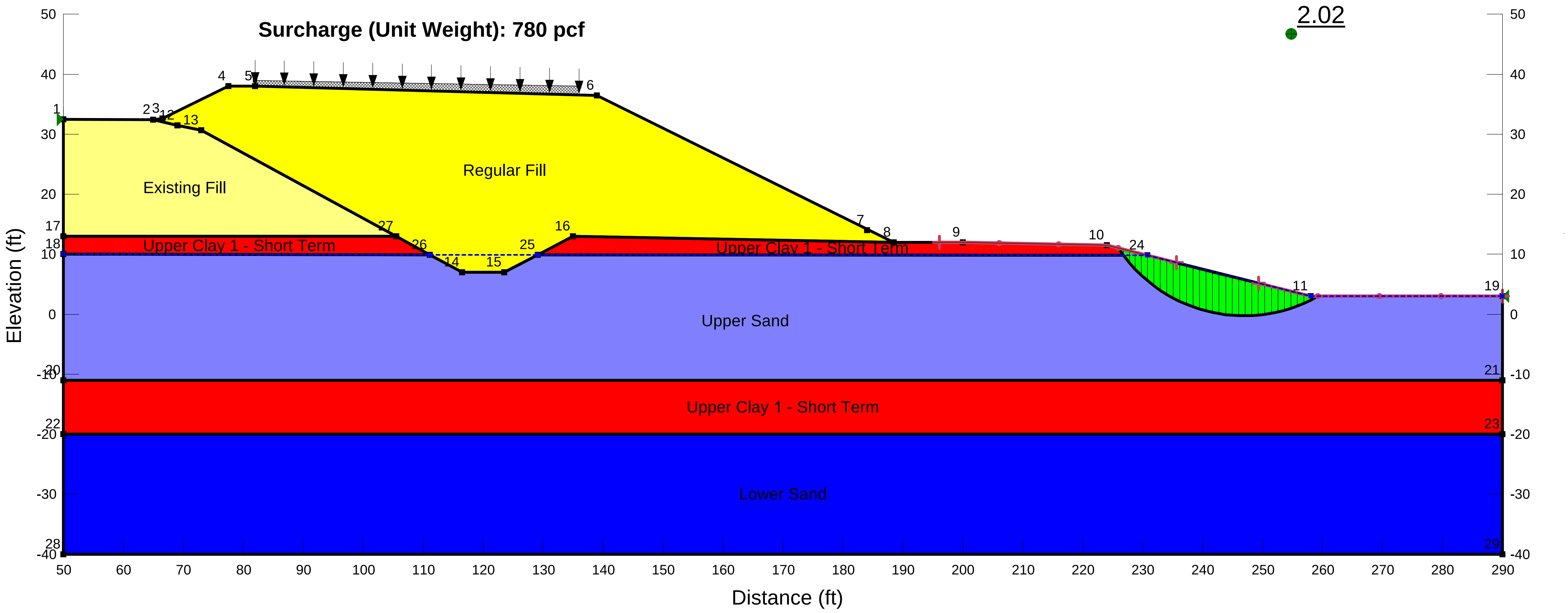


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Short Term Global Stability Analysis RIGHT-2

I-264 C-D Road
Analysis Location: Sta. 58+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-22B (CPT), CD-23B, CD-24

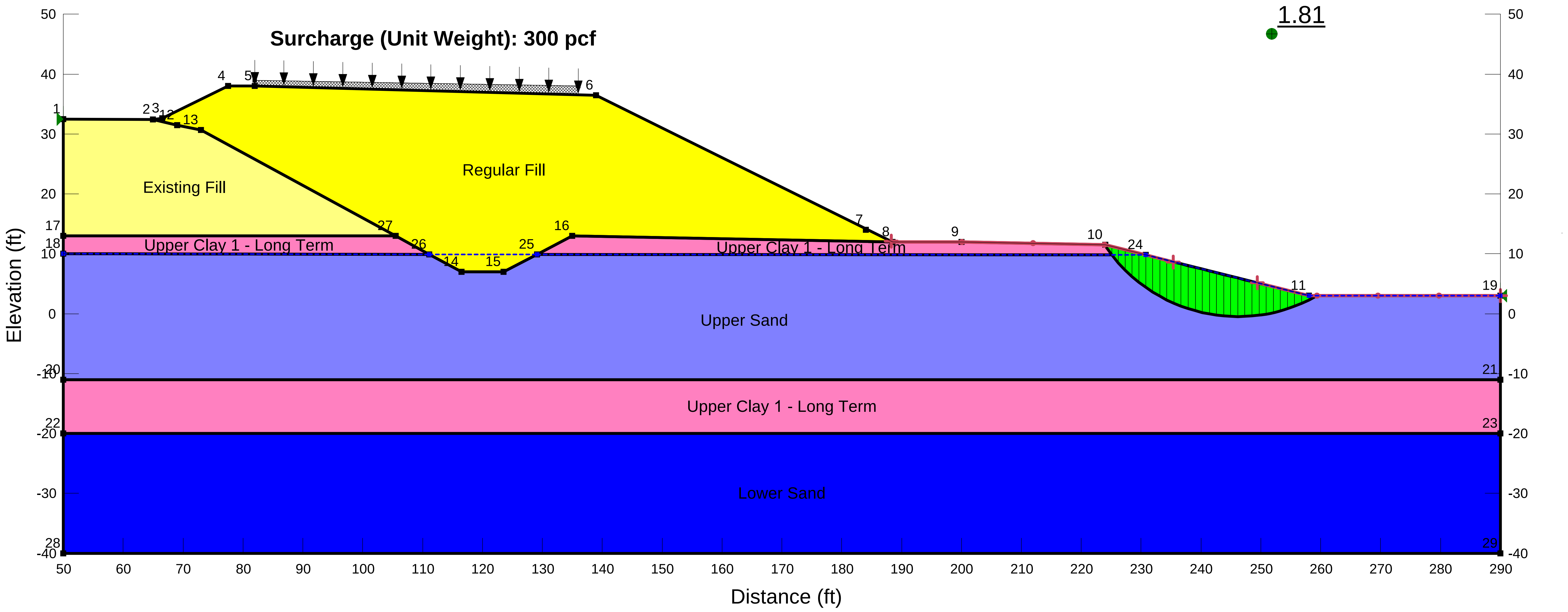


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

Long Term Global Stability Analysis
RIGHT-2

I-264 C-D Road
Analysis Location: Sta. 58+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-22B (CPT), CD-23B, CD-24

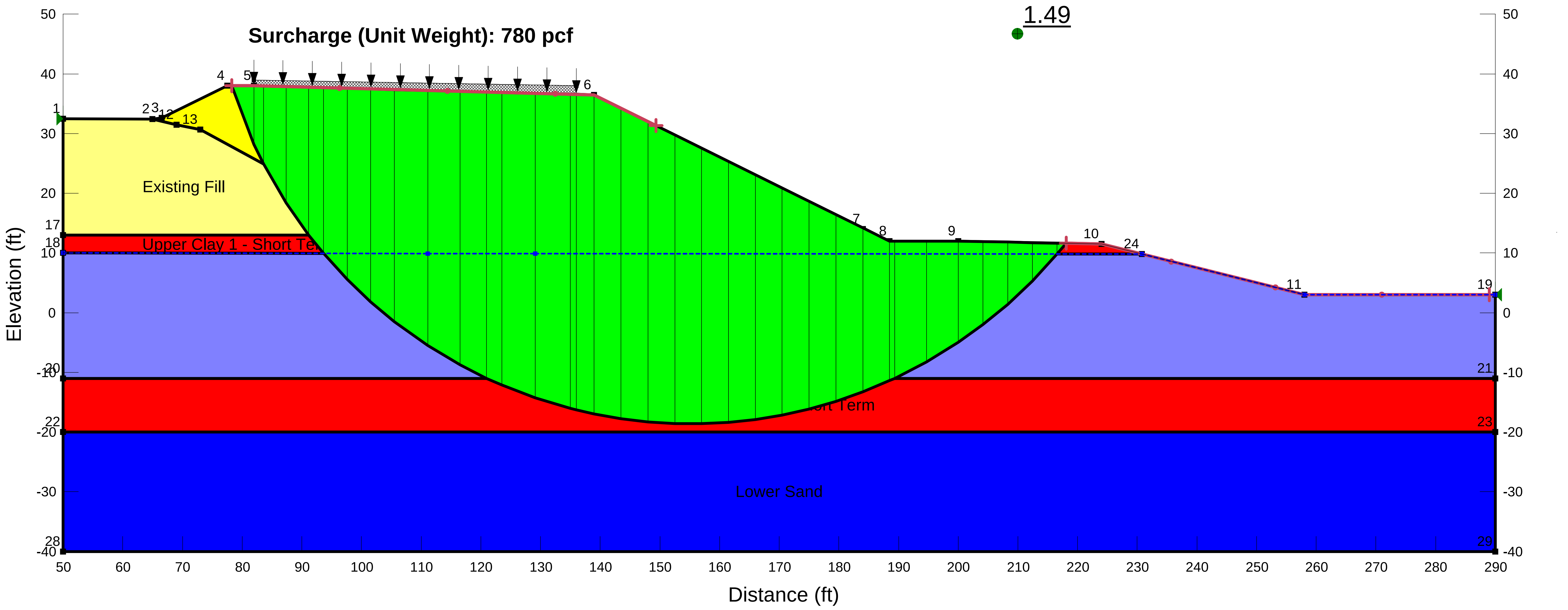


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Short Term Global Stability Analysis RIGHT-3

I-264 C-D Road
Analysis Location: Sta. 58+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-22B (CPT), CD-23B, CD-24



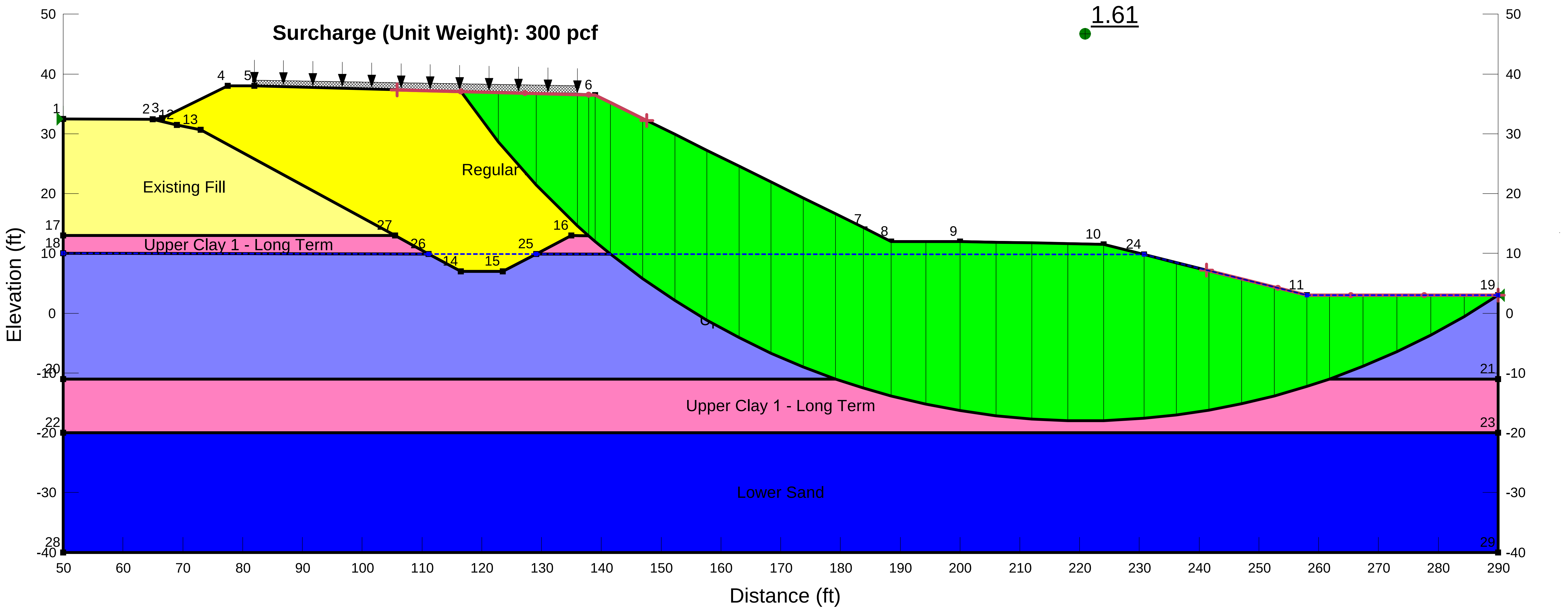
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 50 psf	Phi: 30 °	Piezometric Line: 1
Name: Lower Sand	Unit Weight: 125 pcf	Cohesion: 0 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Clay 1 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1
Name: Upper Clay 2 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1

AECOM

Long Term Global Stability Analysis RIGHT-3

I-264 C-D Road
Analysis Location: Sta. 58+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-22B (CPT), CD-23B, CD-24

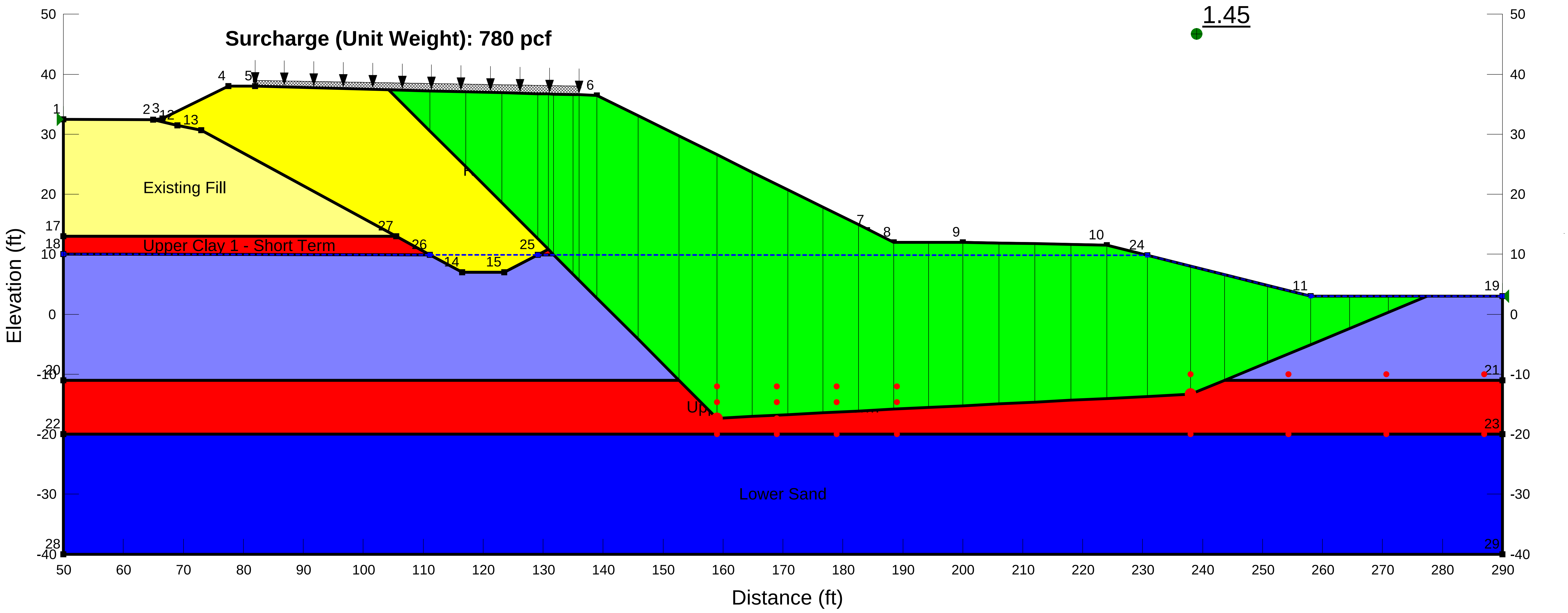


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 58+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-22B (CPT), CD-23B, CD-24



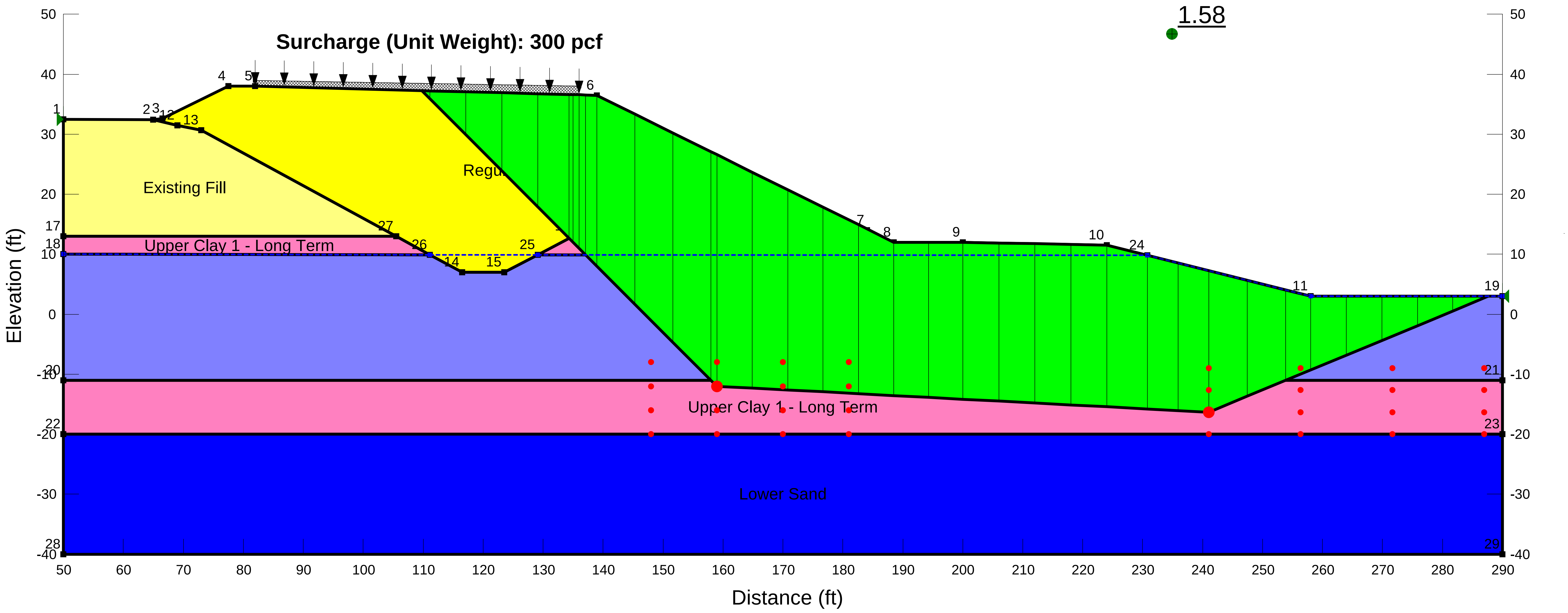
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

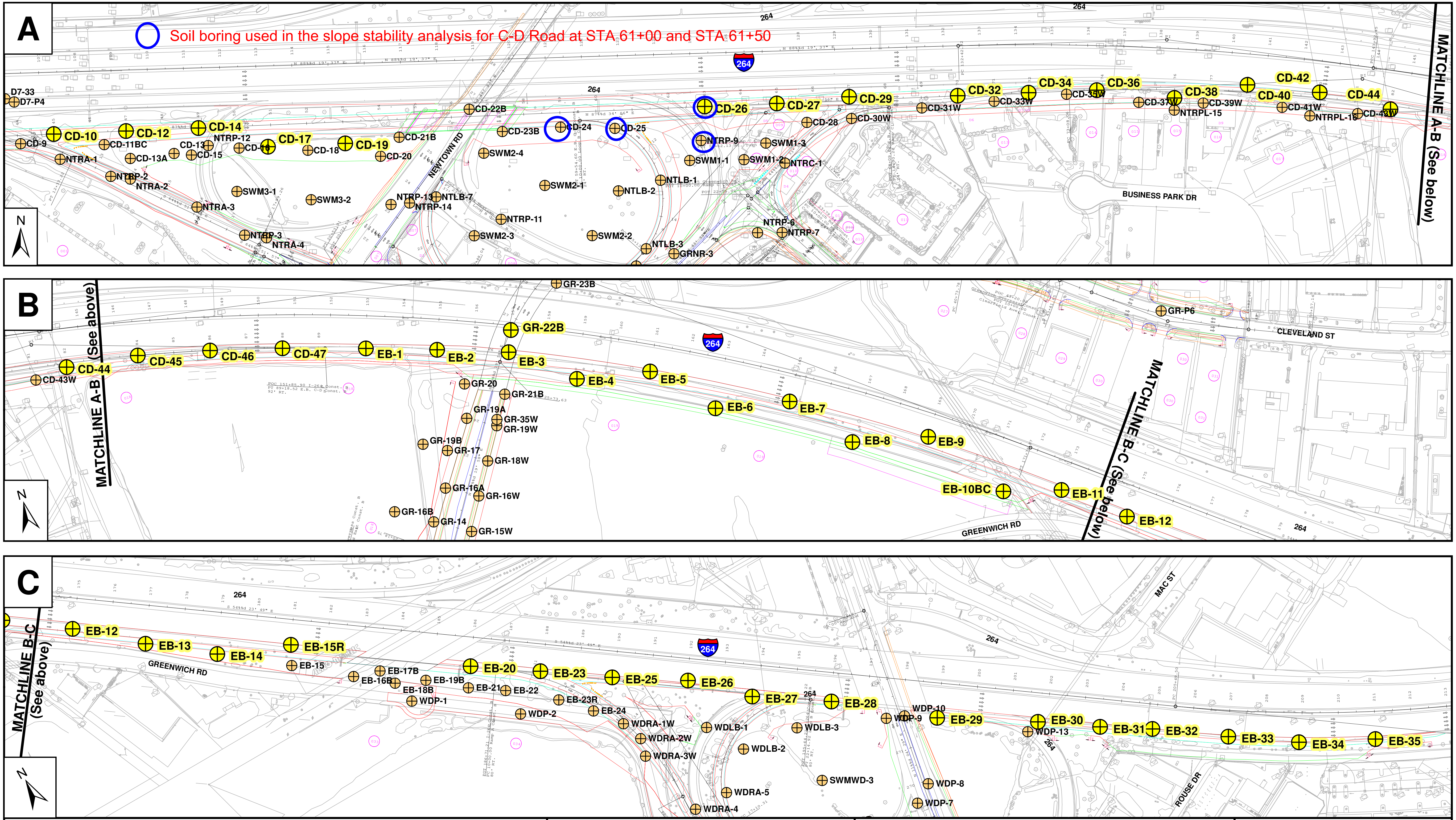
AECOM

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 58+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-22B (CPT), CD-23B, CD-24



Slope Stability Analysis at
STATION 61+00



0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

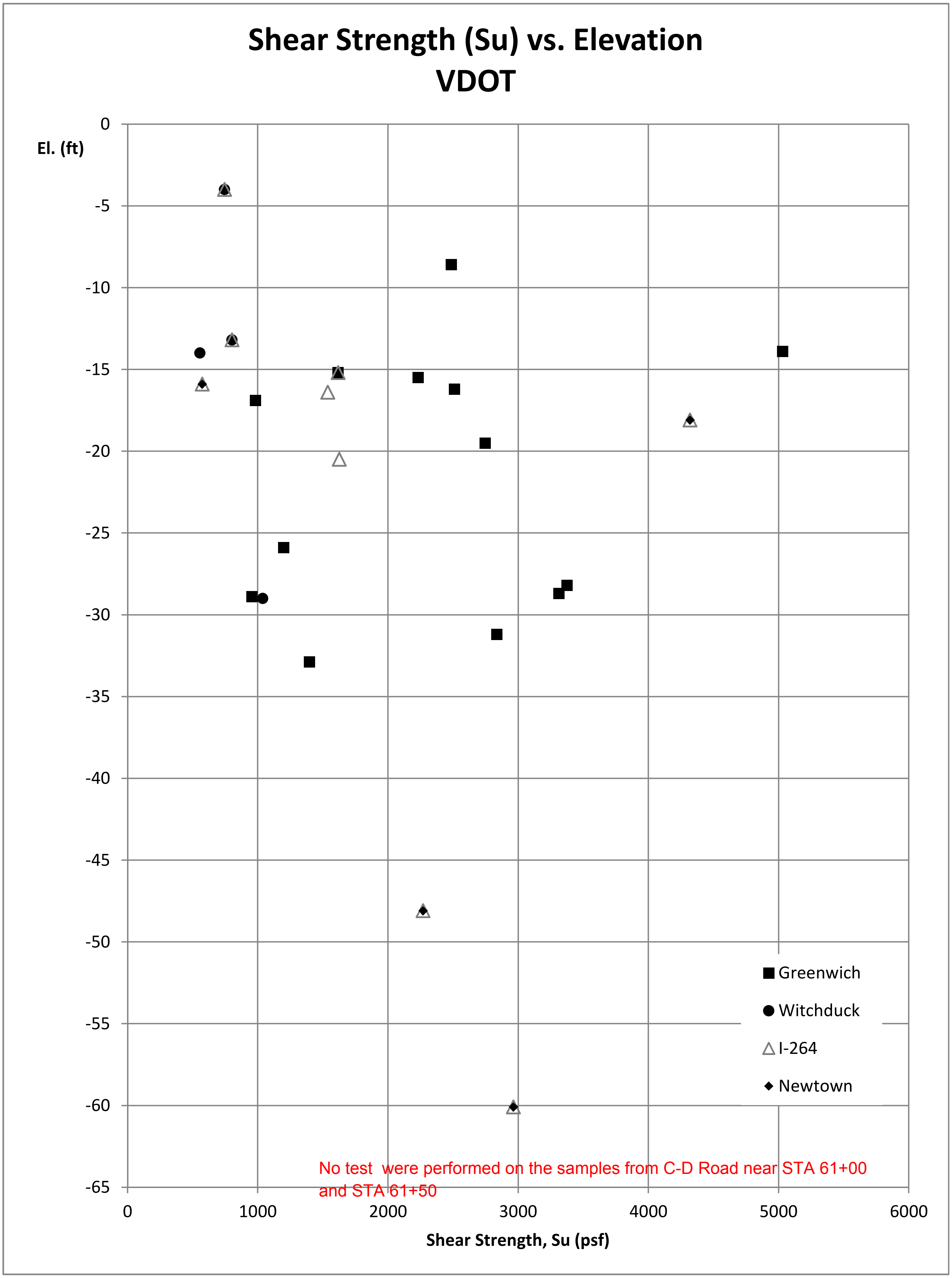
VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan



No test were performed on the samples from C-D Road near STA 61+00 and STA 61+50

CONE PENETROMETER TEST LOG

Virginia Department of Transportation

PROJECT #: 0264-134-102

LOCATION: Va Beach: PSA Newtown

CD-25

PAGE 1 OF 1

STATION: 60+50

OFFSET: 50 ft RT

LATITUDE: 36.845383° N

LONGITUDE: 76.182045° W

SURFACE ELEVATION: 13.1

COORD. DATUM: NAD 83

BENCHMARK LOCATION:

DRILLER: Ron Stewart/MAD

CONE TYPE: Hogentogler Elec. Sub. Cone

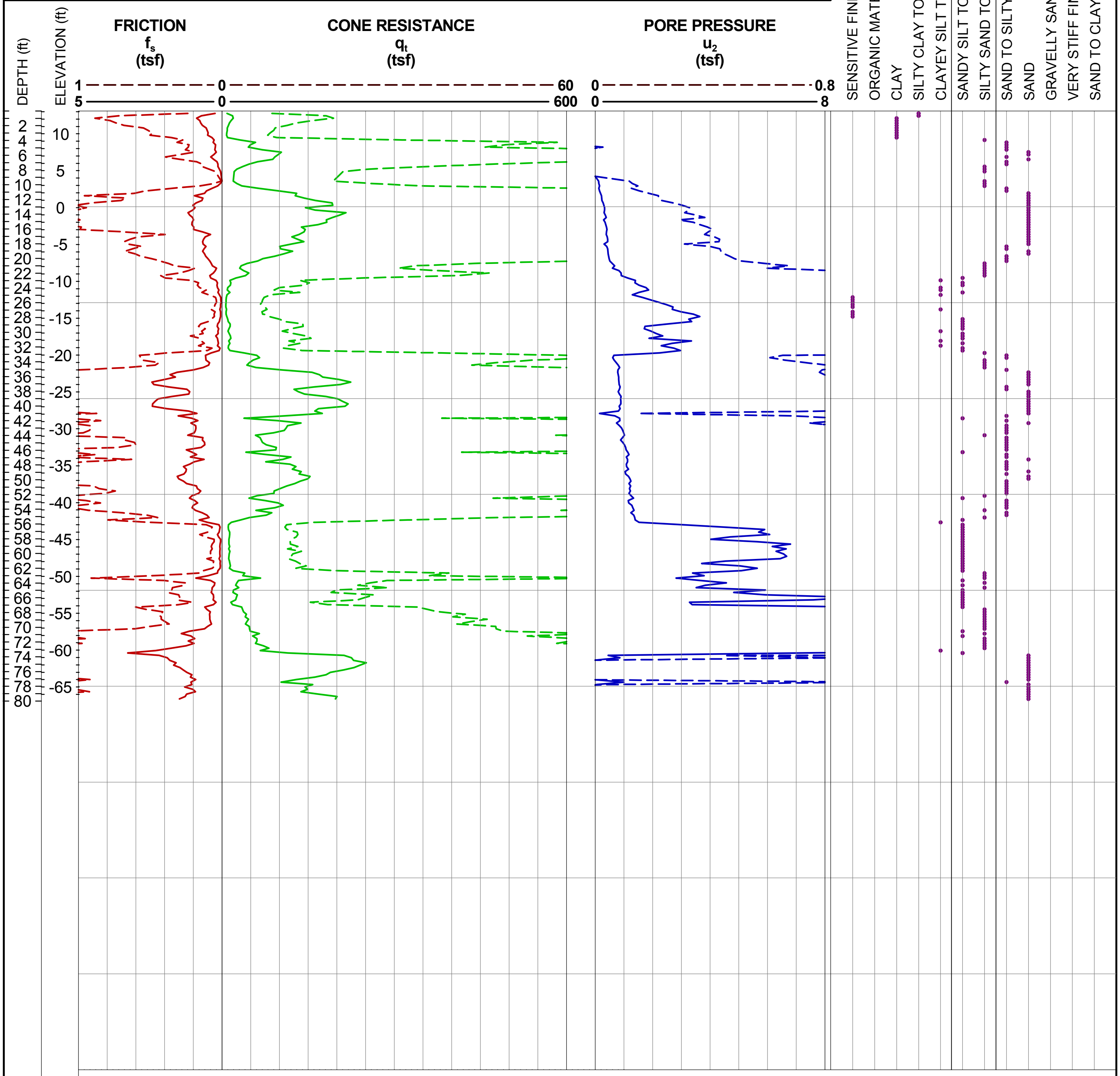
CONE SIZE: 10 sq. cm

CONE ID No.: DSG1031

DATE(S) DRILLED:
01/19/11 - 01/19/11

LOGGER: HDR

SOIL BEHAVIOR TYPE *



* Campanella and Robertson (1983) Friction Ratio correlation

REMARKS: REFERENCE BASELINE: C-D CONST.

PAGE 1 OF 1

CD-25

CPT_LOG:NEWTOWN CPT LOGS.GPJ:8.30.003:061810:1/27/13

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

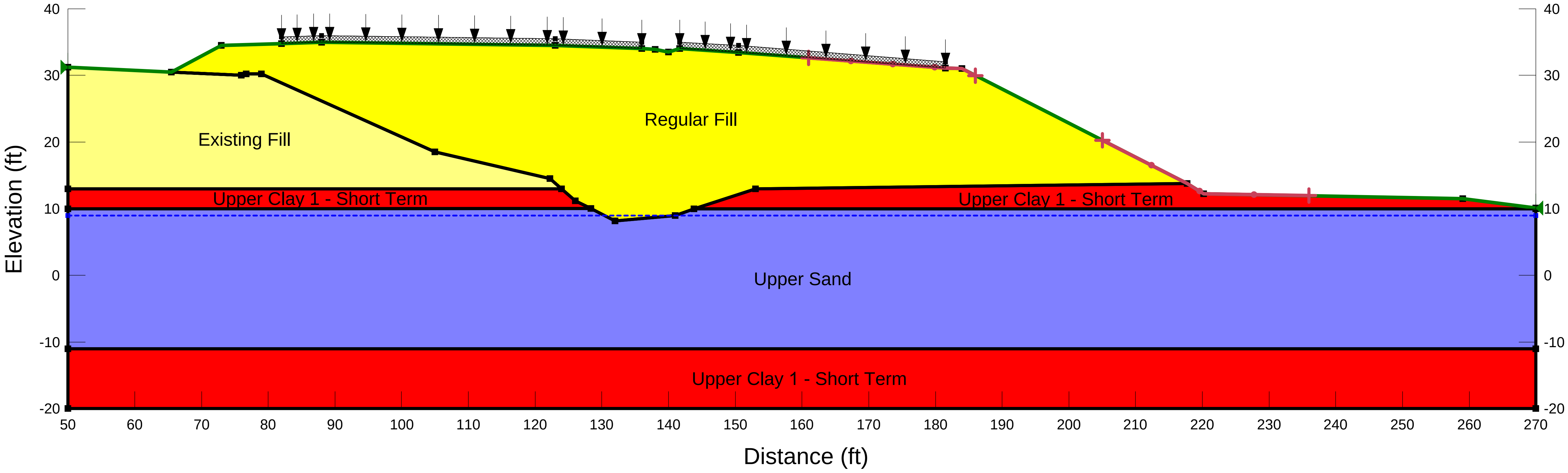
AECOM

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 61+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Traffic Surcharge (Unit Weight): 780 pcf



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

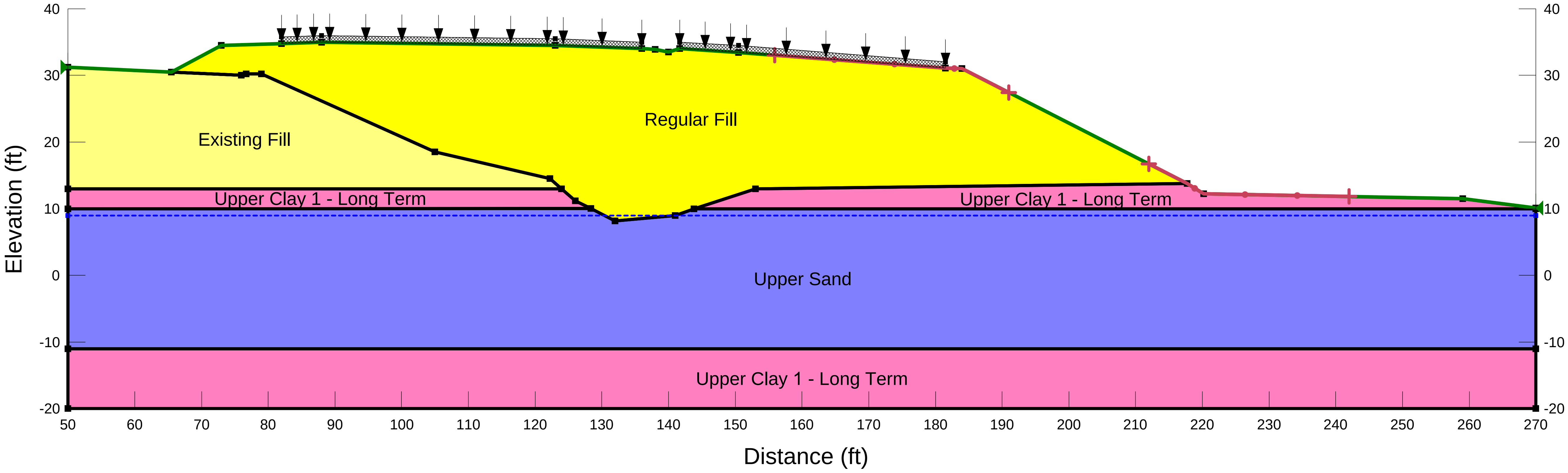
AECOM

Long Term Global Stability Analysis

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 0 psf	Phi: 30 °	Piezometric Line: 1
Name: Upper Clay 1 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 28 °	Piezometric Line: 1
Name: Upper Clay 2 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 28 °	Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 61+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9

Traffic Surcharge (Unit Weight): 300 pcf

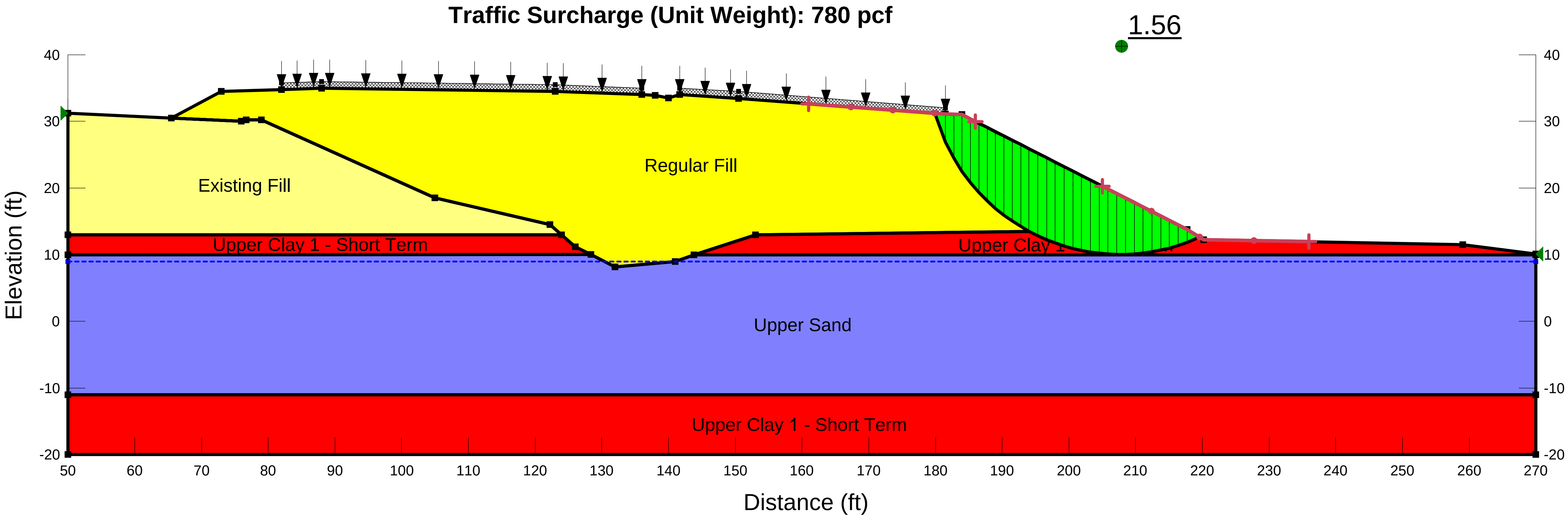


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 61+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 0 psf	Phi: 30 °	Piezometric Line: 1
Name: Upper Clay 1 - Short Term	Unit Weight: 112 pcf	Cohesion Spatial Fn: Upper Clay	Phi: 0 °	Piezometric Line: 1
Name: Upper Clay 2 - Short Term	Unit Weight: 112 pcf	Cohesion Spatial Fn: Upper Clay	Phi: 0 °	Piezometric Line: 1

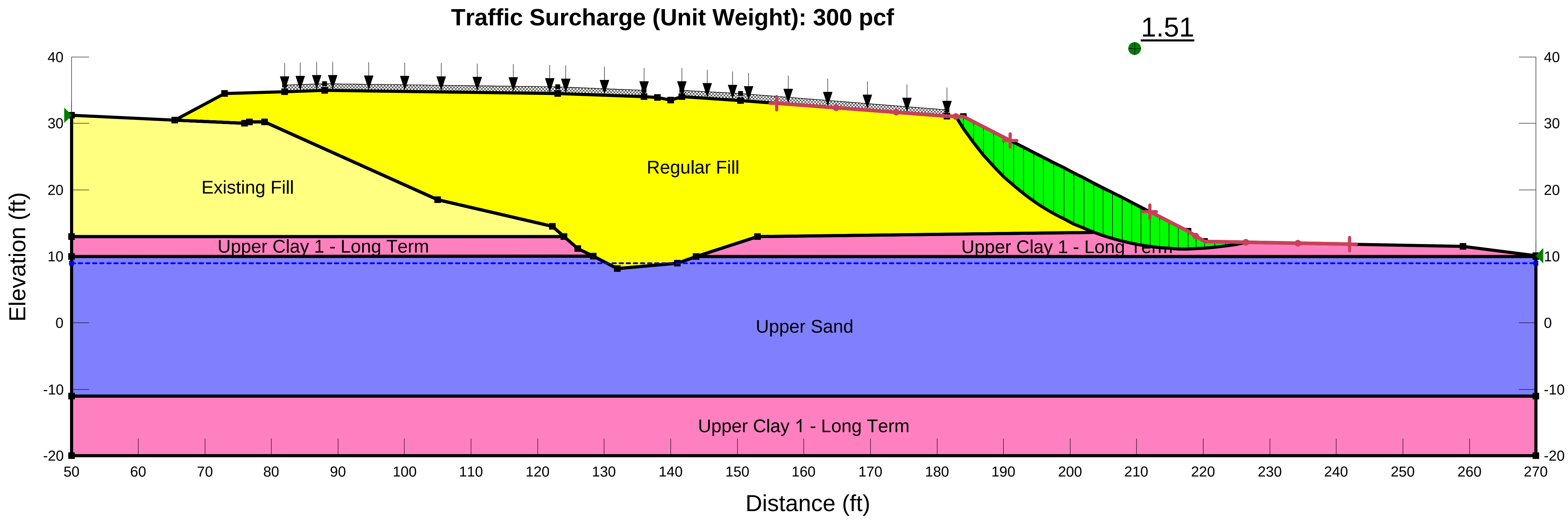


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 28 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 28 ° Piezometric Line: 1

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 61+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9

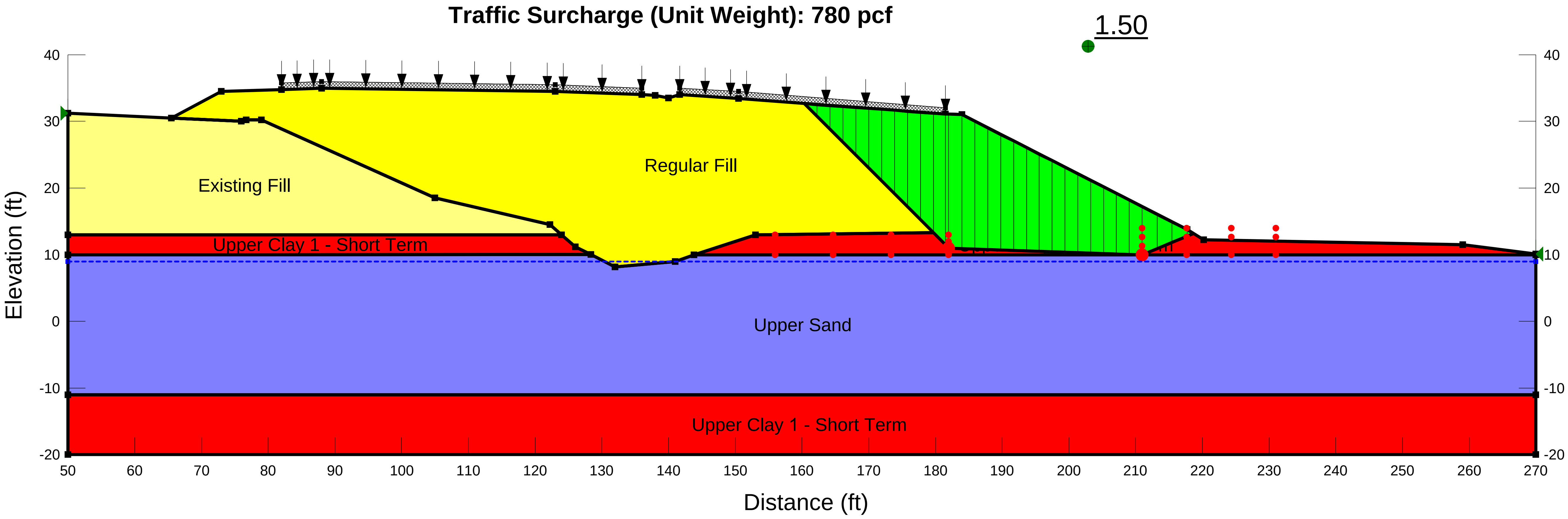


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 61+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9

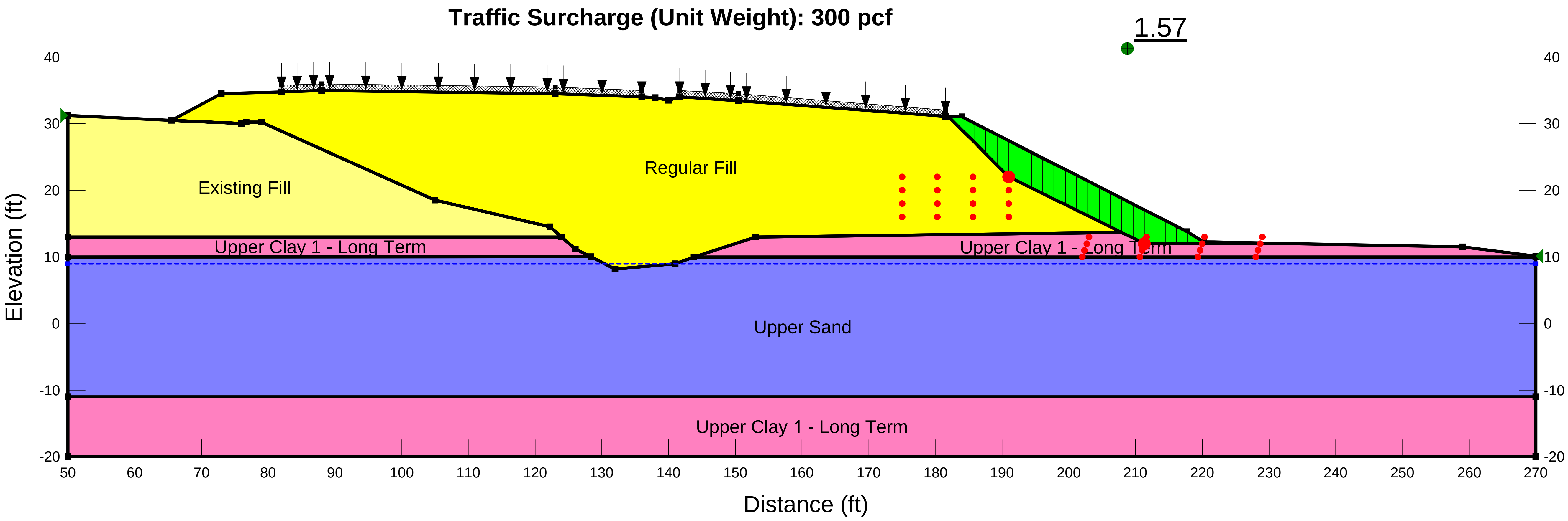


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

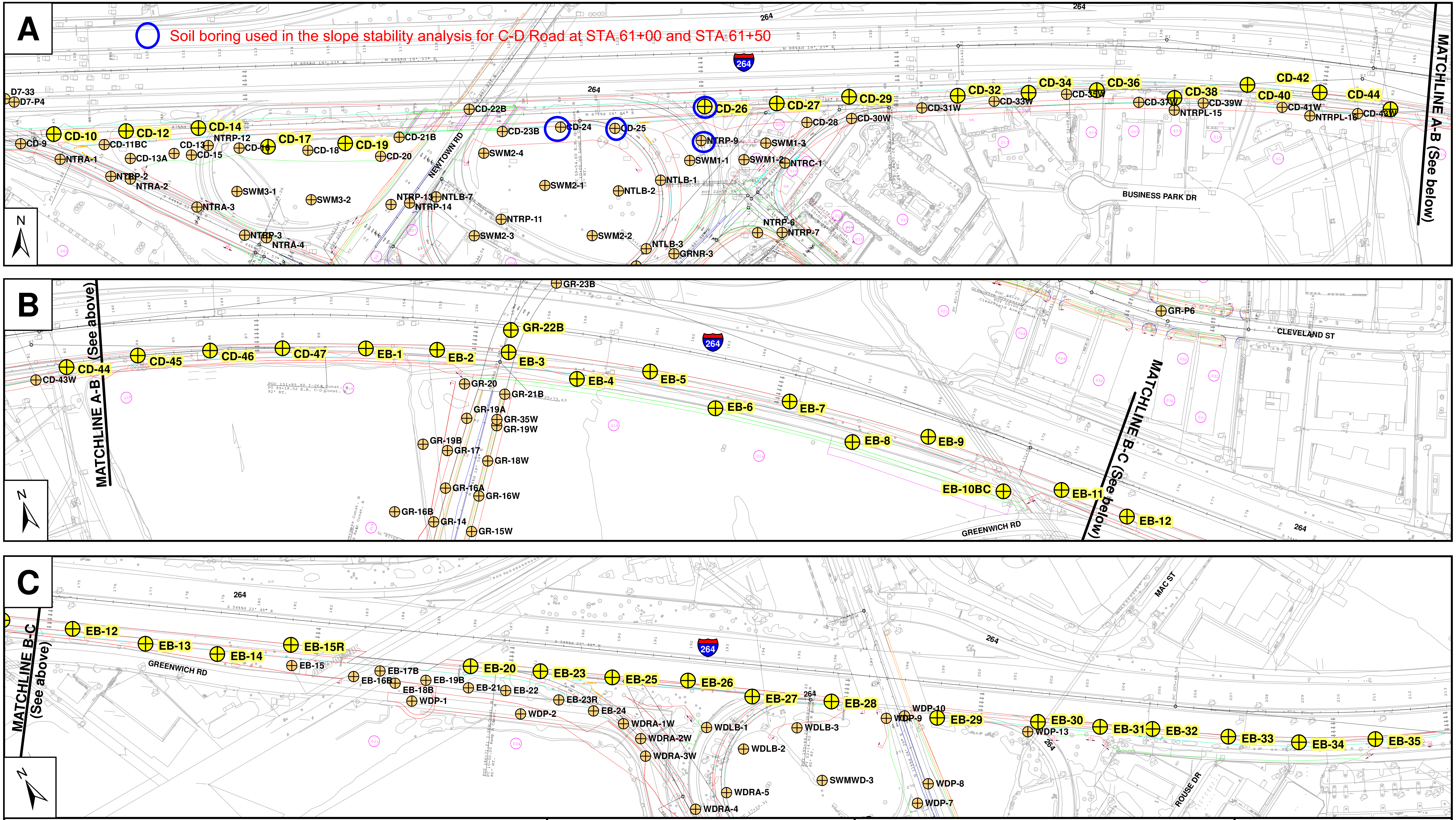
Long Term Global Stability Analysis

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 0 psf	Phi: 30 °	Piezometric Line: 1
Name: Upper Clay 1 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 28 °	Piezometric Line: 1
Name: Upper Clay 2 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 28 °	Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 61+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9



Slope Stability Analysis at
STATION 61+50



0 125 250 Feet

⊕	SPT Exploration Locations
⊕	Borings in other PSAs

Prepared by: HDR

Date: November 2011

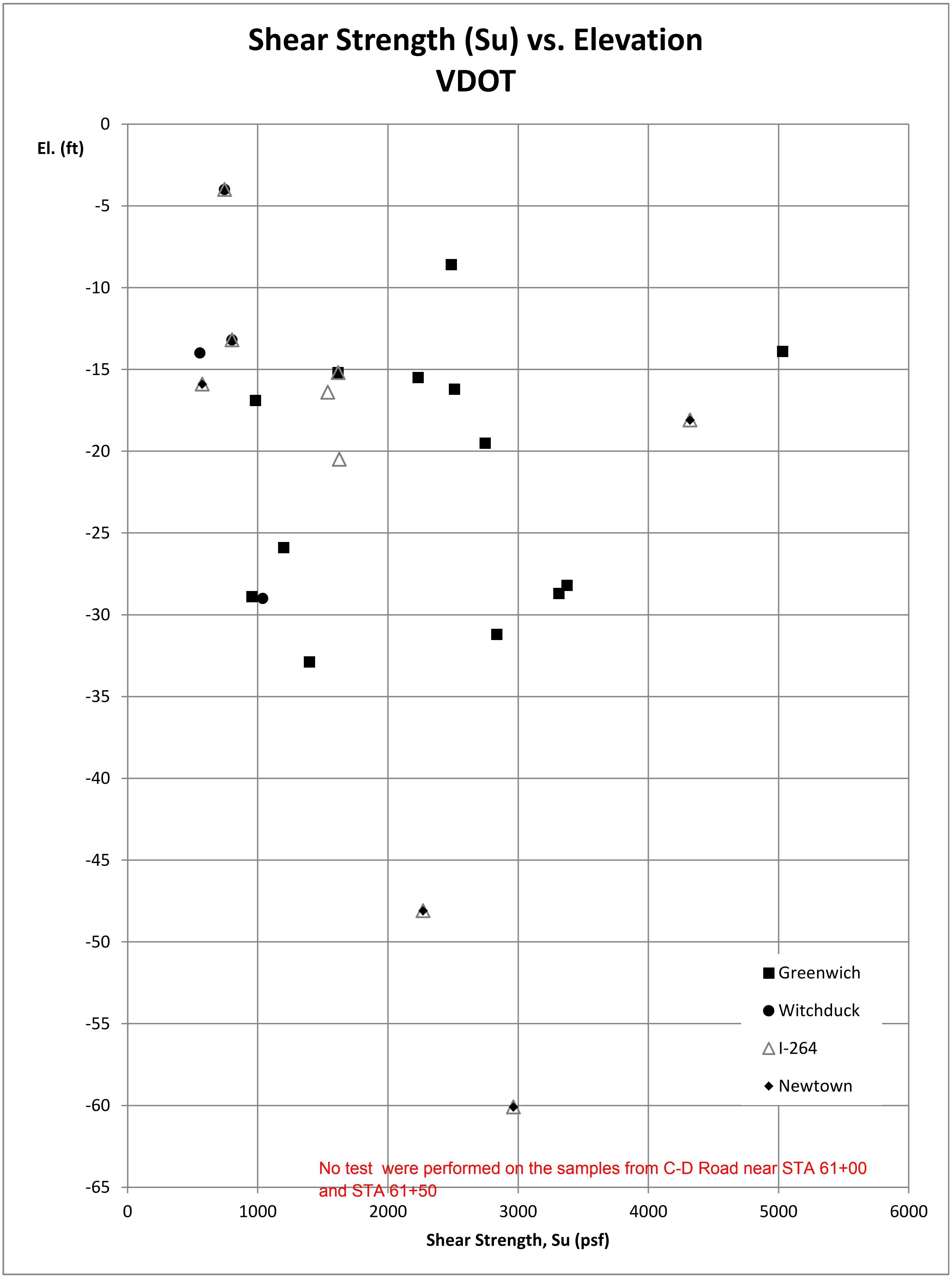
VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan



No test were performed on the samples from C-D Road near STA 61+00 and STA 61+50

CONE PENETROMETER TEST LOG

VDOT
Virginia Department of Transportation

PROJECT #: 0264-134-102
LOCATION: Va Beach: PSA Newtown

CD-25
PAGE 1 OF 1

STATION: 60+50
LATITUDE: 36.845383° N
SURFACE ELEVATION: 13.1
BENCHMARK LOCATION:

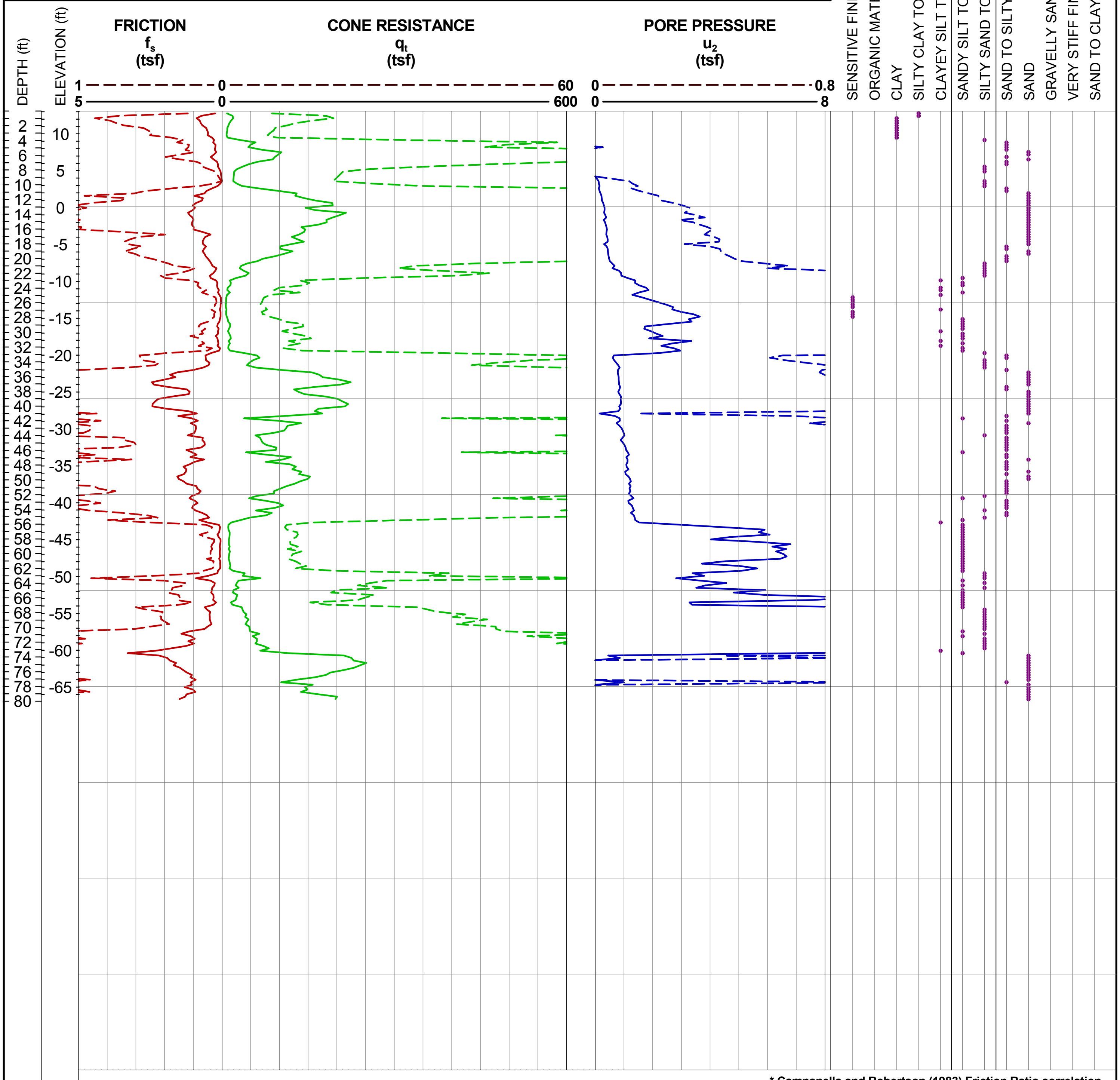
OFFSET: 50 ft RT
LONGITUDE: 76.182045° W
COORD. DATUM: NAD 83

DRILLER: Ron Stewart/MAD
CONE TYPE: Hogentogler Elec. Sub. Cone
CONE SIZE: 10 sq. cm
CONE ID No.: DSG1031

DATE(S) DRILLED:
01/19/11 - 01/19/11

LOGGER: HDR

SOIL BEHAVIOR TYPE*



* Campanella and Robertson (1983) Friction Ratio correlation

REMARKS: REFERENCE BASELINE: C-D CONST.

PAGE 1 OF 1

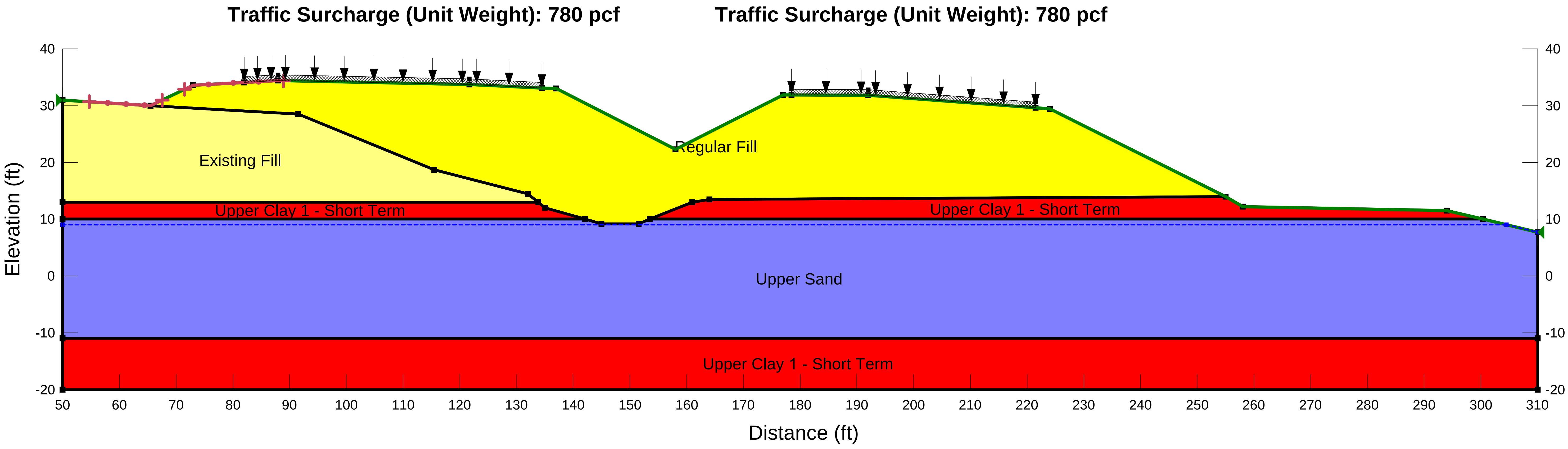
CD-25

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 61+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9



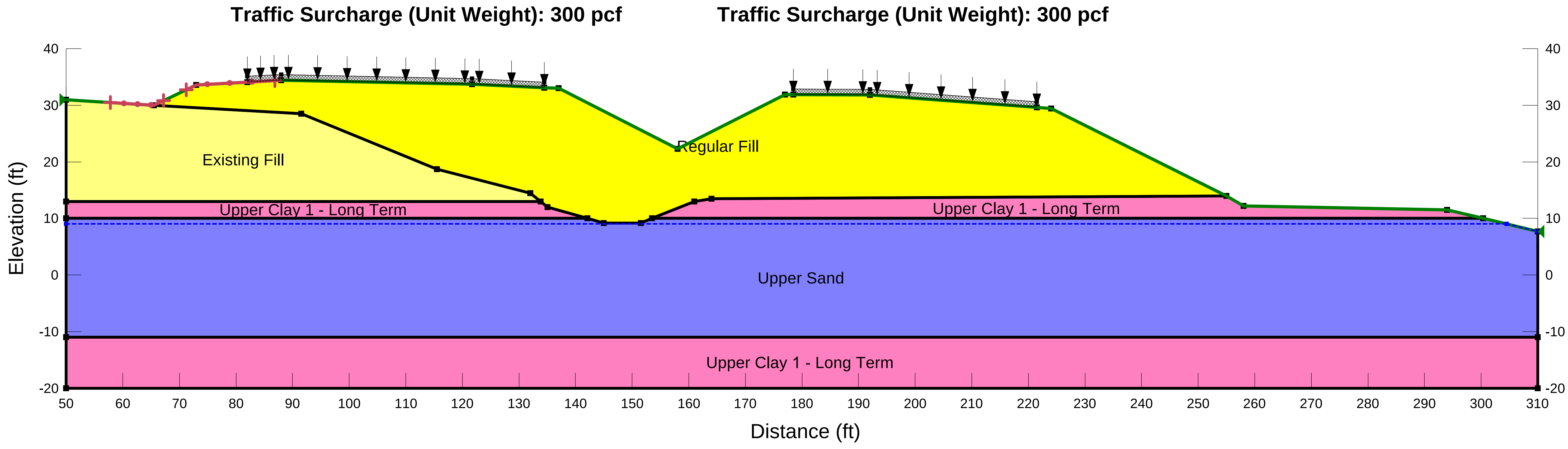
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

Name: Existing Fill   Unit Weight: 125 pcf   Cohesion: 50 psf   Phi: 32 °   Piezometric Line: 1
Name: Regular Fill   Unit Weight: 130 pcf   Cohesion: 50 psf   Phi: 34 °   Piezometric Line: 1
Name: Upper Sand   Unit Weight: 115 pcf   Cohesion: 0 psf   Phi: 30 °   Piezometric Line: 1
Name: Upper Clay 1 - Long Term   Unit Weight: 112 pcf   Cohesion: 0 psf   Phi: 23 °   Piezometric Line: 1
Name: Upper Clay 2 - Long Term   Unit Weight: 112 pcf   Cohesion: 0 psf   Phi: 23 °   Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 61+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9



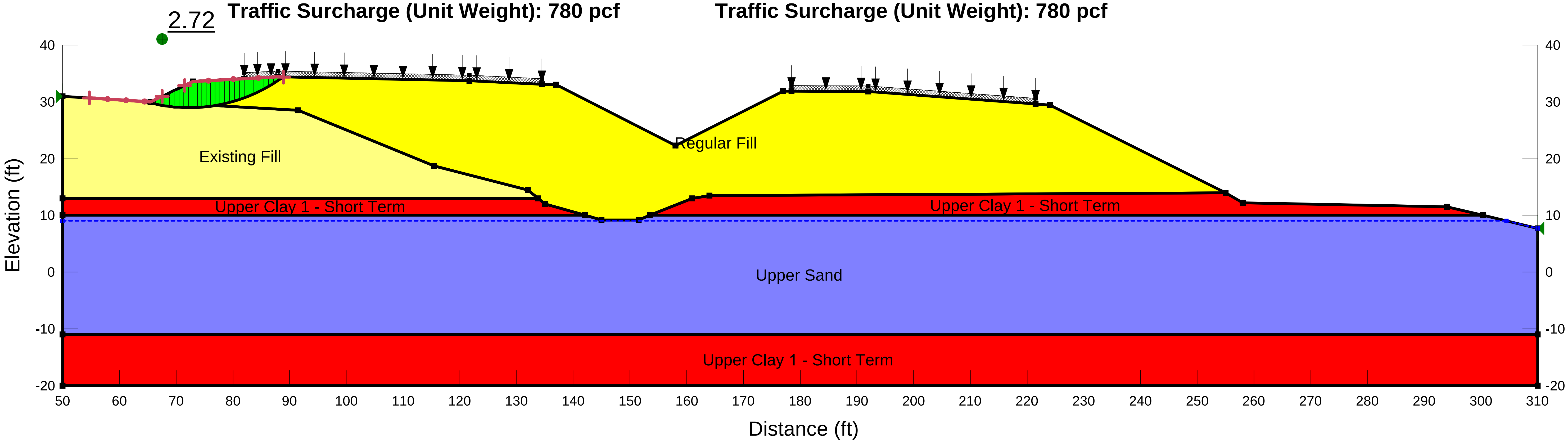
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 61+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9

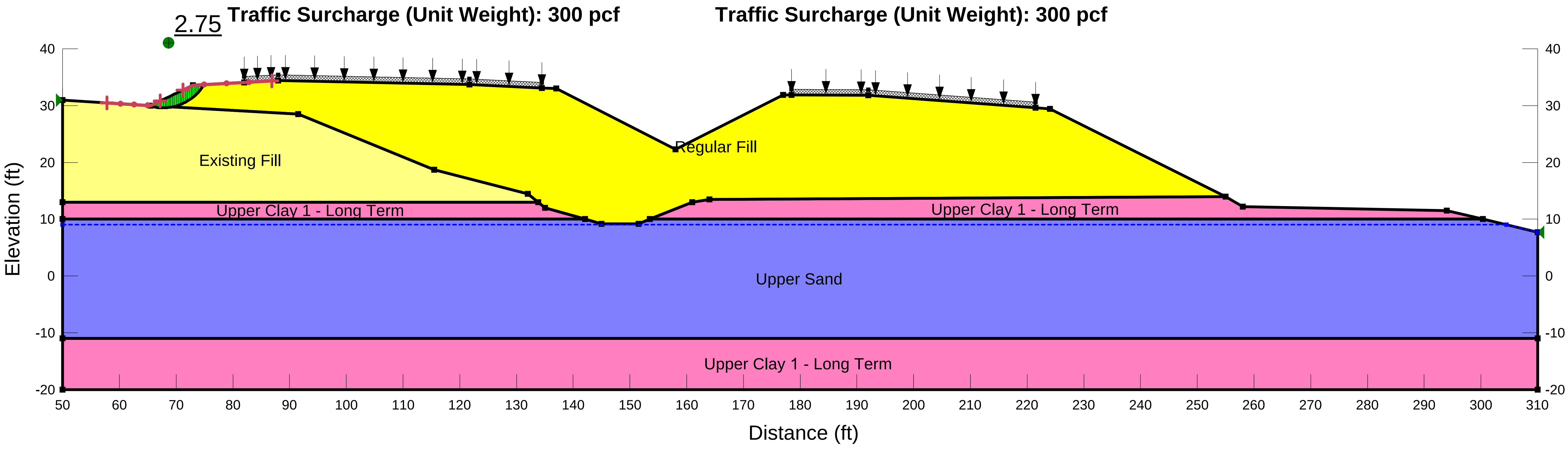


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 0 psf	Phi: 30 °	Piezometric Line: 1
Name: Upper Clay 1 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1
Name: Upper Clay 2 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 61+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9

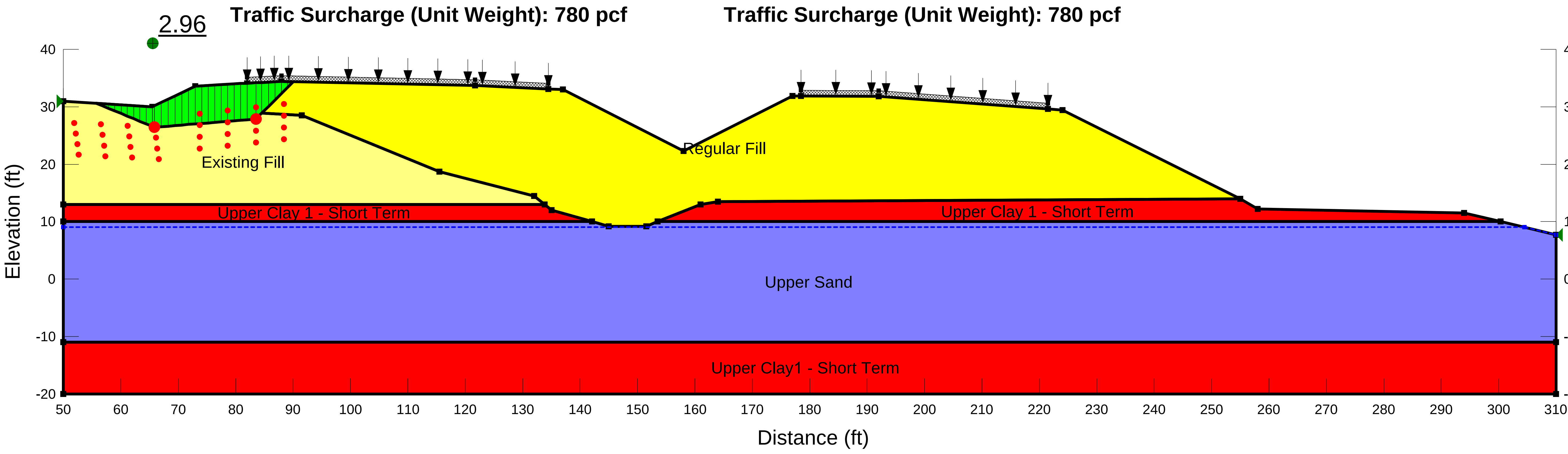


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 61+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9



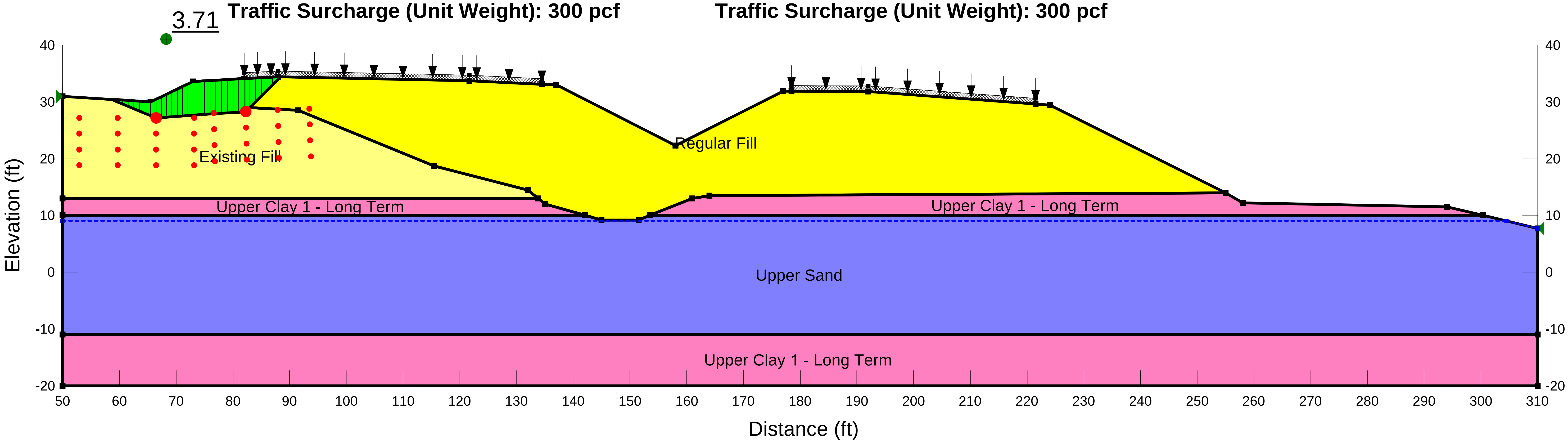
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 61+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9

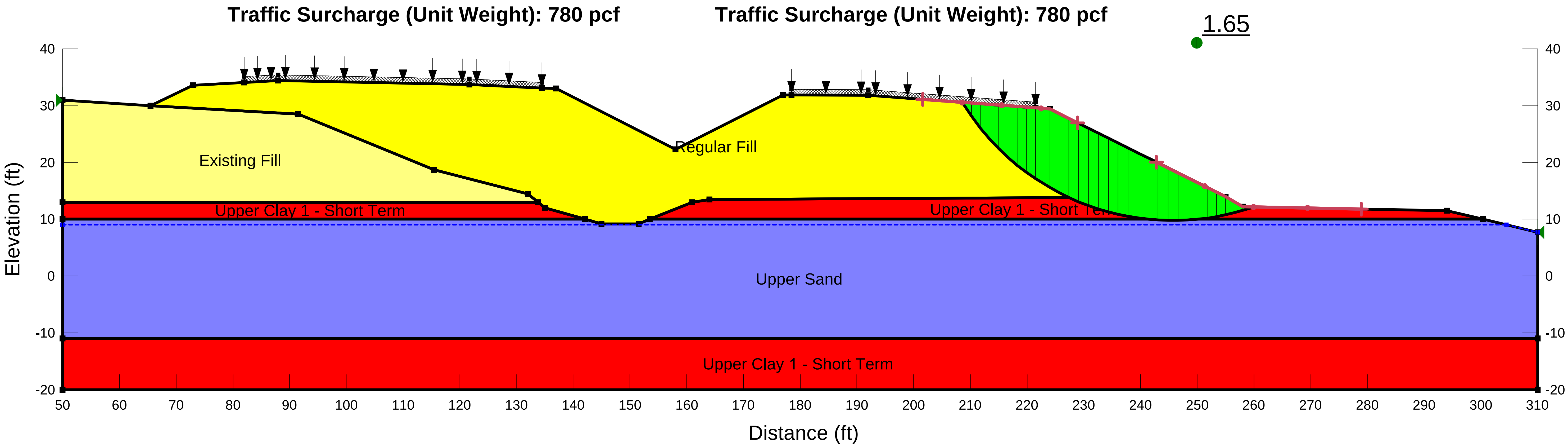


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 61+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9

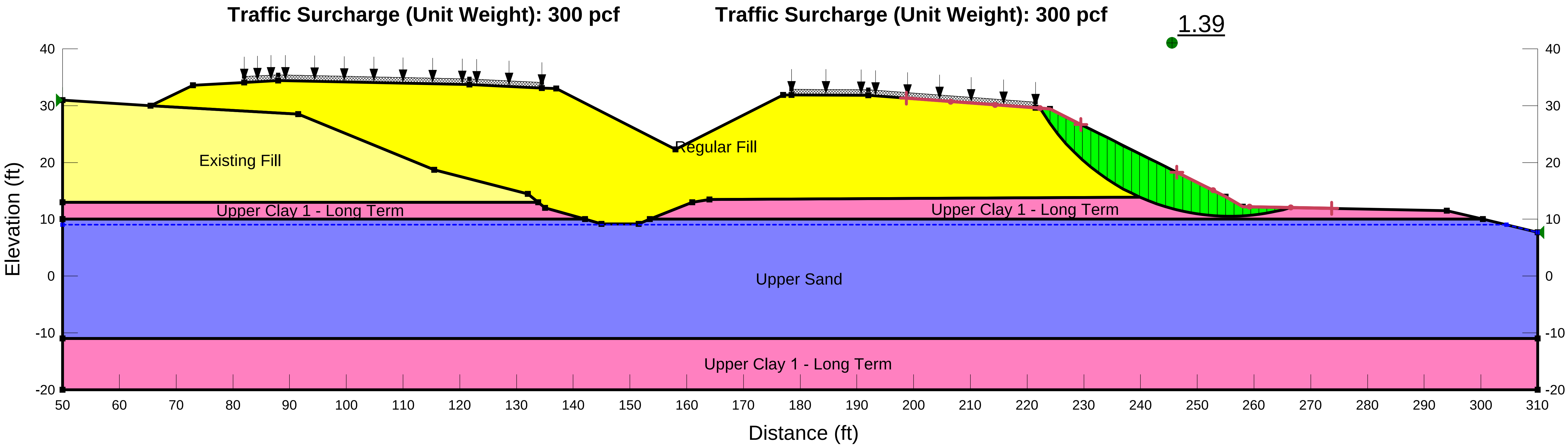


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 61+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
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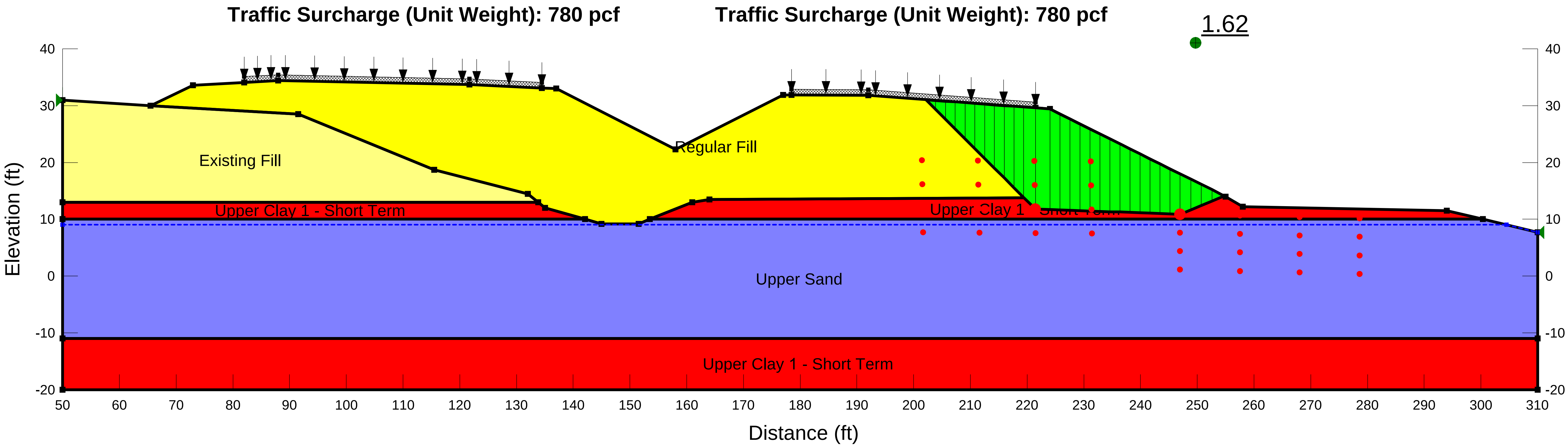
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 61+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

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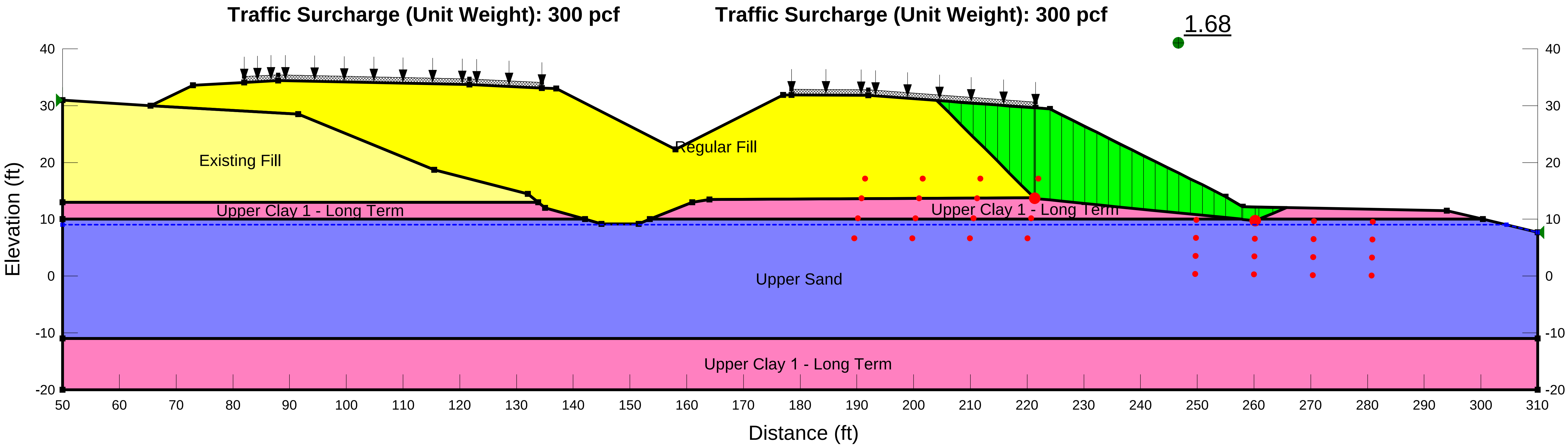
I-264 C-D Road
Analysis Location: Sta. 61+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

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I-264 C-D Road
Analysis Location: Sta. 61+50
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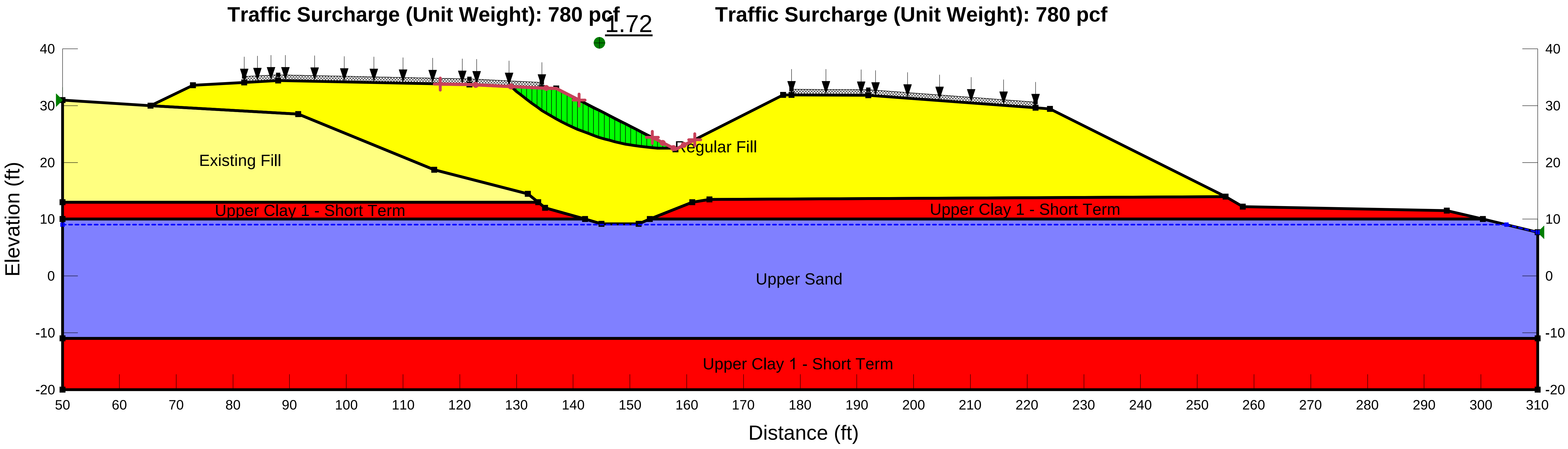

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

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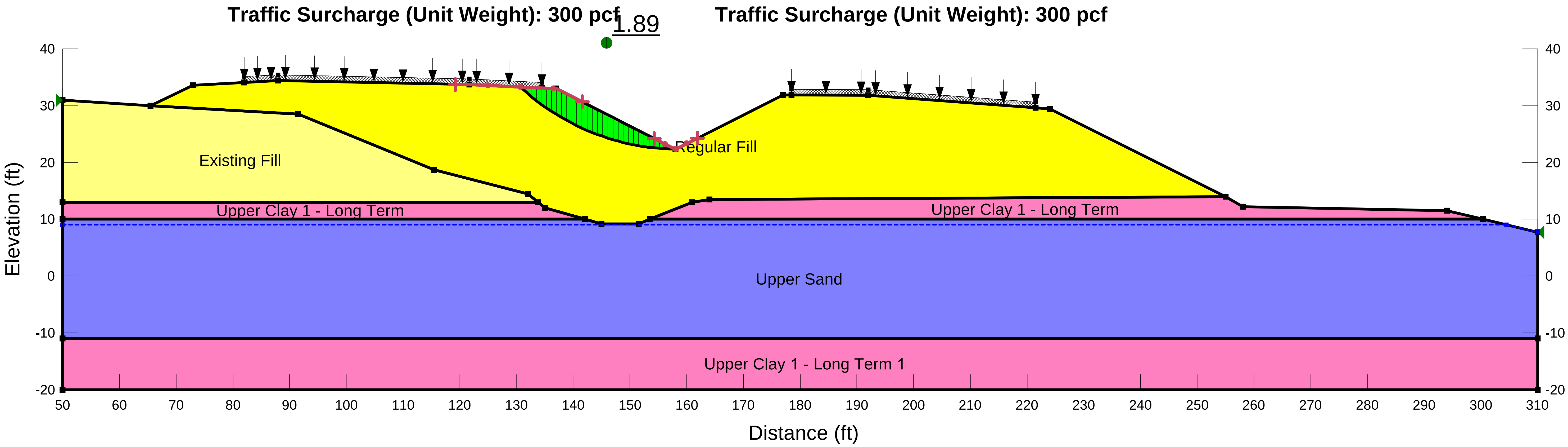
Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 61+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

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Short Term Global Stability Analysis

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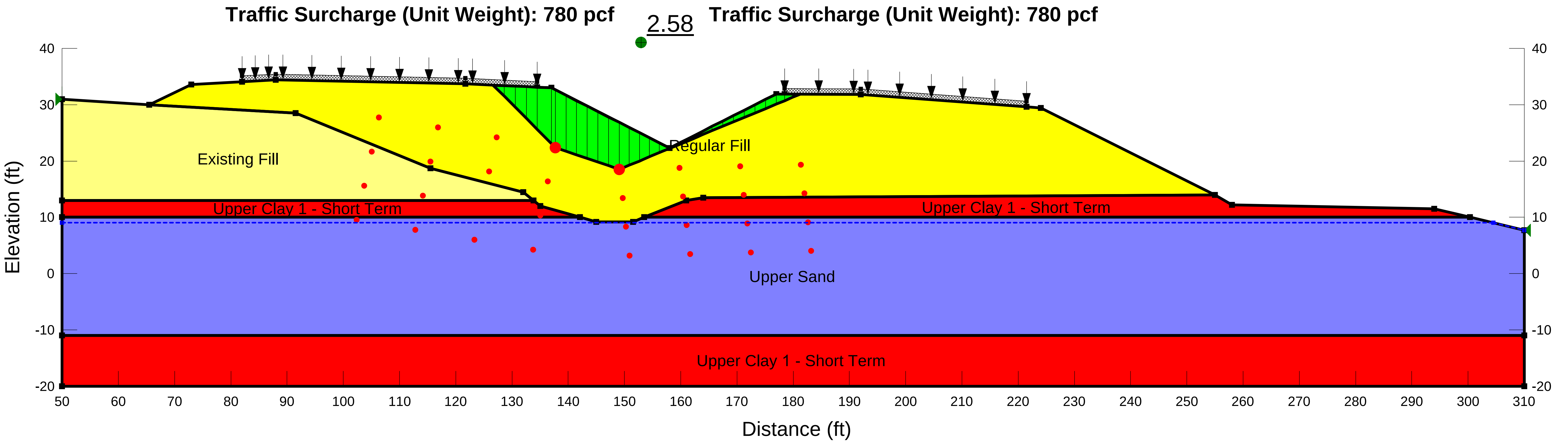

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Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

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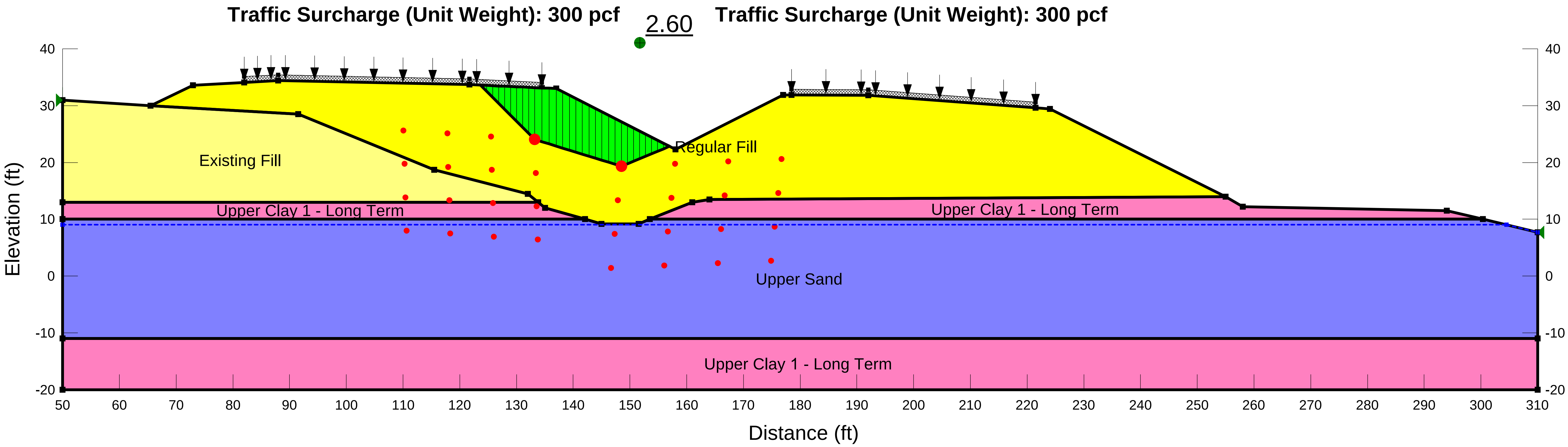
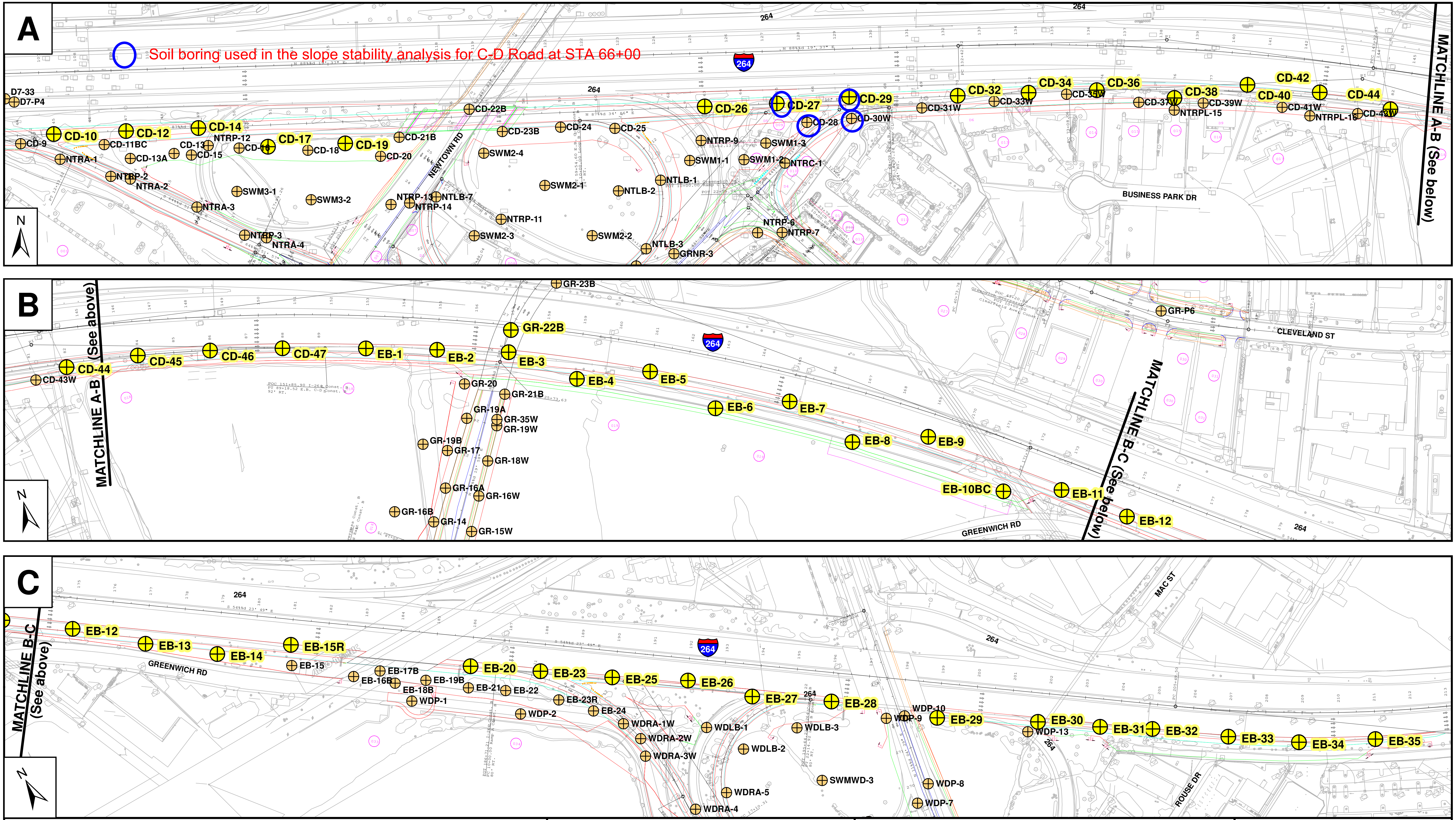
I-264 C-D Road
Analysis Location: Sta. 61+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-24, CD-25, CD-26, NTRP-9



Slope Stability Analysis at
STATION 66+00



Soil boring used in the slope stability analysis for C-D Road at STA 66+00

0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

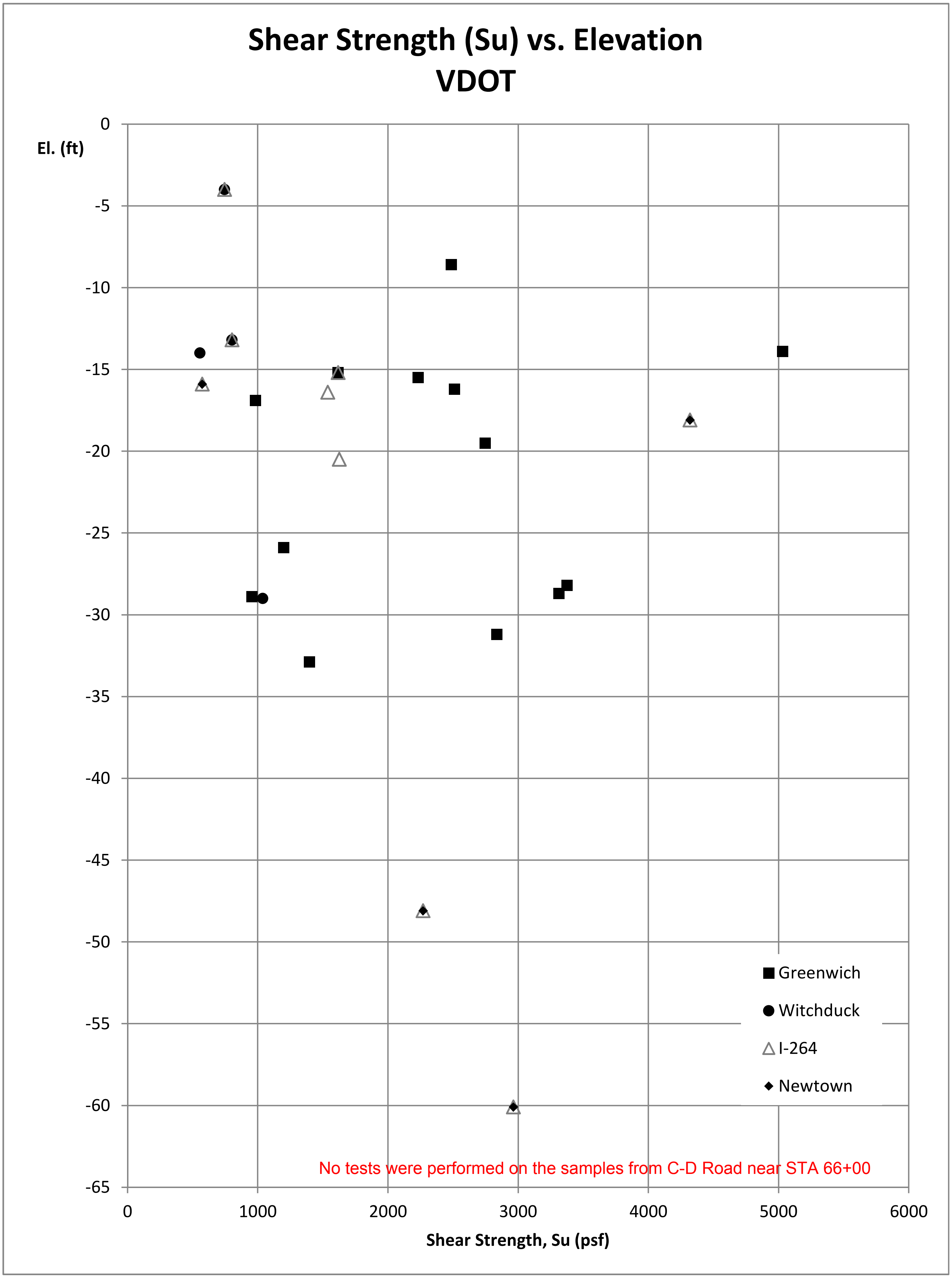
VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan


Shear Strength (Su) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
1000
2000
3000
4000
5000
6000
Shear Strength, Su (psf)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown
No tests were performed on the samples from C-D Road near STA 66+00

CONE PENETROMETER TEST LOG

Virginia Department of Transportation

PROJECT #: 0264-134-102

LOCATION: Va Beach: PSA Newtown

CD-30W

PAGE 1 OF 1

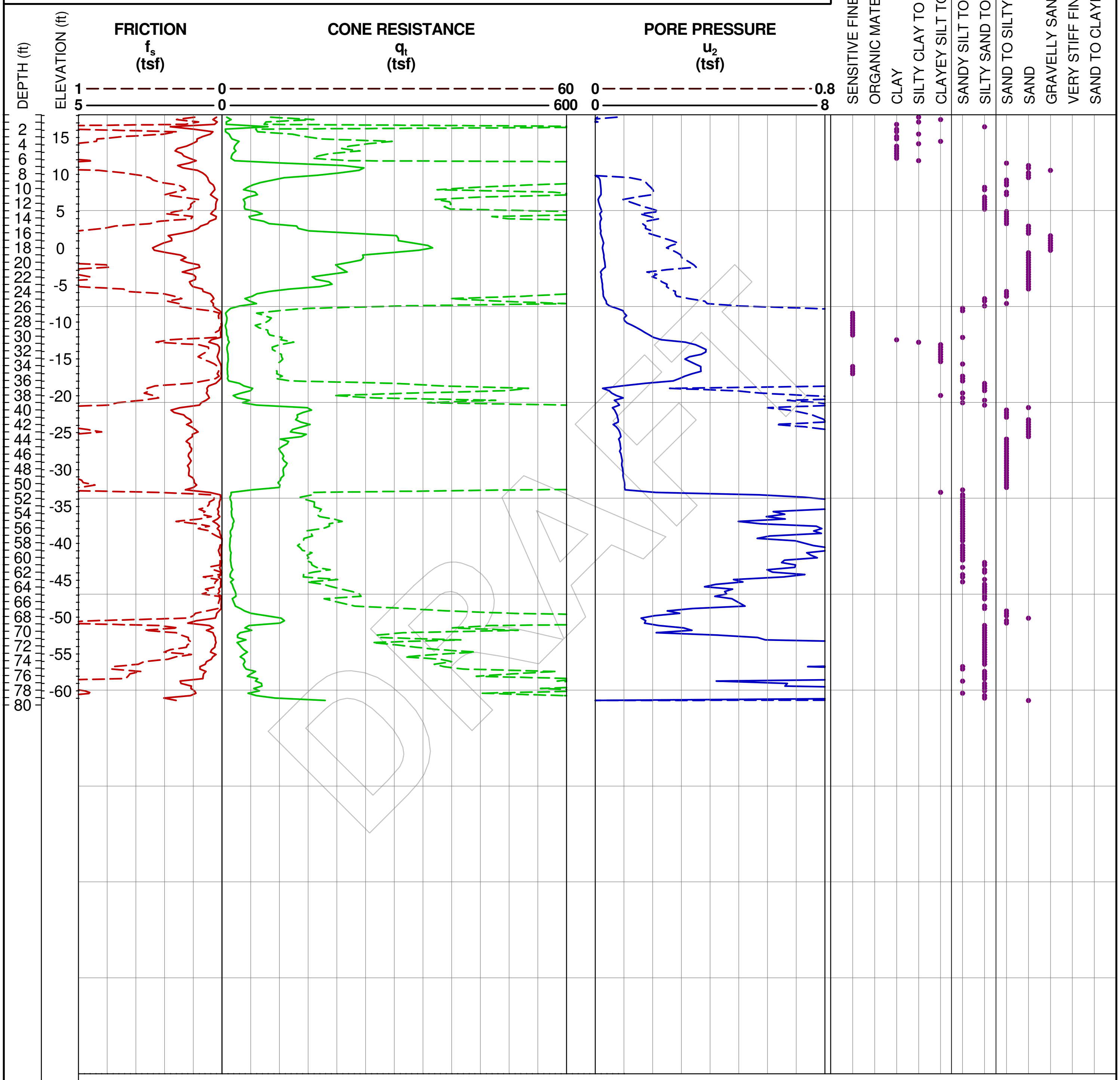
STATION: 67+05
OFFSET: 50 ft RT
LATITUDE: 36.845414° N
LONGITUDE: 76.179810° W
SURFACE ELEVATION: 18.1
COORD. DATUM: NAD 83
BENCHMARK LOCATION:

DRILLER: Ron Stewart/MAD
CONE TYPE: Hogentogler Elec. Sub. Cone
CONE SIZE: 10 sq. cm
CONE ID No.: DSG1031

DATE(S) DRILLED:
01/18/11 - 01/18/11

LOGGER: HDR

SOIL BEHAVIOR TYPE *



* Campanella and Robertson (1983) Friction Ratio correlation

REMARKS:
REFERENCE BASELINE: C-D CONST.

PAGE 1 OF 1

CD-30W

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
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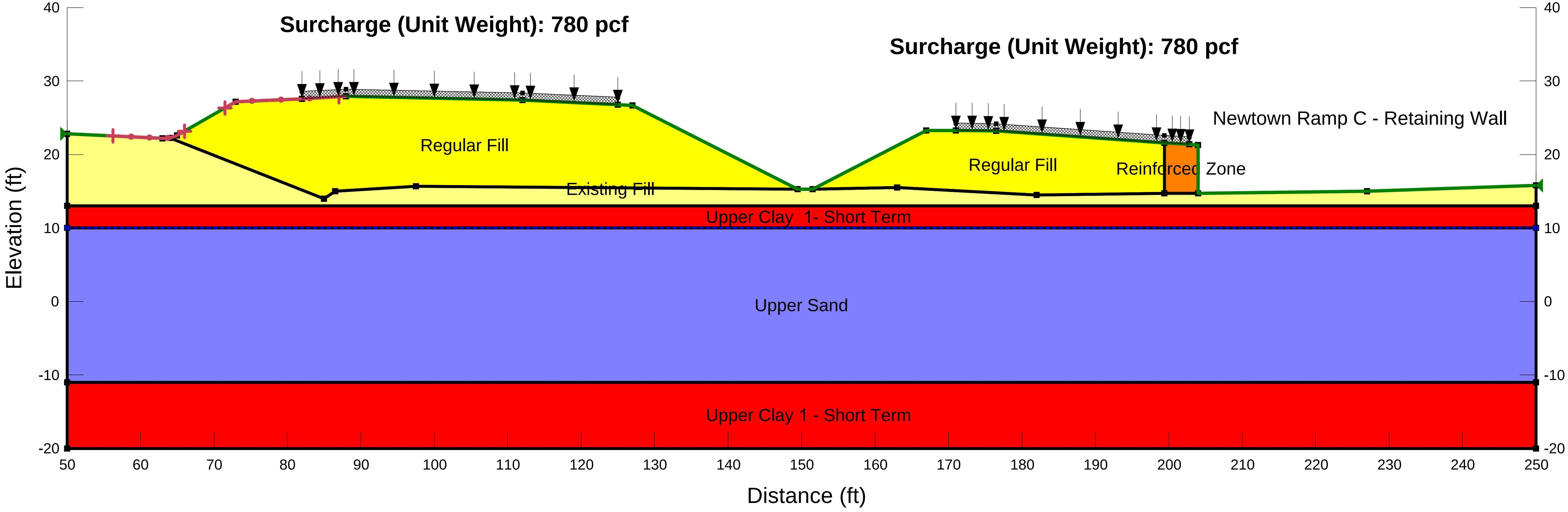
Name: Upper Clay - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Reinforced Zone Unit Weight: 110 pcf Cohesion: 10000 psf Phi: 34 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 66+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-27, CD-28, CD-29, CD-30W (CPT)



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

Name: Existing Fill   Unit Weight: 125 pcf   Cohesion: 50 psf   Phi: 32 °   Piezometric Line: 1
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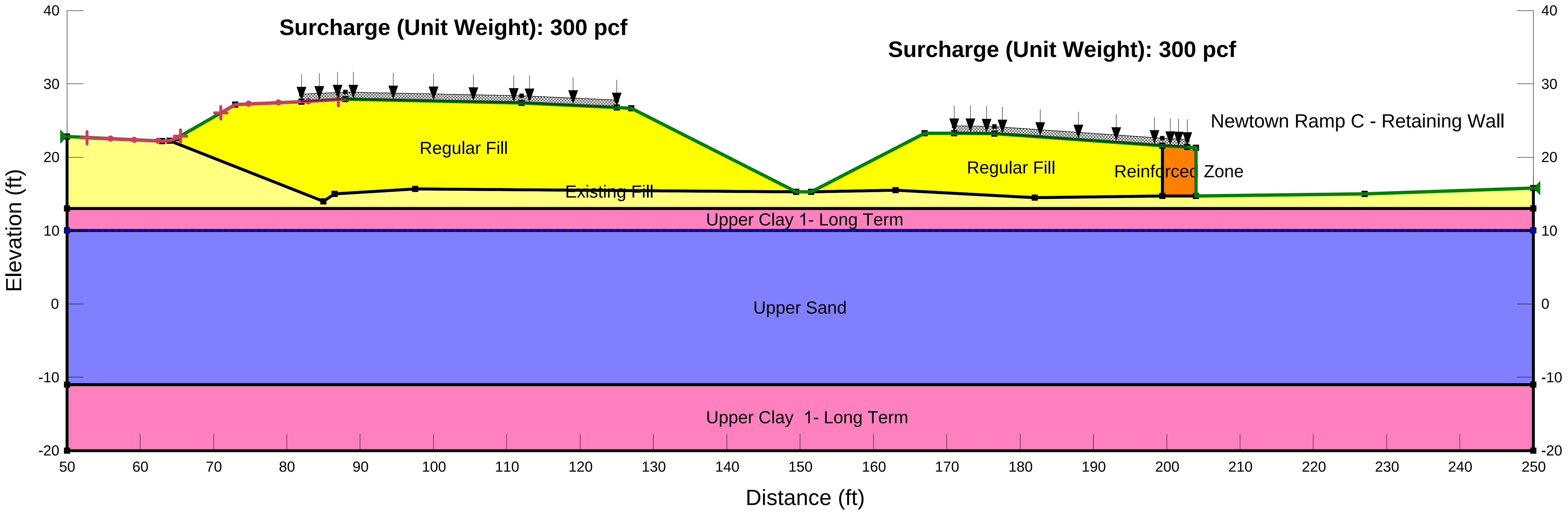
Name: Upper Clay - Long Term   Unit Weight: 112 pcf   Cohesion: 0 psf   Phi: 23 °   Piezometric Line: 1
Name: Reinforced Zone   Unit Weight: 110 pcf   Cohesion: 10000 psf   Phi: 34 °   Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 66+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-27, CD-28, CD-29, CD-30W (CPT)



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Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

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Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 66+00
GER Used for Soil Parameters: PSA I264 CD
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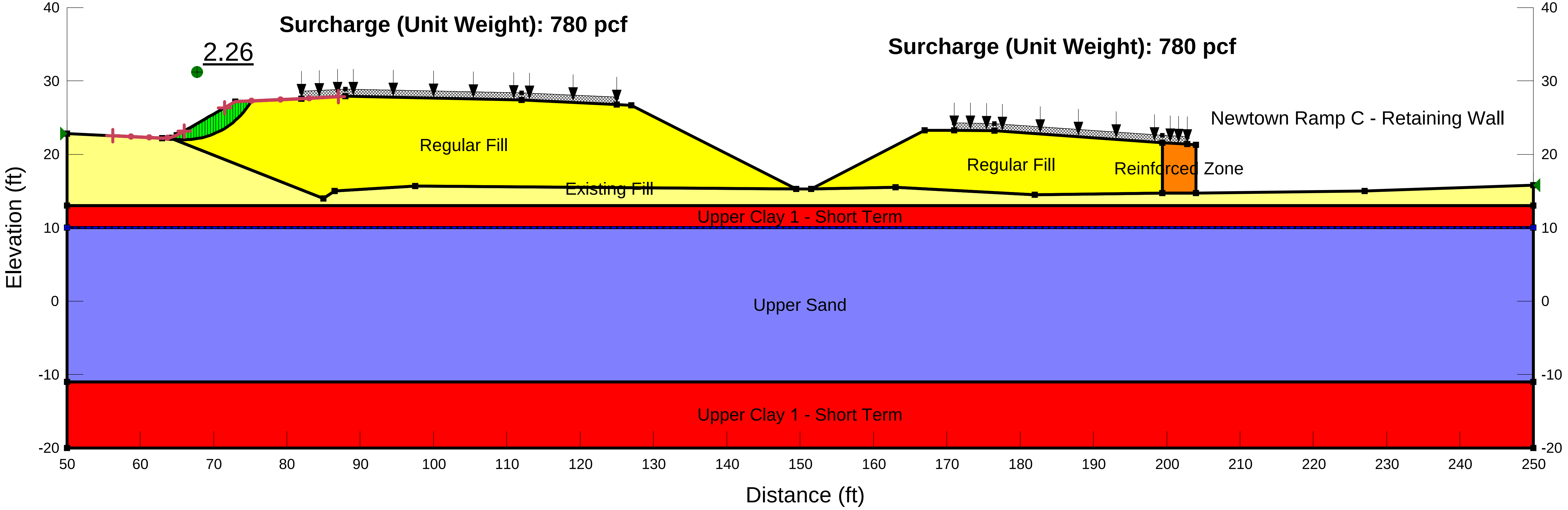

Project: I-264 Witchduck Roadway Improvements
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Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 66+00
GER Used for Soil Parameters: PSA I264 CD
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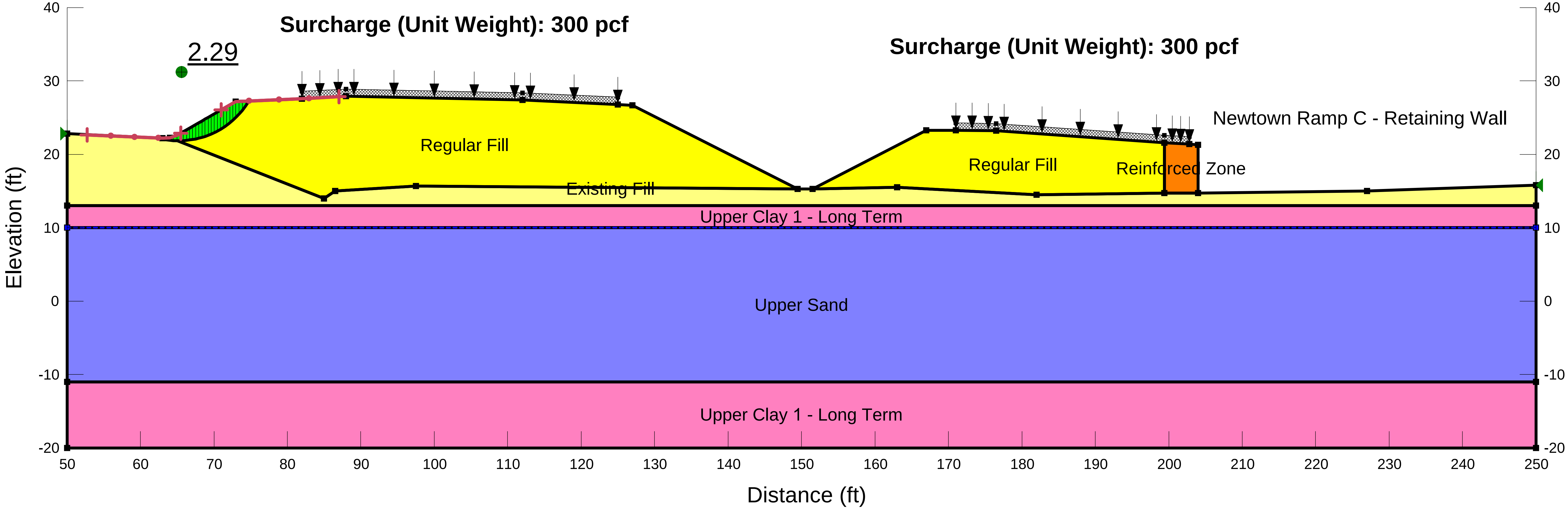

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Short Term Global Stability Analysis

I-264 C-D Road
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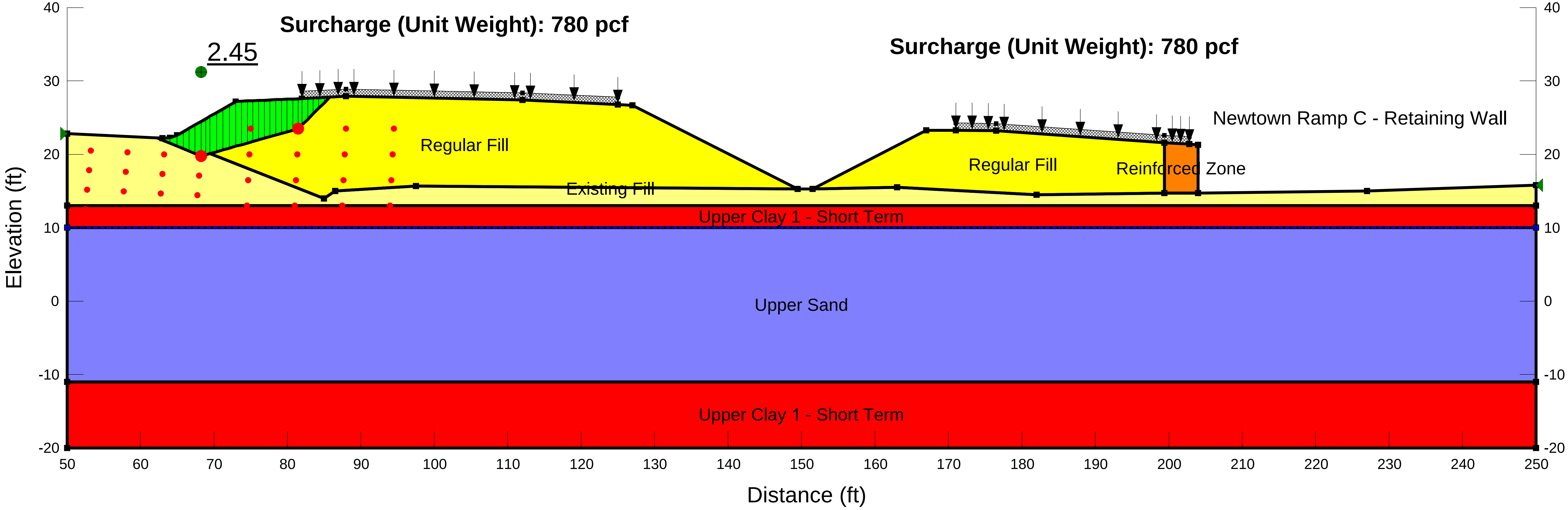

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Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 66+00
GER Used for Soil Parameters: PSA I264 CD
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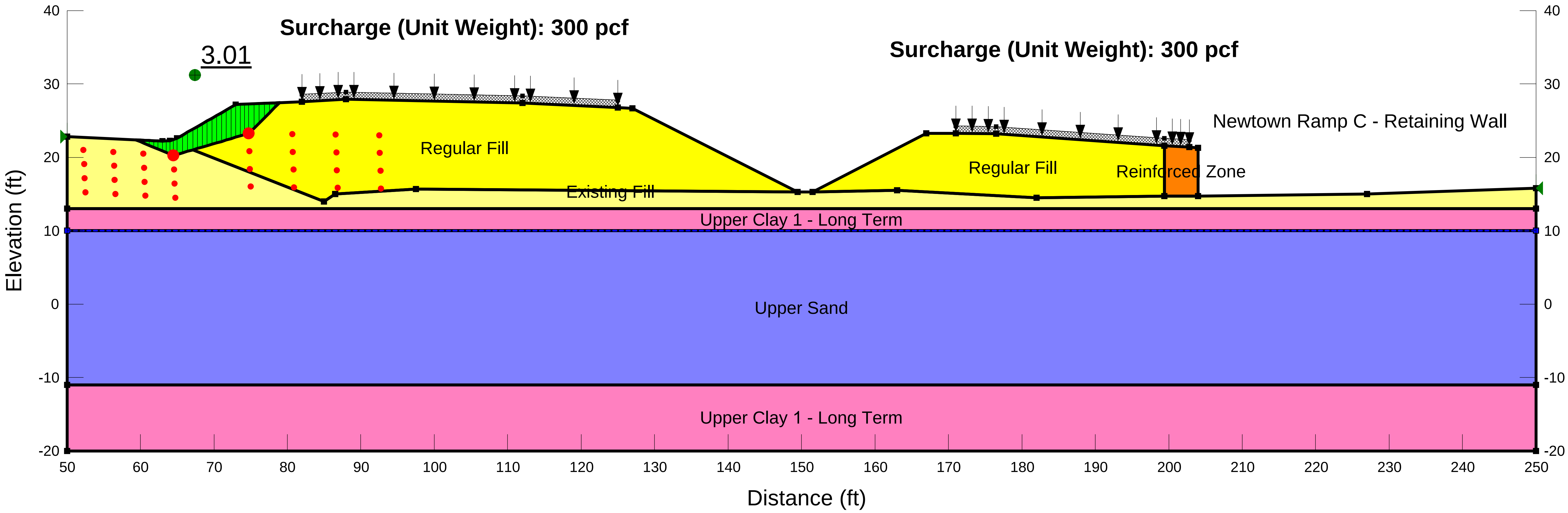

Project: I-264 Witchduck Roadway Improvements
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Analysis Type: Slope Stability
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AECOM

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Short Term Global Stability Analysis

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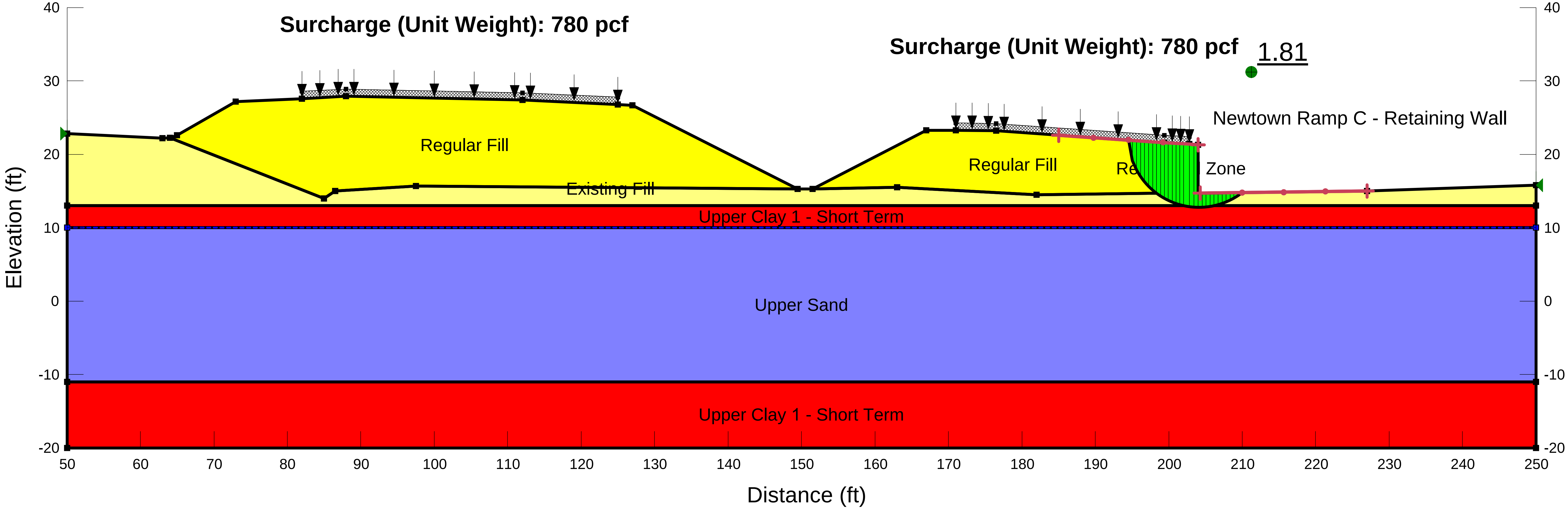

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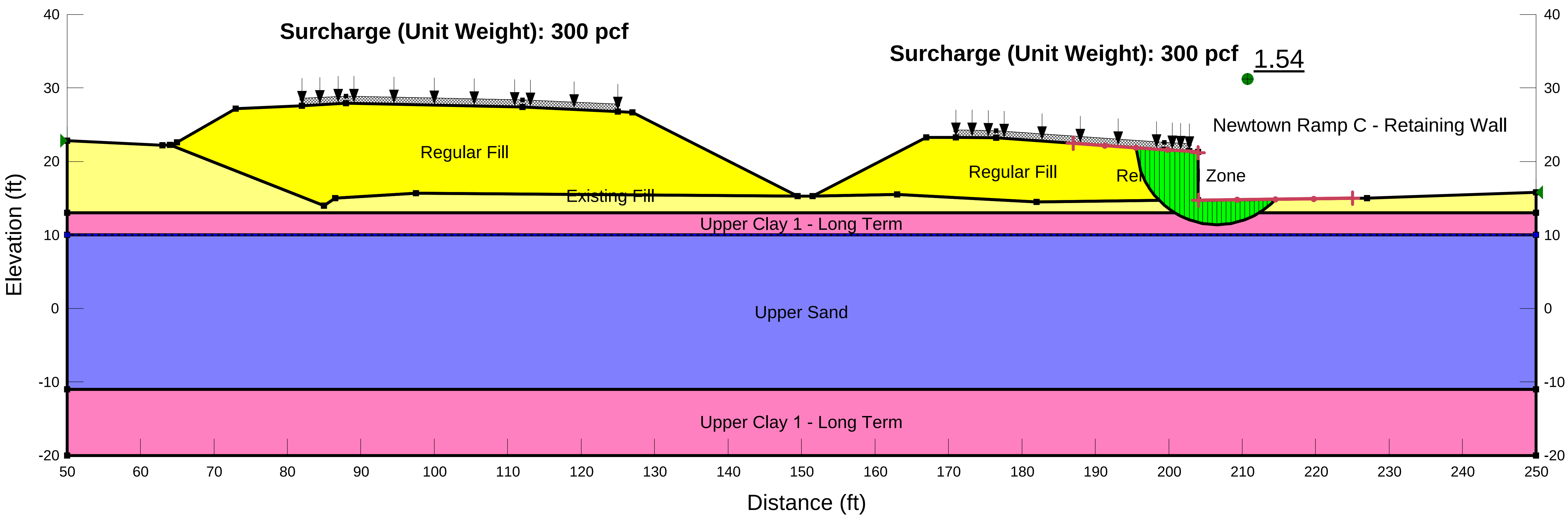

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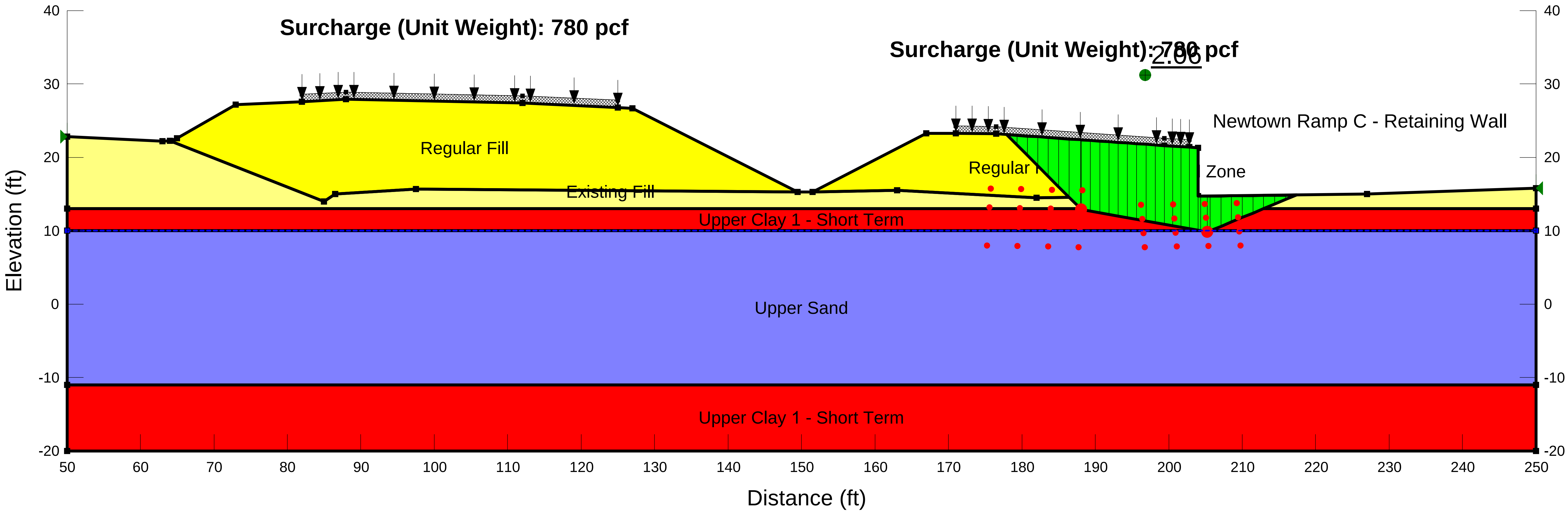

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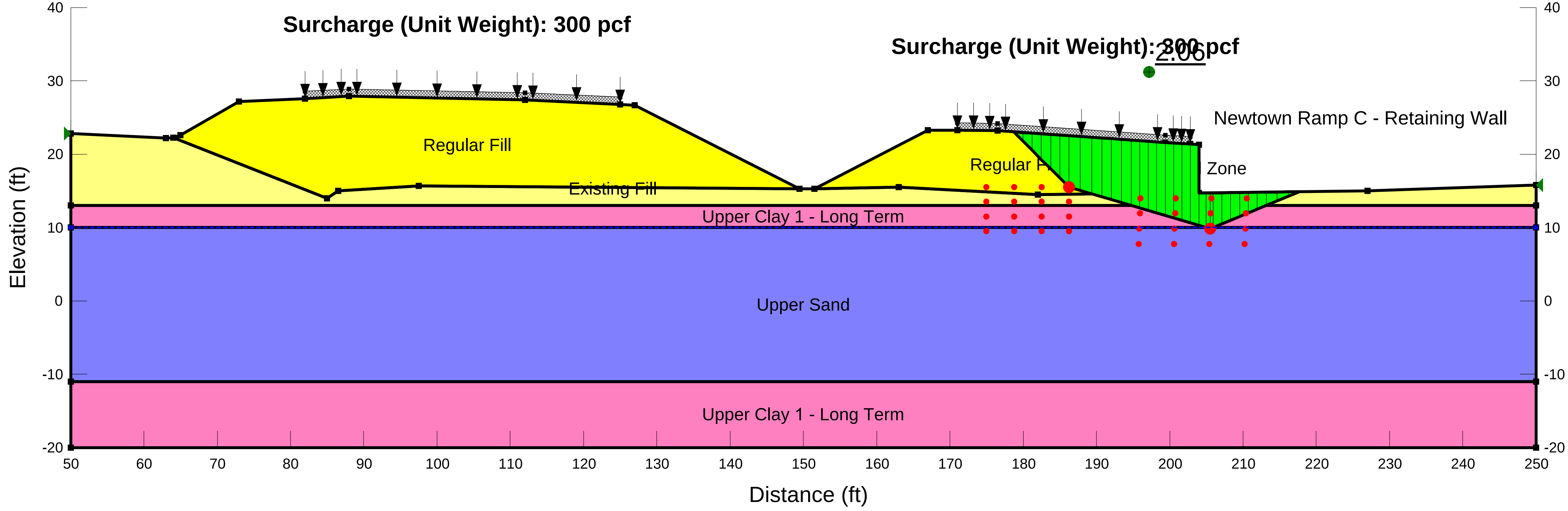

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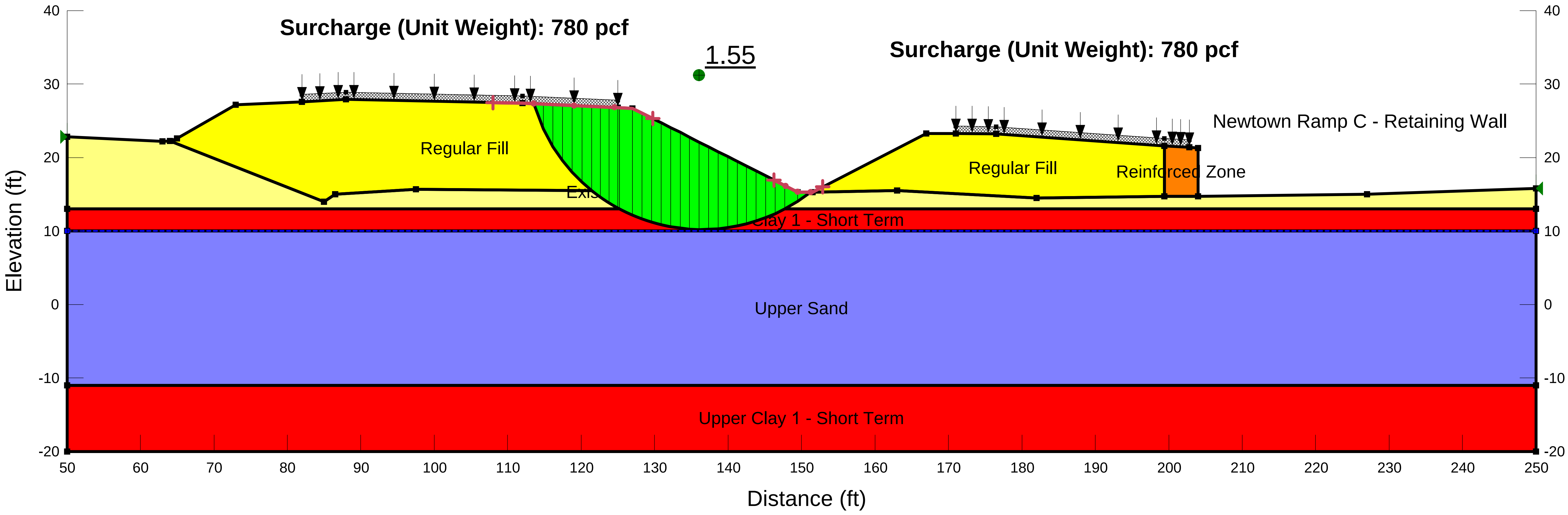
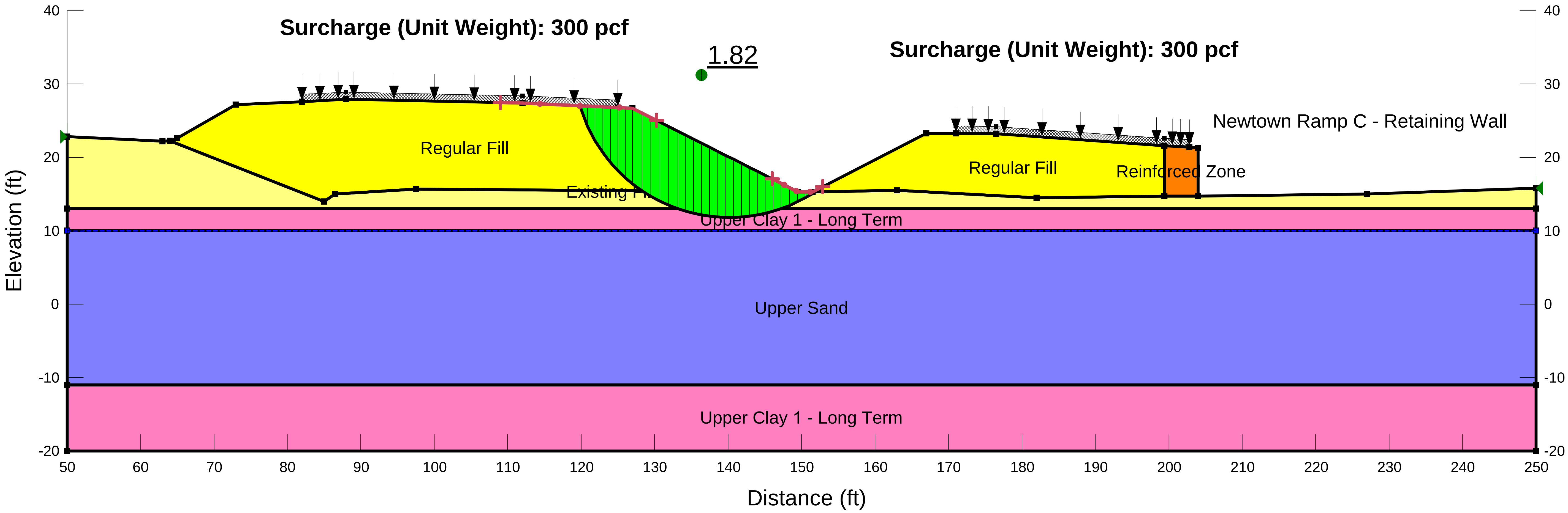


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 0 psf	Phi: 30 °	Piezometric Line: 1
Name: Upper Clay 1 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1
Name: Reinforced Zone	Unit Weight: 110 pcf	Cohesion: 10000 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Clay 2 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 66+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-27, CD-28, CD-29, CD-30W (CPT)



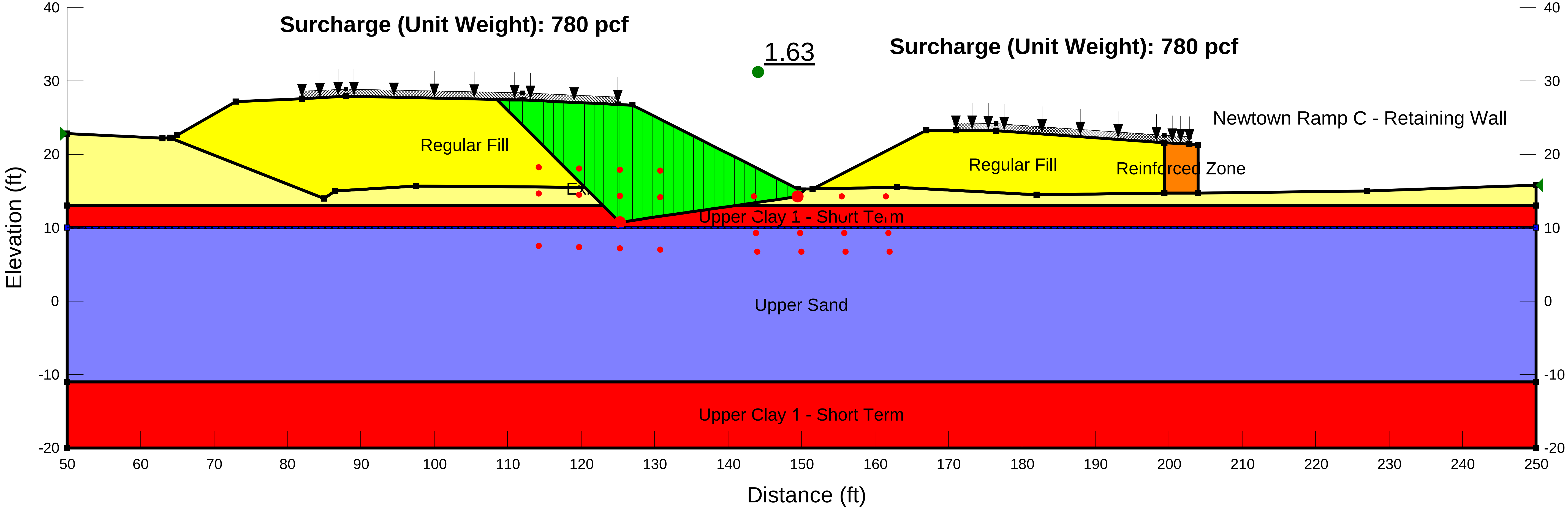
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Reinforced Zone Unit Weight: 110 pcf Cohesion: 10000 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 66+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-27, CD-28, CD-29, CD-30W (CPT)

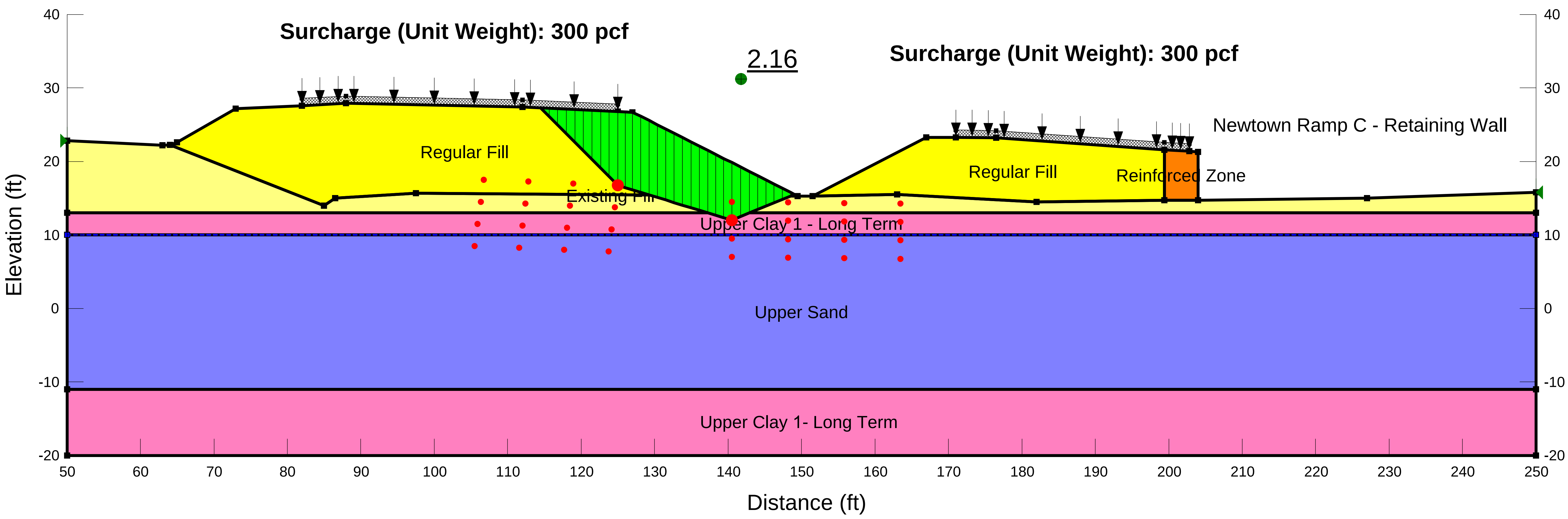


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

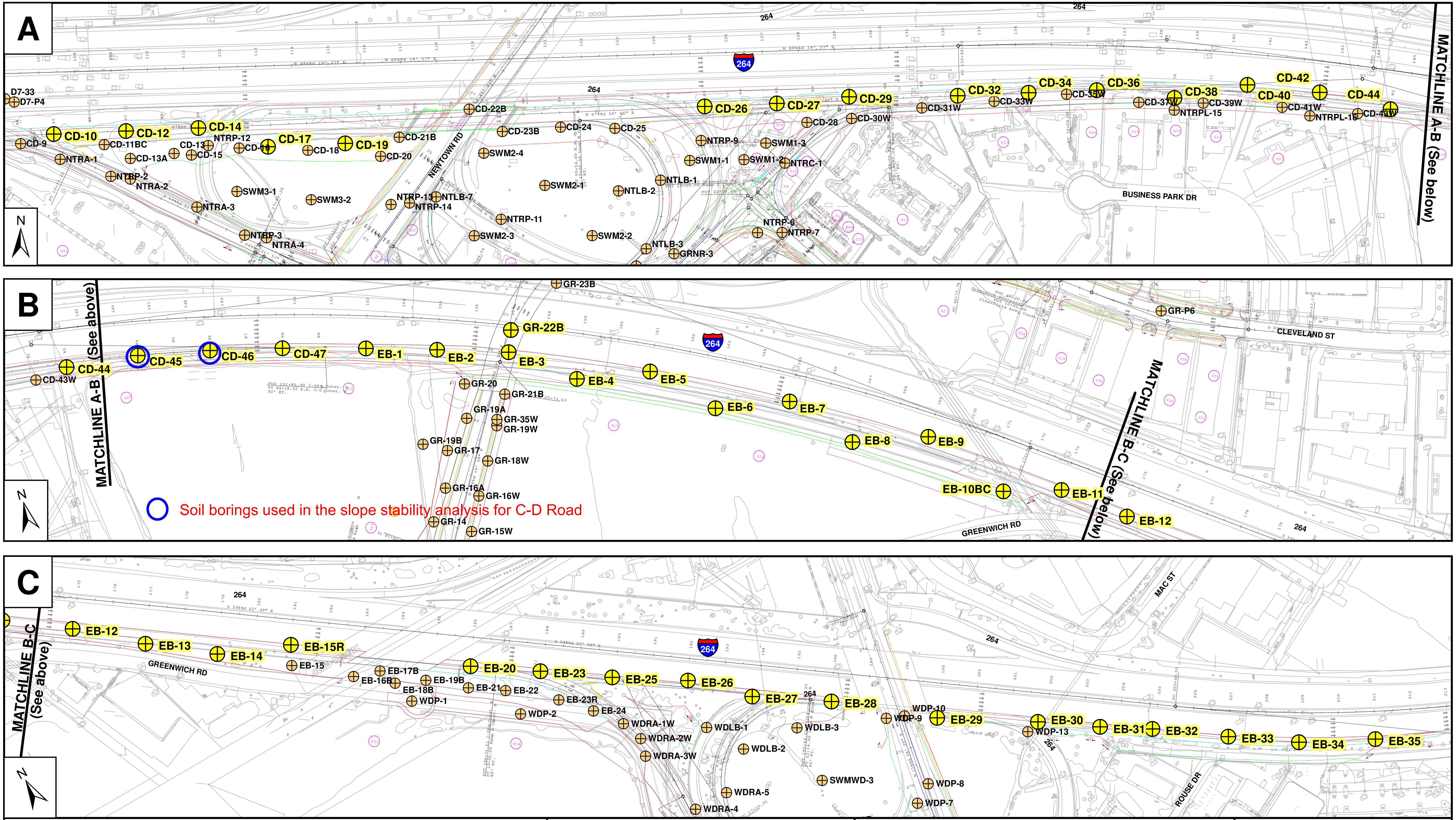
Name: Existing Fill   Unit Weight: 125 pcf   Cohesion: 50 psf   Phi: 32 °   Piezometric Line: 1
Name: Regular Fill   Unit Weight: 130 pcf   Cohesion: 50 psf   Phi: 34 °   Piezometric Line: 1
Name: Upper Sand   Unit Weight: 115 pcf   Cohesion: 0 psf   Phi: 30 °   Piezometric Line: 1
Name: Upper Clay 1 - Long Term   Unit Weight: 112 pcf   Cohesion: 0 psf   Phi: 23 °   Piezometric Line: 1
Name: Reinforced Zone   Unit Weight: 110 pcf   Cohesion: 10000 psf   Phi: 34 °   Piezometric Line: 1
Name: Upper Clay 2 - Long Term   Unit Weight: 112 pcf   Cohesion: 0 psf   Phi: 23 °   Piezometric Line: 1

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 66+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-27, CD-28, CD-29, CD-30W (CPT)



Slope Stability Analysis at
STATION 85+00



0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

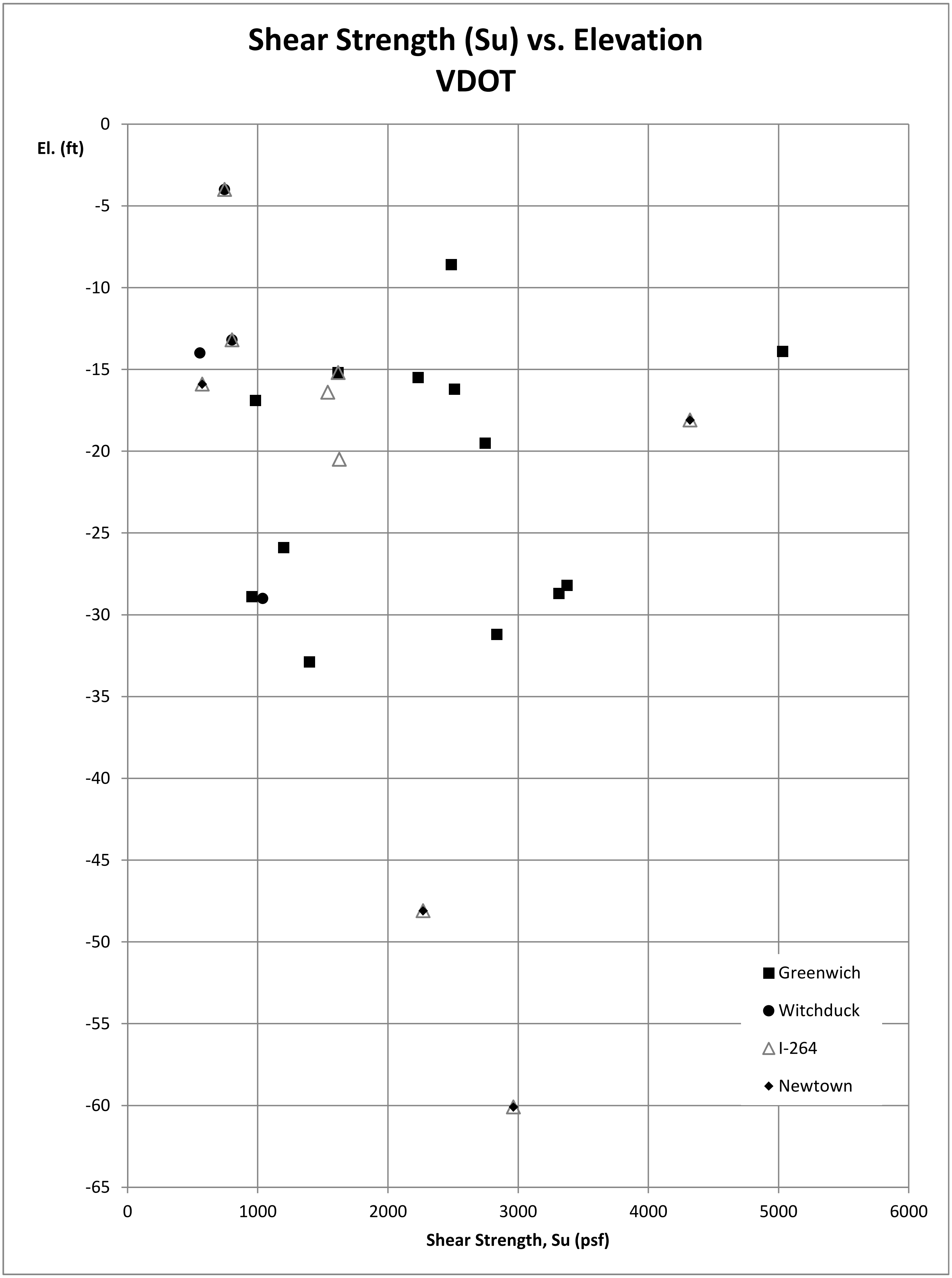
VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan

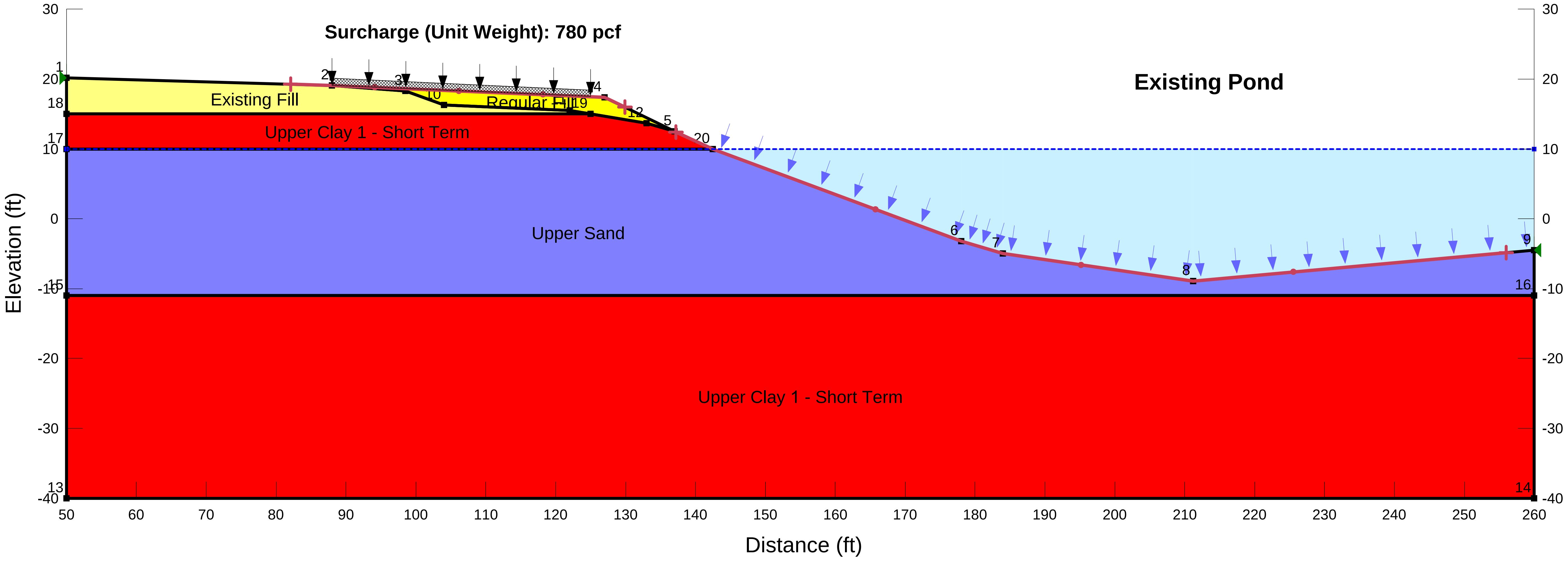
Shear Strength (Su) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
1000
2000
3000
4000
5000
6000
Shear Strength, Su (psf)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 85+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-45, CD-46

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1



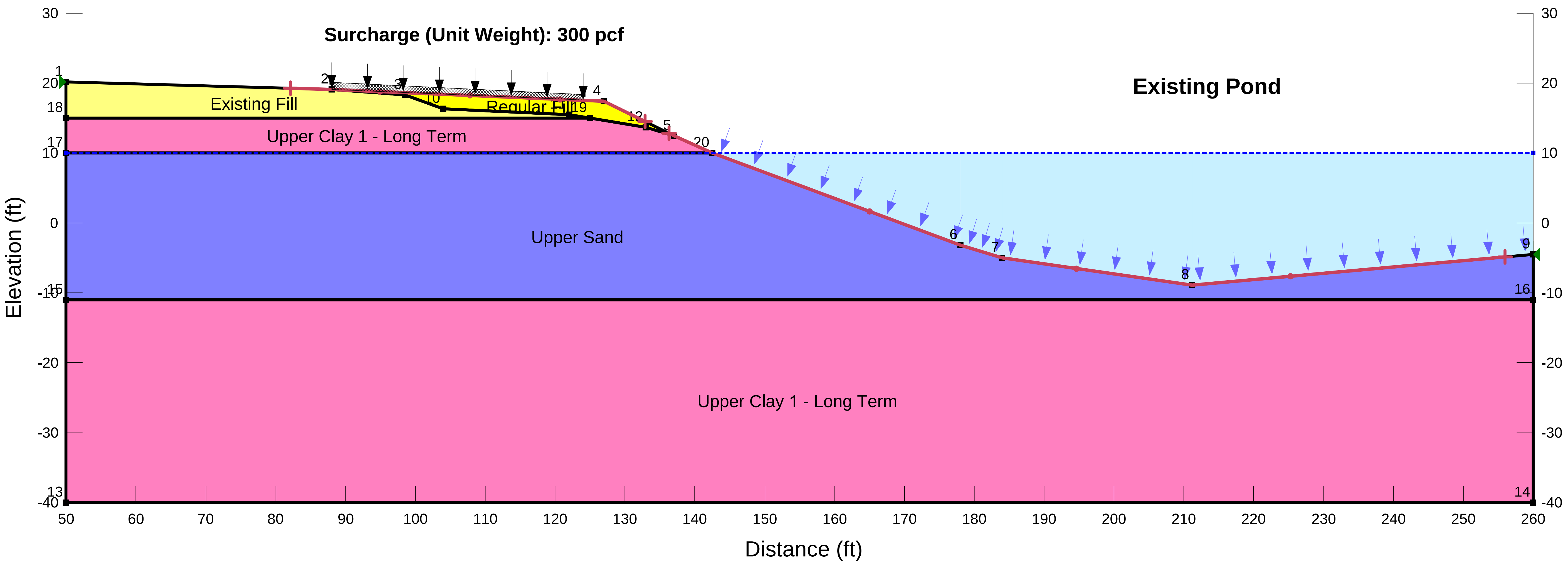
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 85+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-45, CD-46



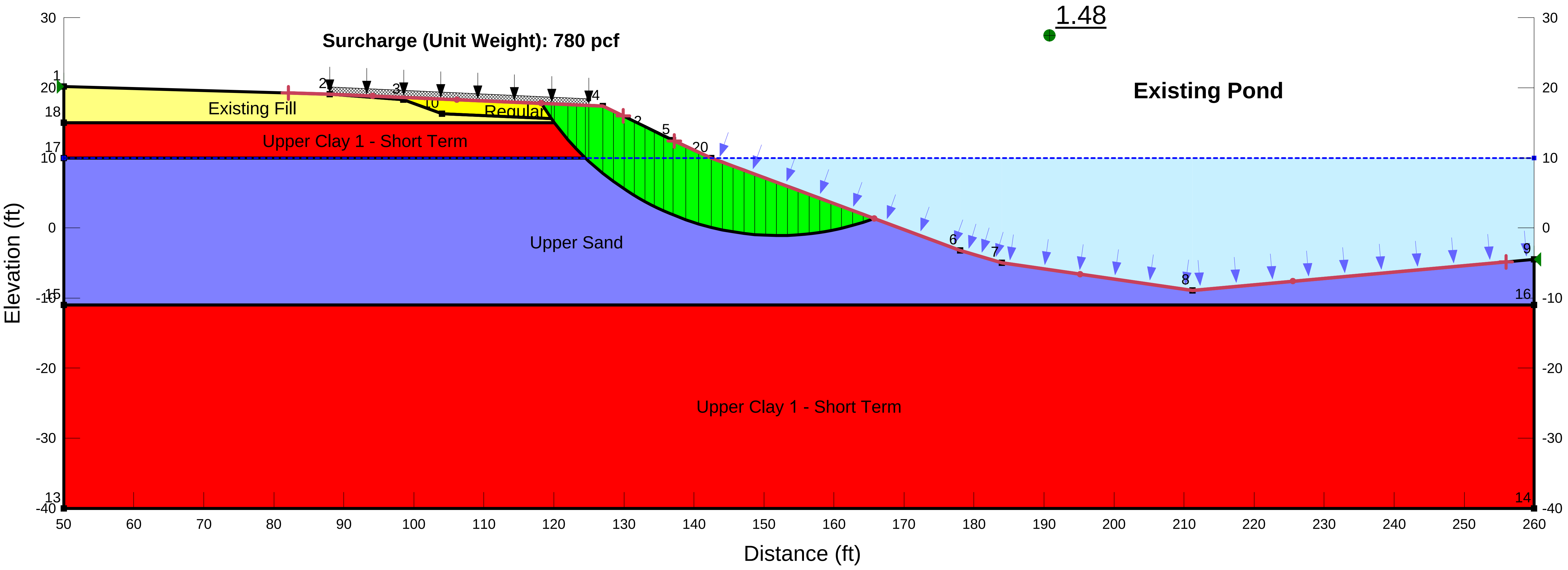
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 85+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-45, CD-46

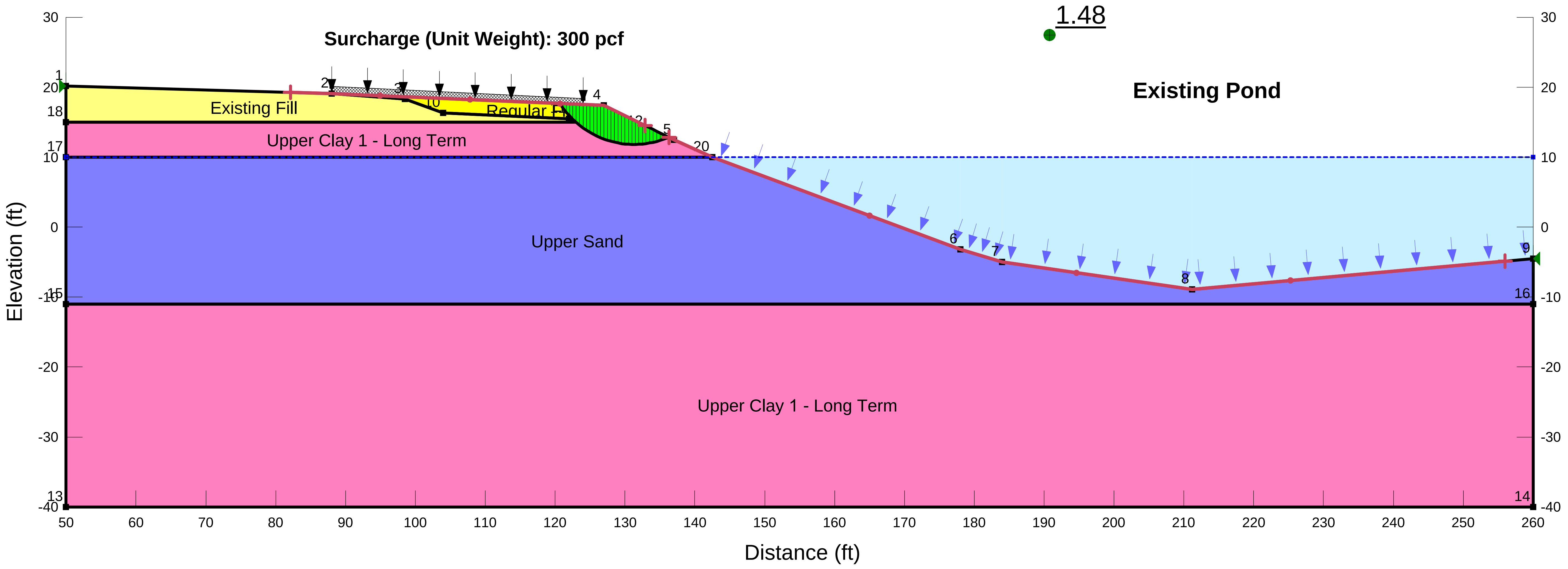


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 85+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-45, CD-46

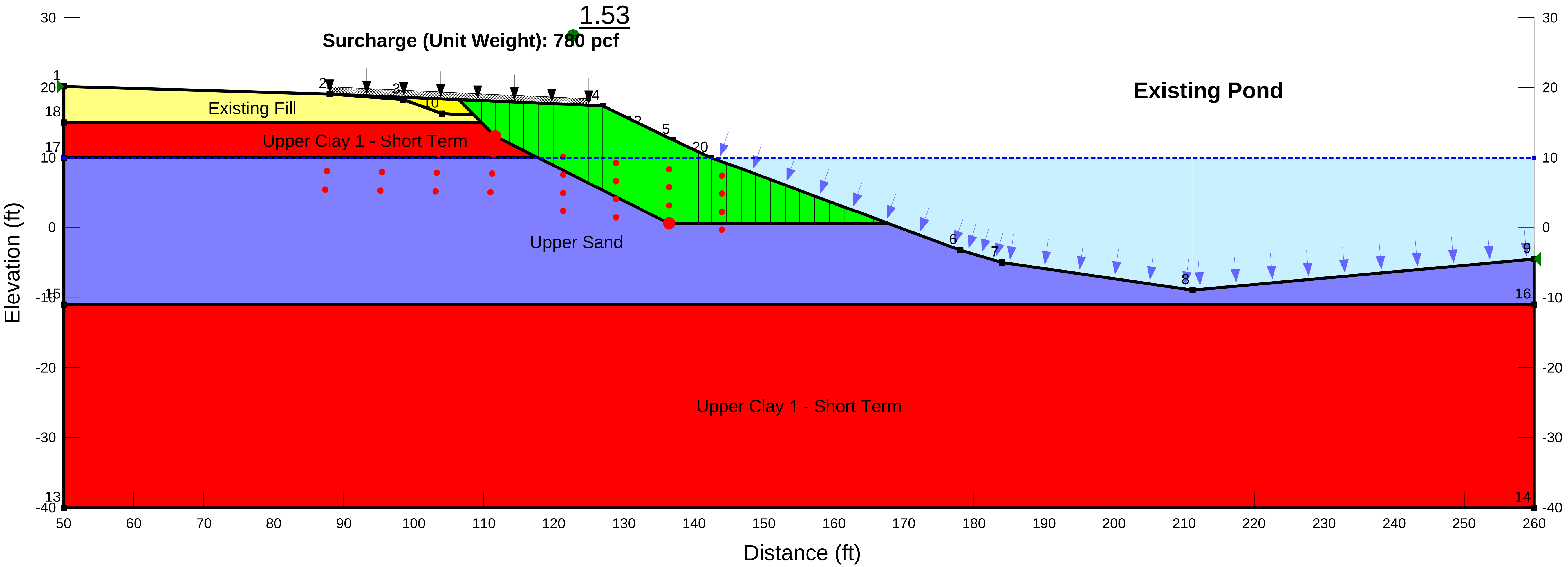


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 85+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-45, CD-46



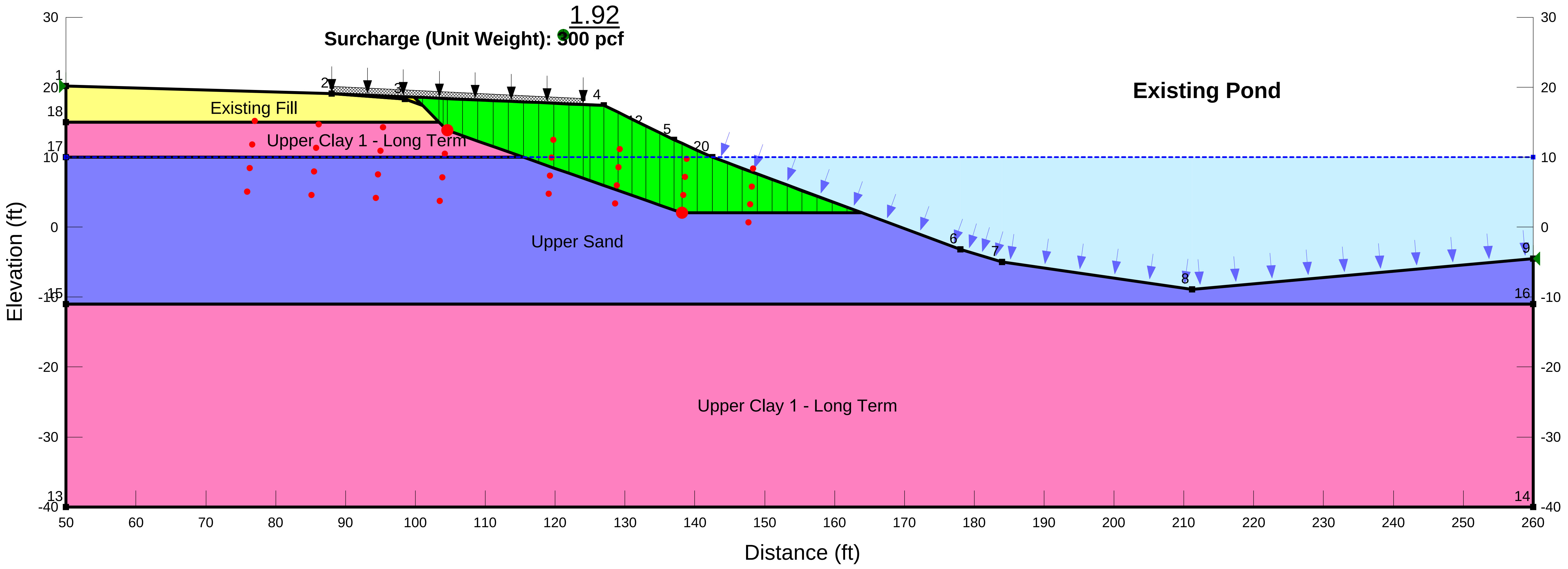
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

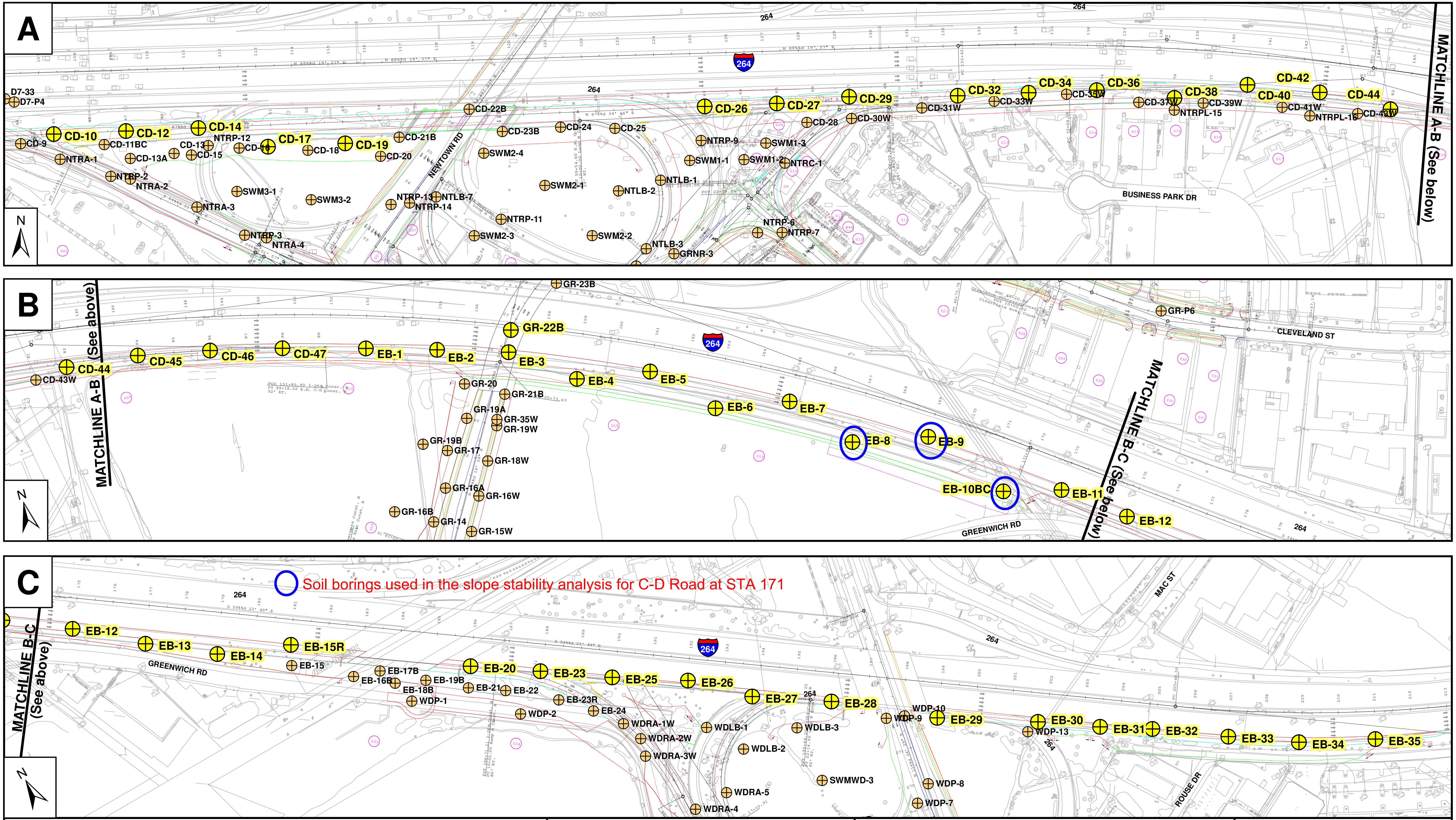
Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 85+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-45, CD-46



Slope Stability Analysis at

STATION 171+00



Soil borings used in the slope stability analysis for C-D Road at STA 171

0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan

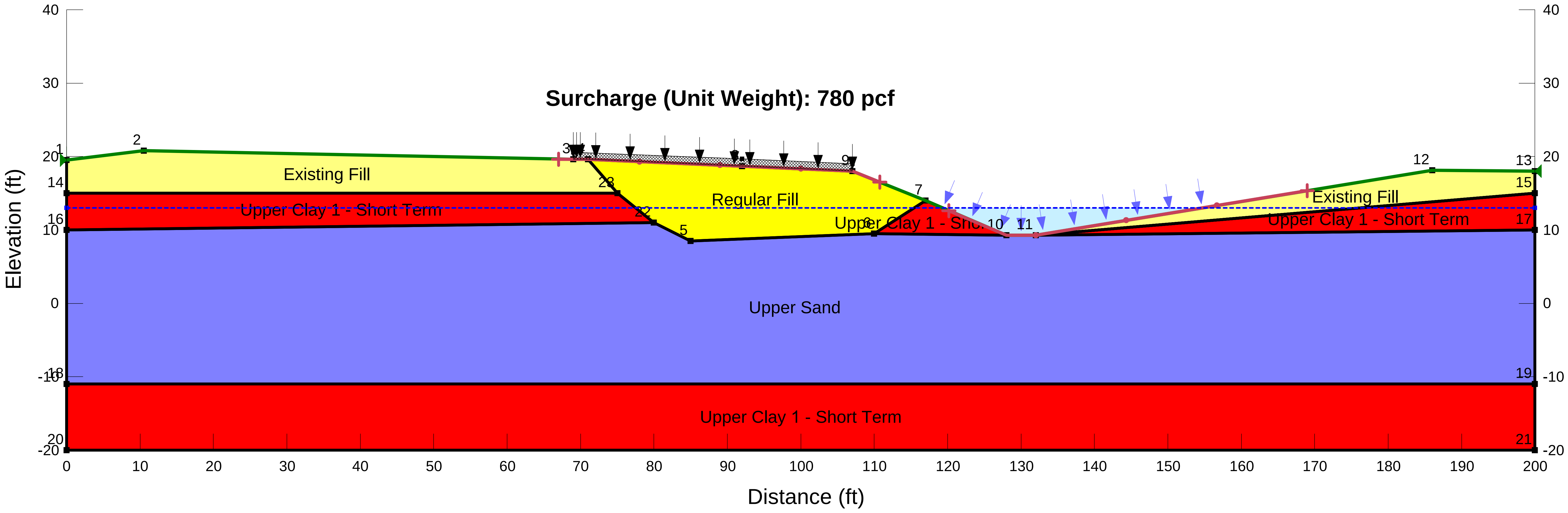
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Remove and Replace Upper Clay at Toe with Compacted Fill.

I-264 C-D Road
Analysis Location: Sta. 171+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-45, CD-46

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1



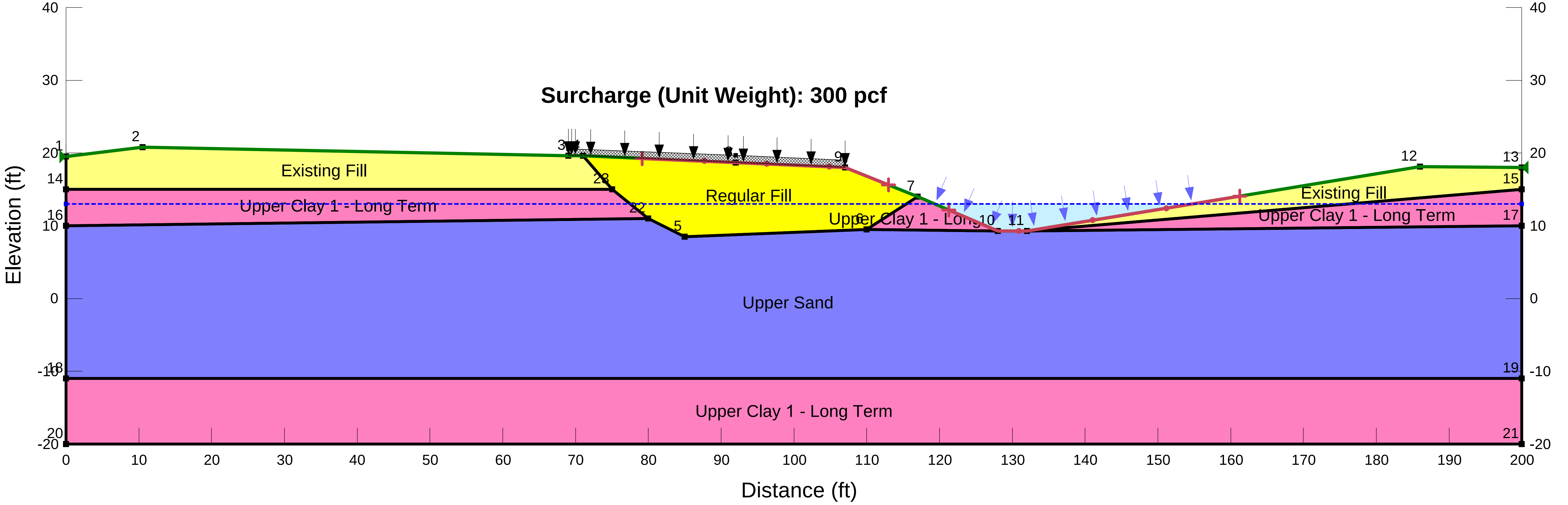
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

Remove and Replace Upper Clay at Toe with Compacted Fill.

I-264 C-D Road
Analysis Location: Sta. 171+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-45, CD-46

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 0 psf	Phi: 30 °	Piezometric Line: 1
Name: Upper Clay 1 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1
Name: Upper Clay 2 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1



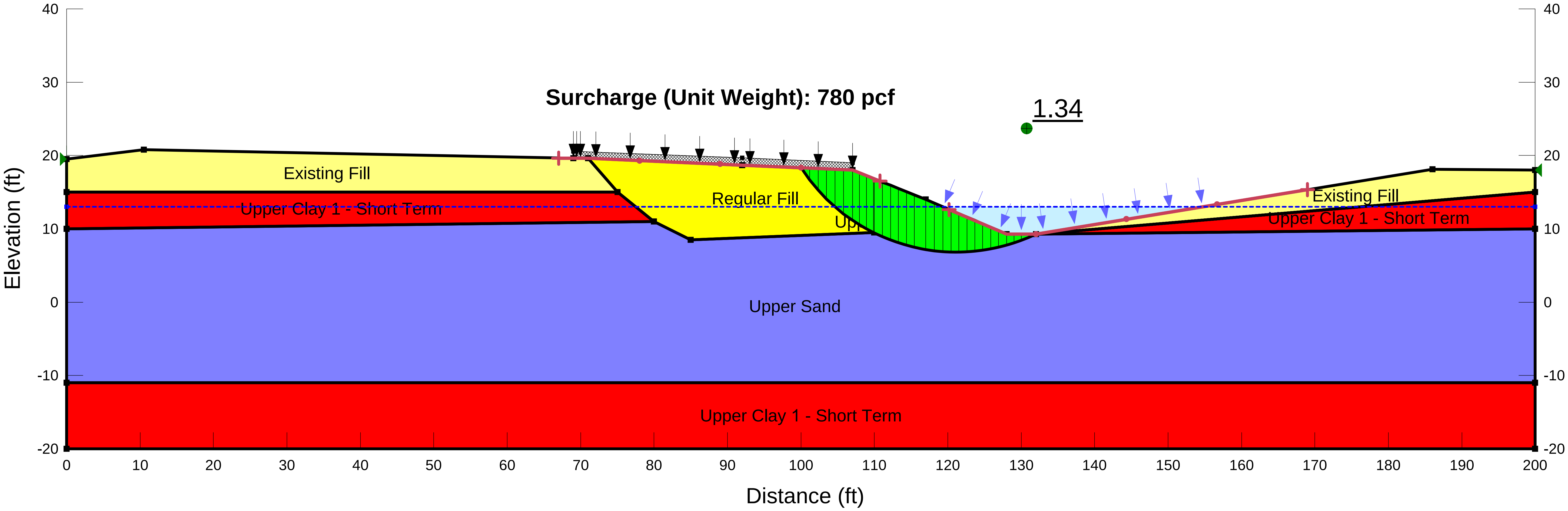
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Remove and Replace Upper Clay at Toe with Compacted Fill.

I-264 C-D Road
Analysis Location: Sta. 171+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-45, CD-46

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1



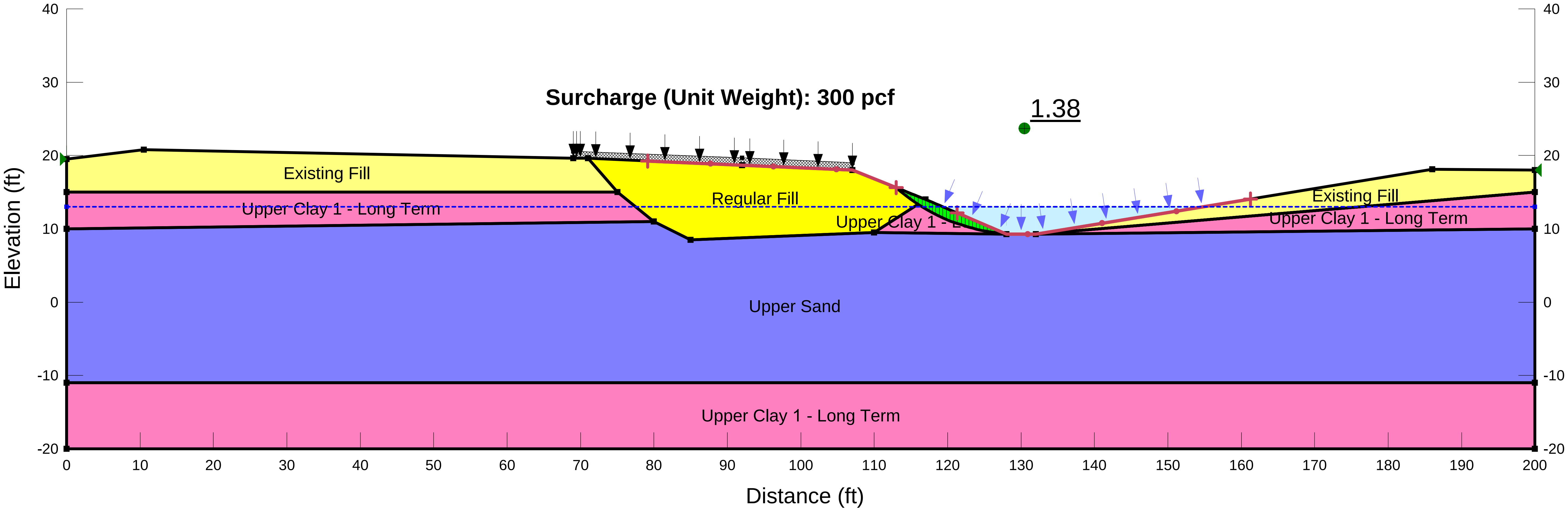
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

Remove and Replace Upper Clay at Toe with Compacted Fill.

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 171+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-45, CD-46



Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

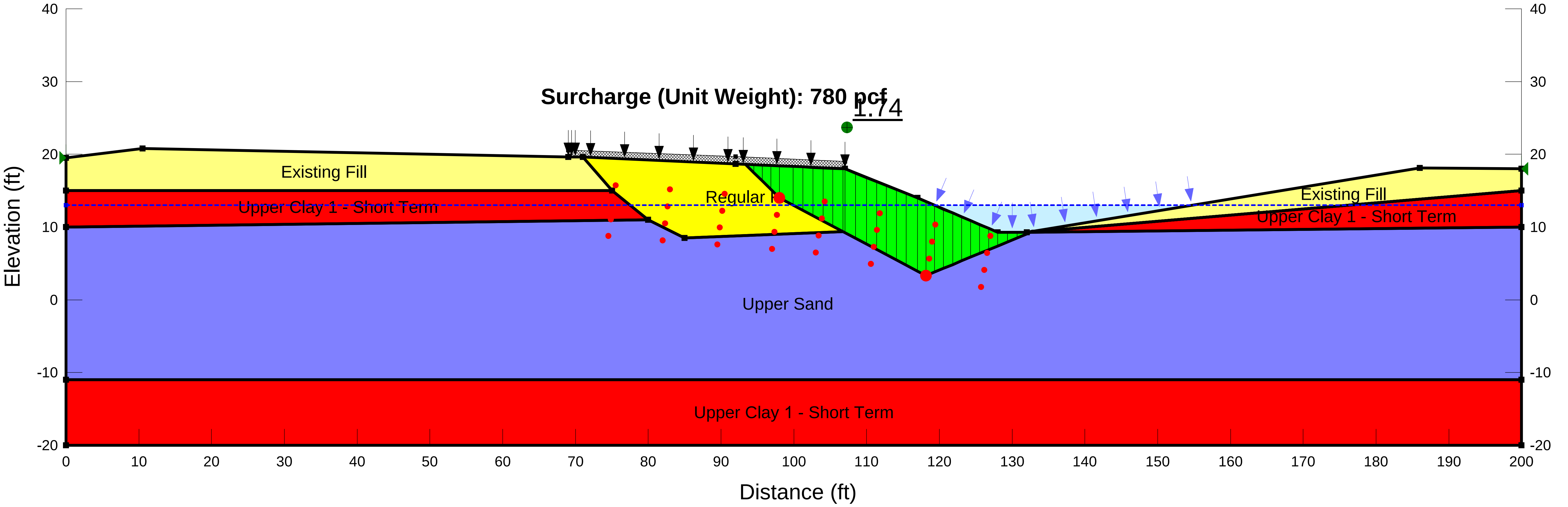
AECOM

Short Term Global Stability Analysis

Remove and Replace Upper Clay at Toe with Compacted Fill.

I-264 C-D Road
Analysis Location: Sta. 171+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-45, CD-46

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1



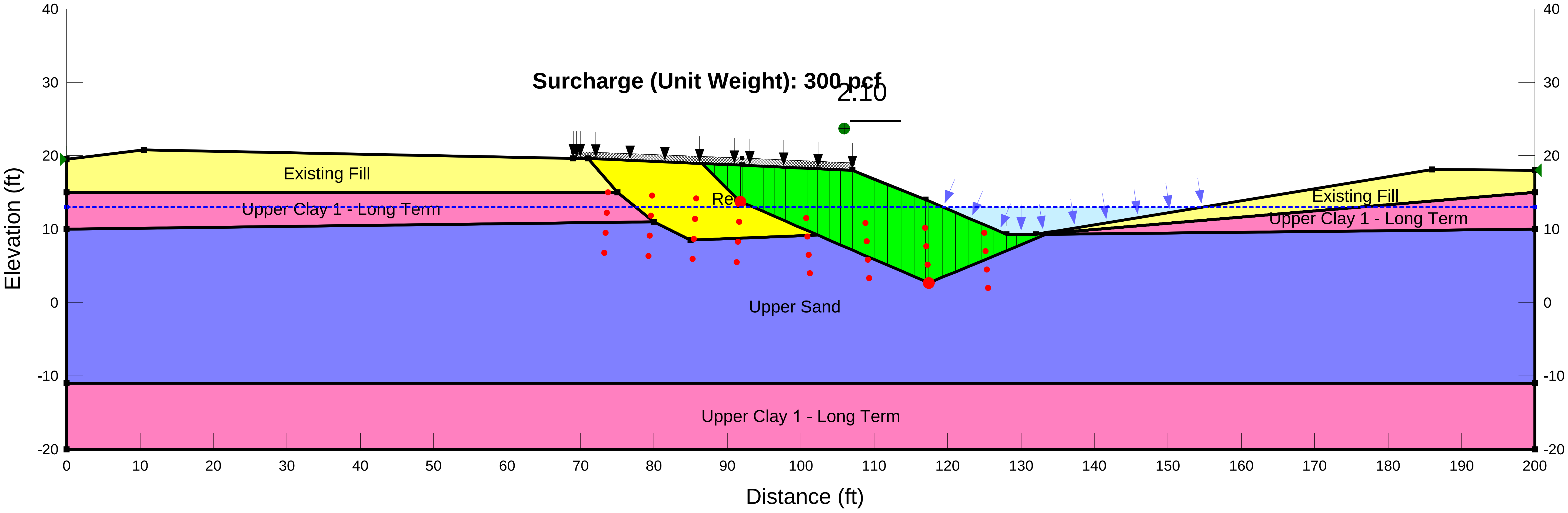
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

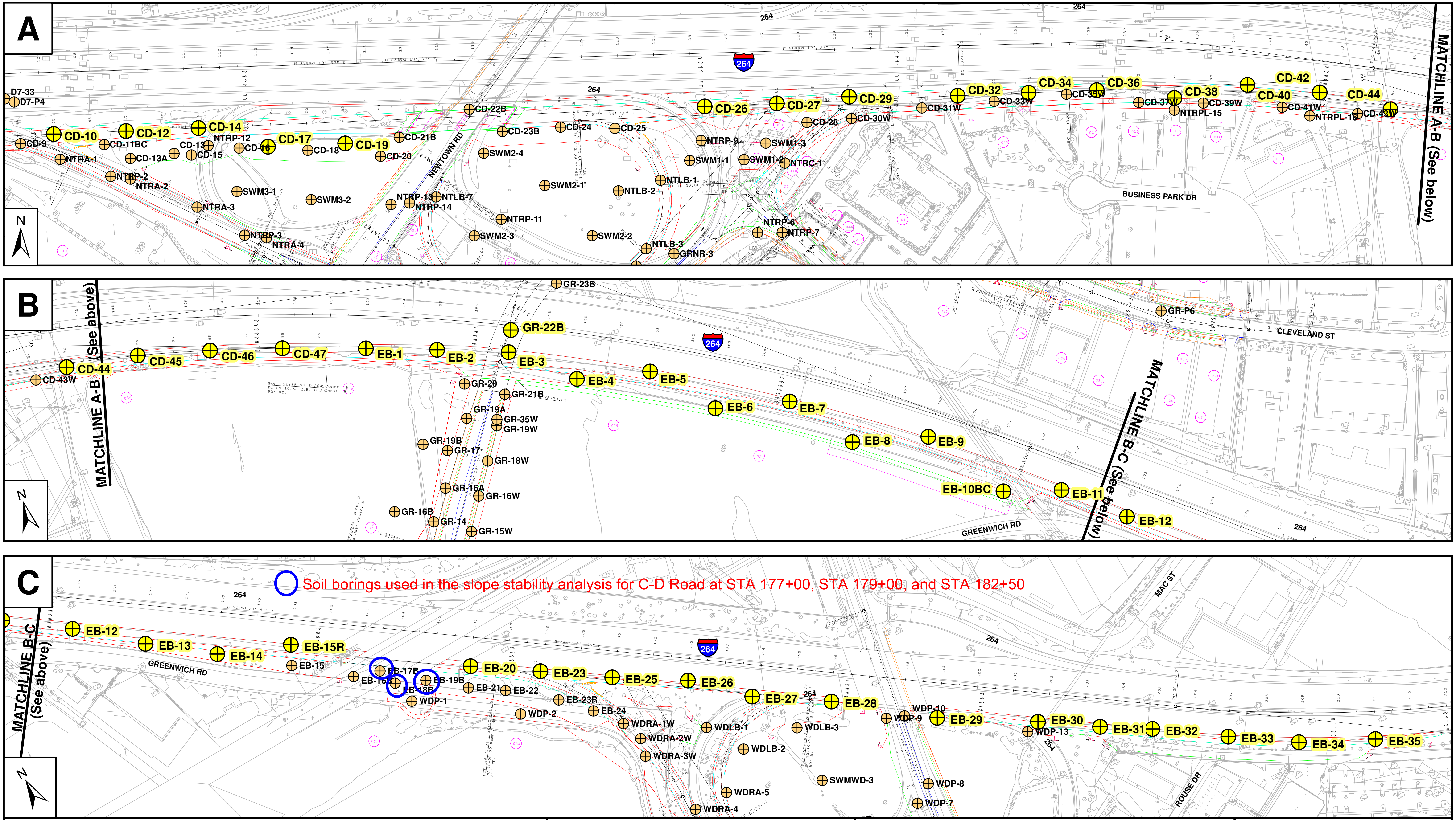
Remove and Replace Upper Clay at Toe with Compacted Fill.

I-264 C-D Road
Analysis Location: Sta. 171+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: CD-45, CD-46

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 0 psf	Phi: 30 °	Piezometric Line: 1
Name: Upper Clay 1 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1
Name: Upper Clay 2 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1



Slope Stability Analysis at
STATION 177+00



○ Soil borings used in the slope stability analysis for C-D Road at STA 177+00, STA 179+00, and STA 182+50

0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

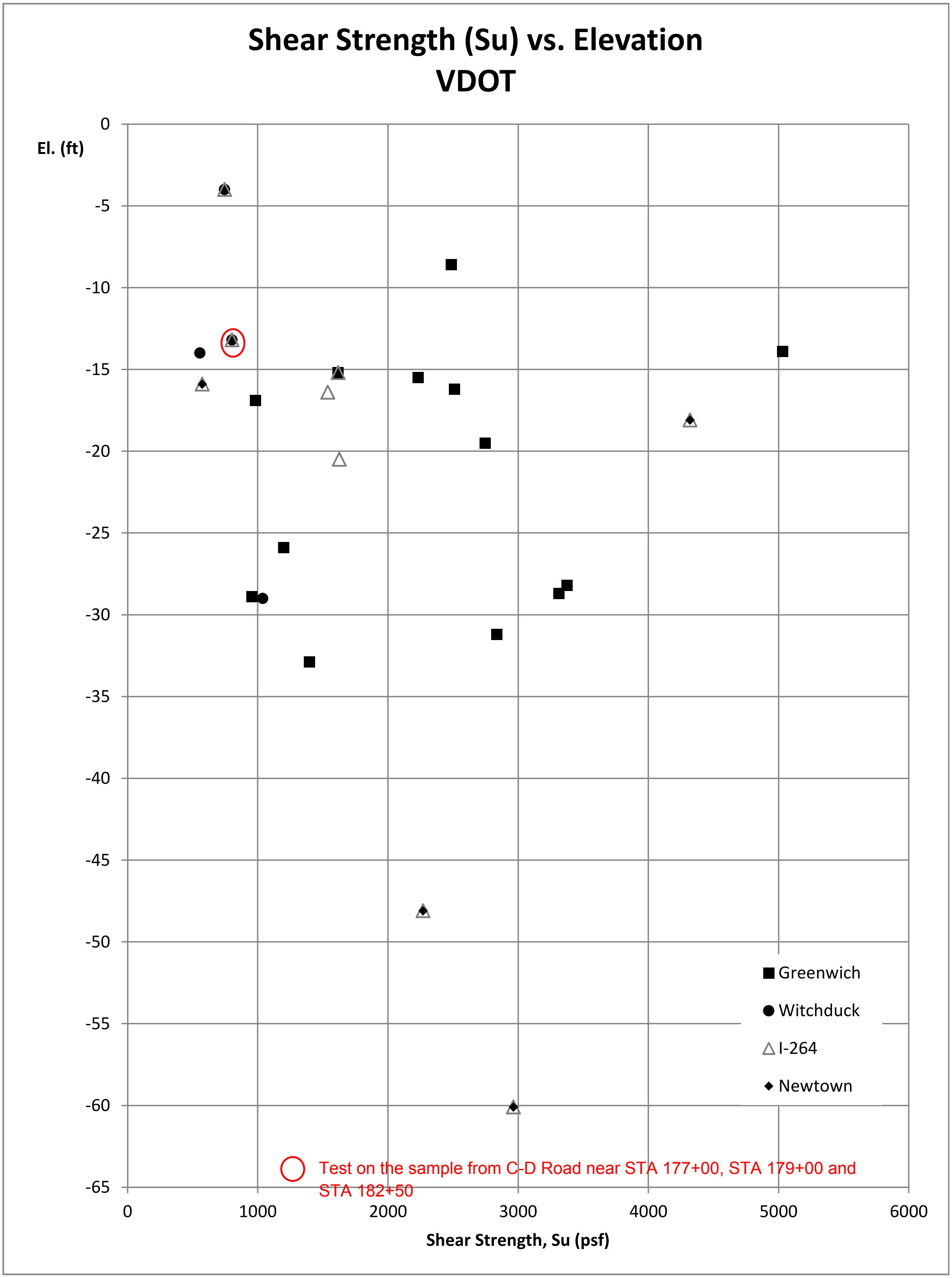
VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan


Shear Strength (Su) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
1000
2000
3000
4000
5000
6000
Shear Strength, Su (psf)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown
○ Test on the sample from C-D Road near STA 177+00, STA 179+00 and STA 182+50

CONE PENETROMETER TEST LOG

Virginia Department of Transportation

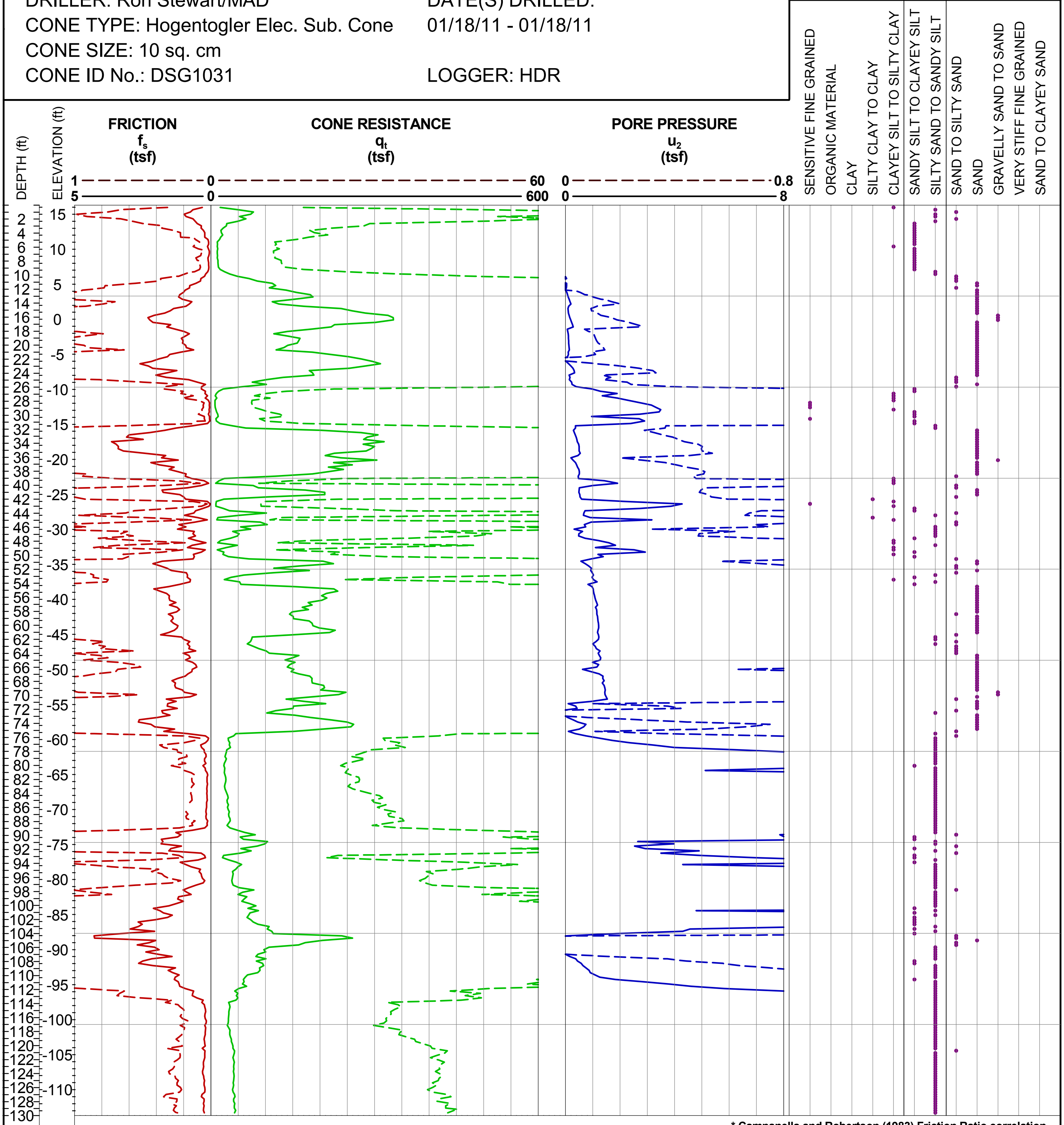
PROJECT #: 0264-134-102
LOCATION: VA Beach: PSA Witchduck

EB-17B
PAGE 1 OF 1

STATION: 183+52
OFFSET: 118 ft RT
LATITUDE: 36.840531° N
LONGITUDE: 76.163238° W
SURFACE ELEVATION: 16.3
COORD. DATUM: NAD 83
BENCHMARK LOCATION:

DRILLER: Ron Stewart/MAD
DATE(S) DRILLED:
CONE TYPE: Hogentogler Elec. Sub. Cone
01/18/11 - 01/18/11
CONE SIZE: 10 sq. cm
CONE ID No.: DSG1031
LOGGER: HDR

SOIL BEHAVIOR TYPE *



* Campanella and Robertson (1983) Friction Ratio correlation

REMARKS: REFERENCE BASELINE: I-264 CD

PAGE 1 OF 1

EB-17B

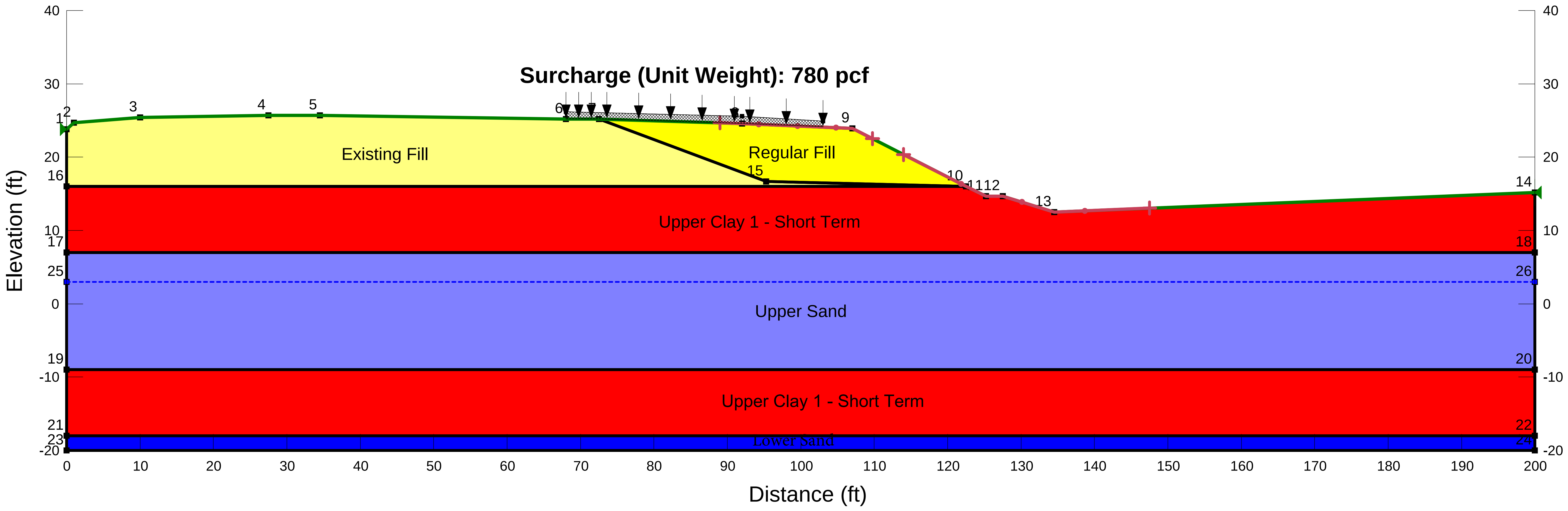
CPT_LOG:WITCHDUCK CPT LOGS.GPJ;8.30.003:061810:1/27/13

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 0 psf	Phi: 30 °	Piezometric Line: 1
Name: Lower Sand	Unit Weight: 125 pcf	Cohesion: 0 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Clay 1 - Short Term	Unit Weight: 112 pcf	Cohesion Spatial Fn: Upper Clay	Phi: 0 °	Piezometric Line: 1
Name: Upper Clay 2 - Short Term	Unit Weight: 112 pcf	Cohesion Spatial Fn: Upper Clay	Phi: 0 °	Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 177+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B

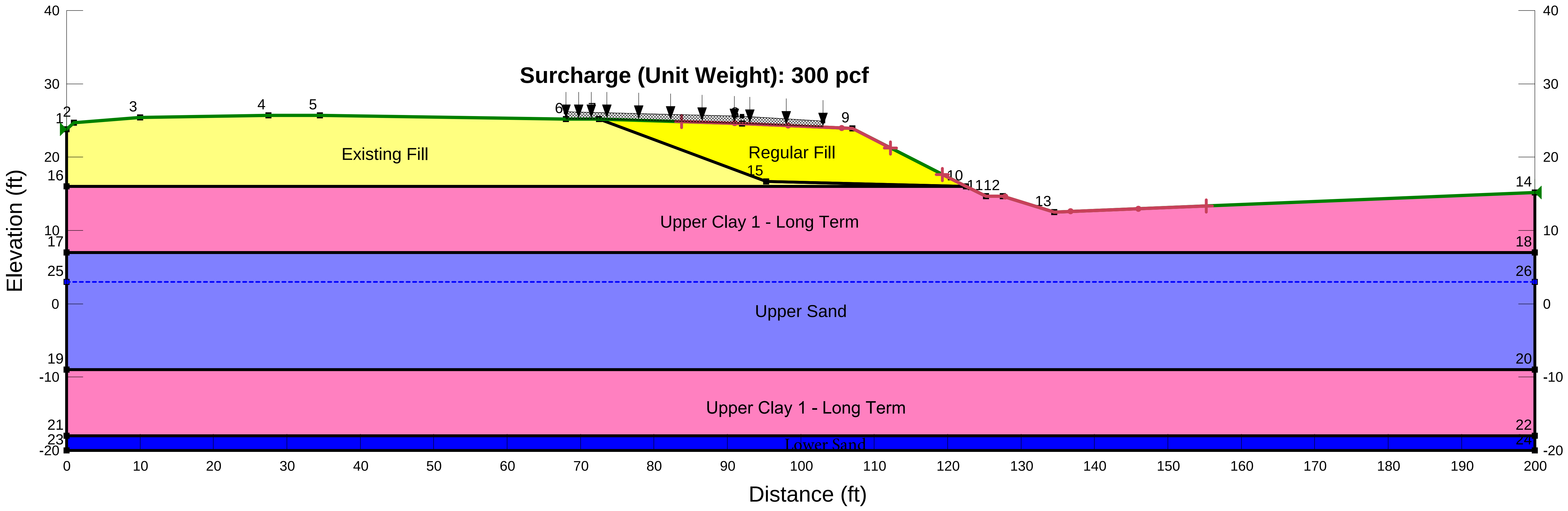


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 177+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B

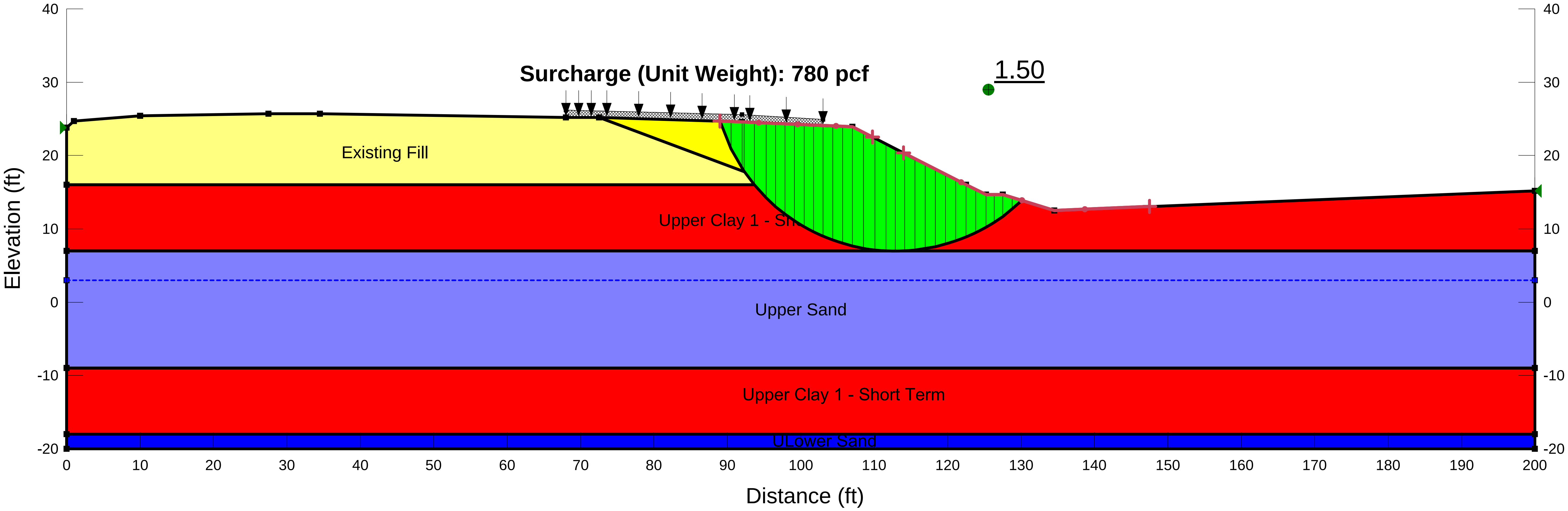


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 177+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B



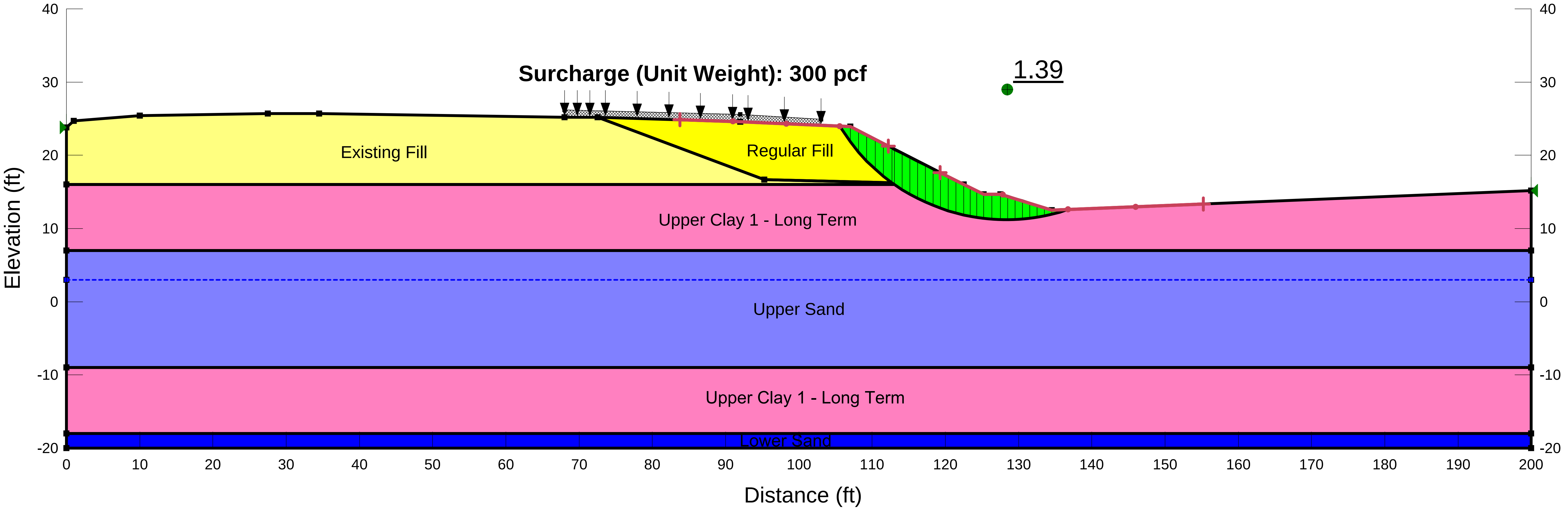
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 177+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1



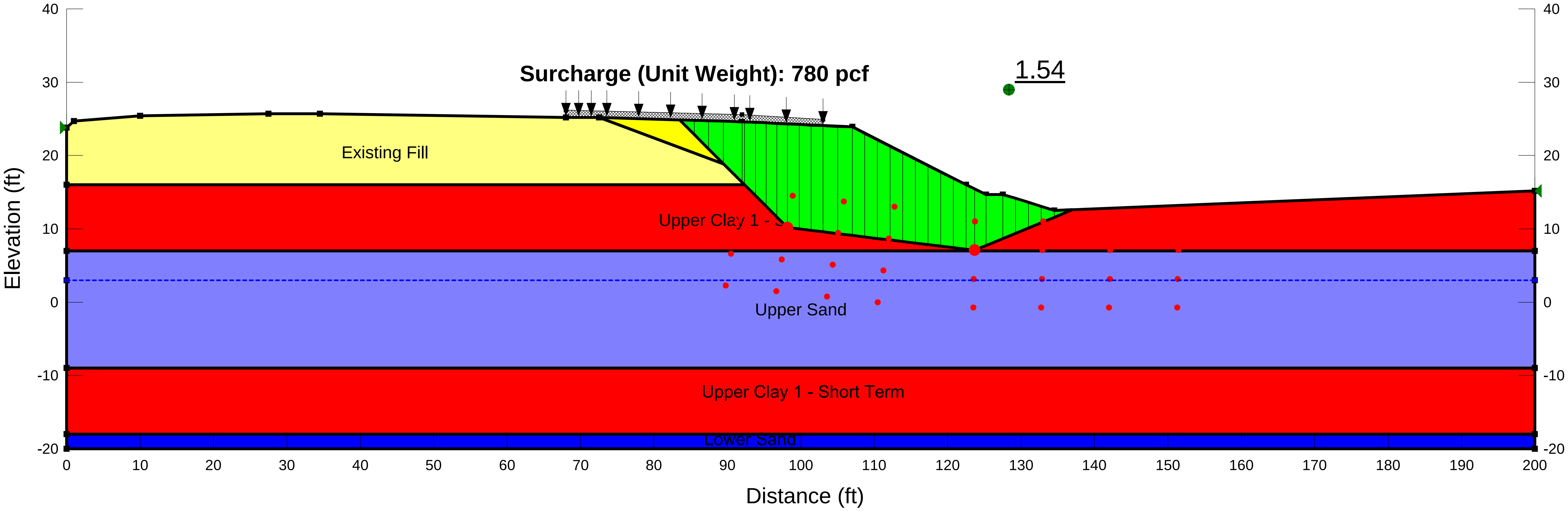
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 177+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B

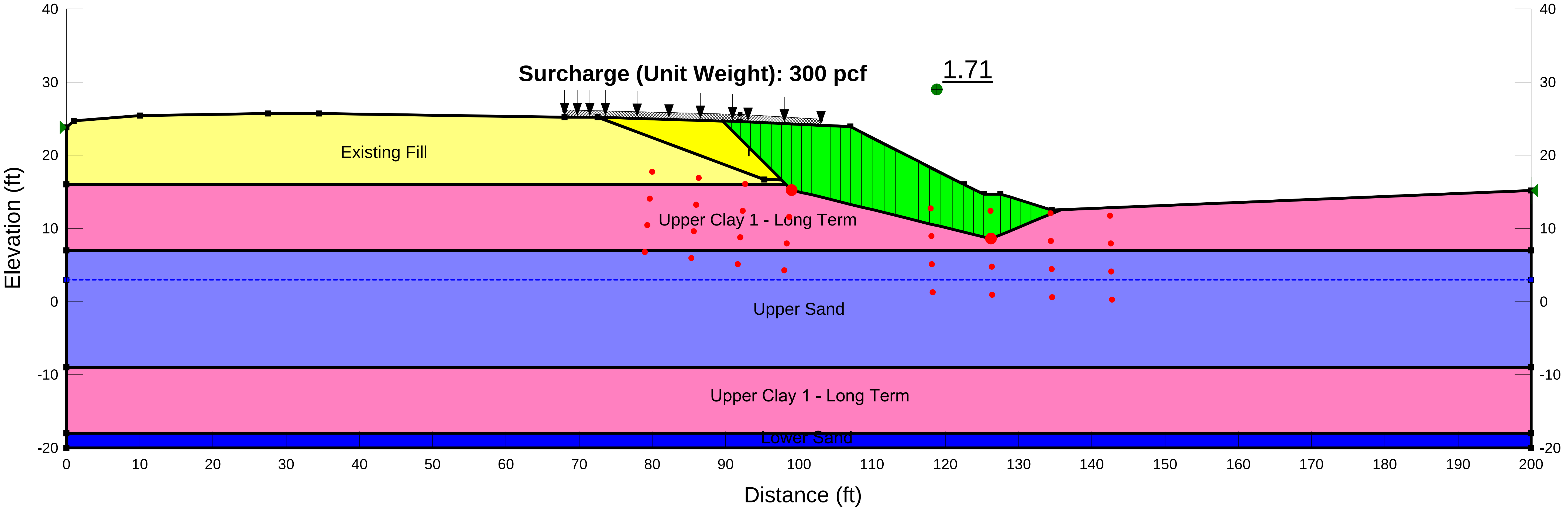


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

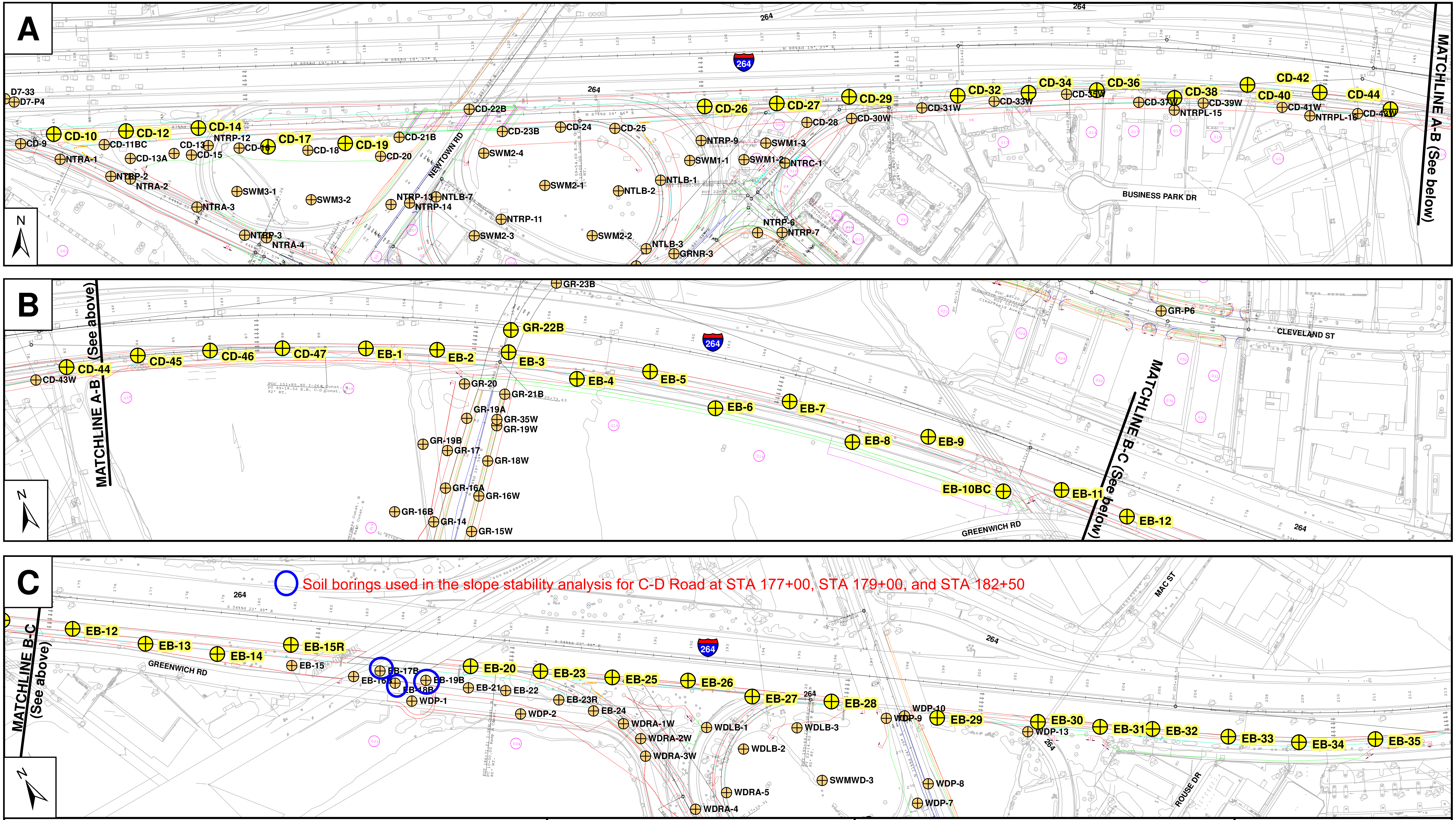
Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 177+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1



Slope Stability Analysis at
STATION 179+00



○ Soil borings used in the slope stability analysis for C-D Road at STA 177+00, STA 179+00, and STA 182+50

0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

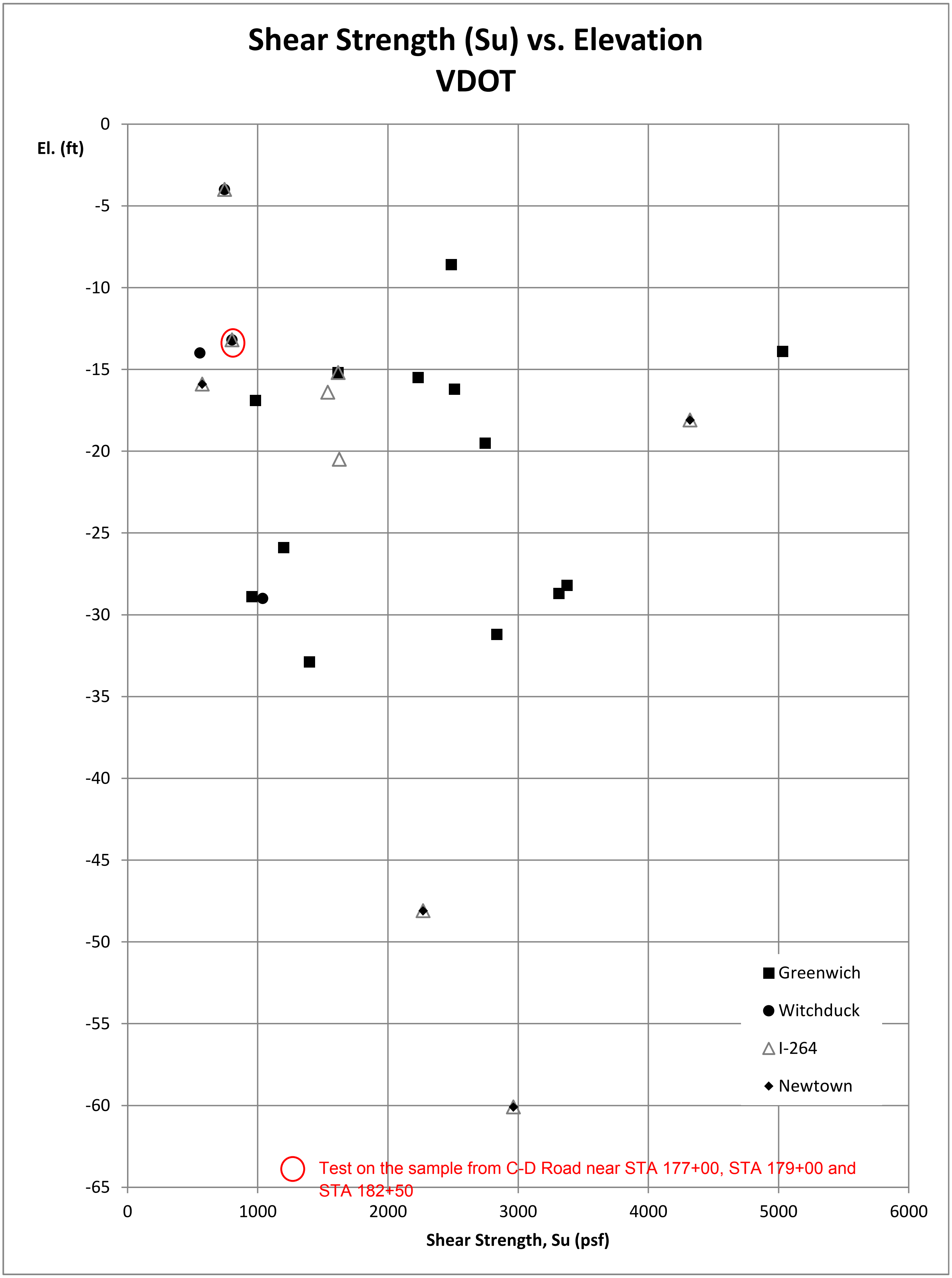
Date: November 2011

VDOT Virginia Department of Transportation

Project 0264-122-108	**Project 0264-134-102**
City of Norfolk	**City of Virginia Beach**

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan


Shear Strength (Su) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
1000
2000
3000
4000
5000
6000
Shear Strength, Su (psf)
Greenwich
Witchduck
I-264
Newtown
Test on the sample from C-D Road near STA 177+00, STA 179+00 and STA 182+50

CONE PENETROMETER TEST LOG

EB-17B

PAGE 1 OF 1

PROJECT #: 0264-134-102
LOCATION: VA Beach: PSA Witchduck

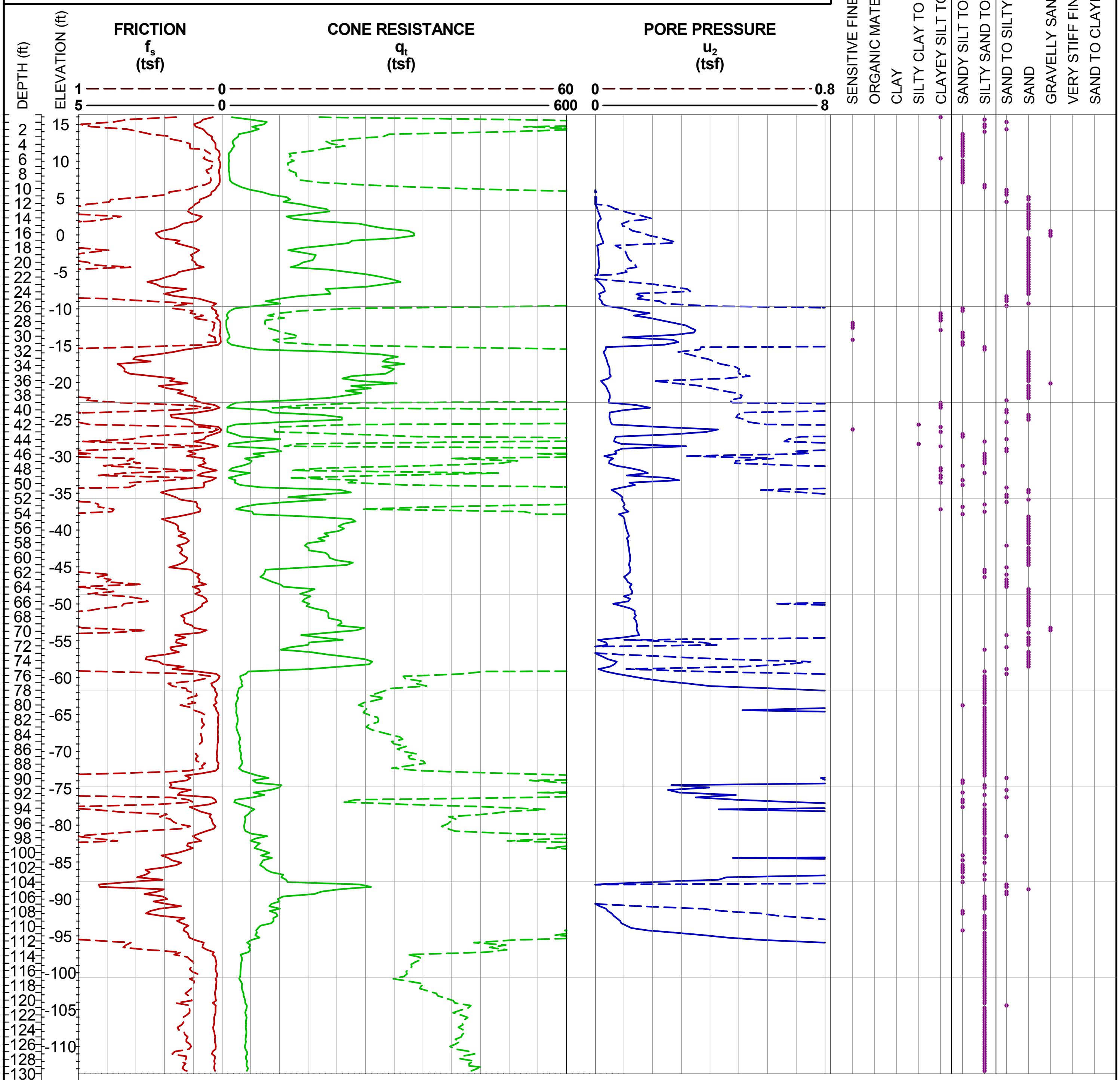
STATION: 183+52
OFFSET: 118 ft RT
LATITUDE: 36.840531° N
LONGITUDE: 76.163238° W
SURFACE ELEVATION: 16.3
COORD. DATUM: NAD 83
BENCHMARK LOCATION:

DRILLER: Ron Stewart/MAD
CONE TYPE: Hogentogler Elec. Sub. Cone
CONE SIZE: 10 sq. cm
CONE ID No.: DSG1031

DATE(S) DRILLED:
01/18/11 - 01/18/11

LOGGER: HDR

SOIL BEHAVIOR TYPE *



*** Campanella and Robertson (1983) Friction Ratio correlation**

REMARKS: REFERENCE BASELINE: I-264 CD

PAGE 1 OF 1

EB-17B

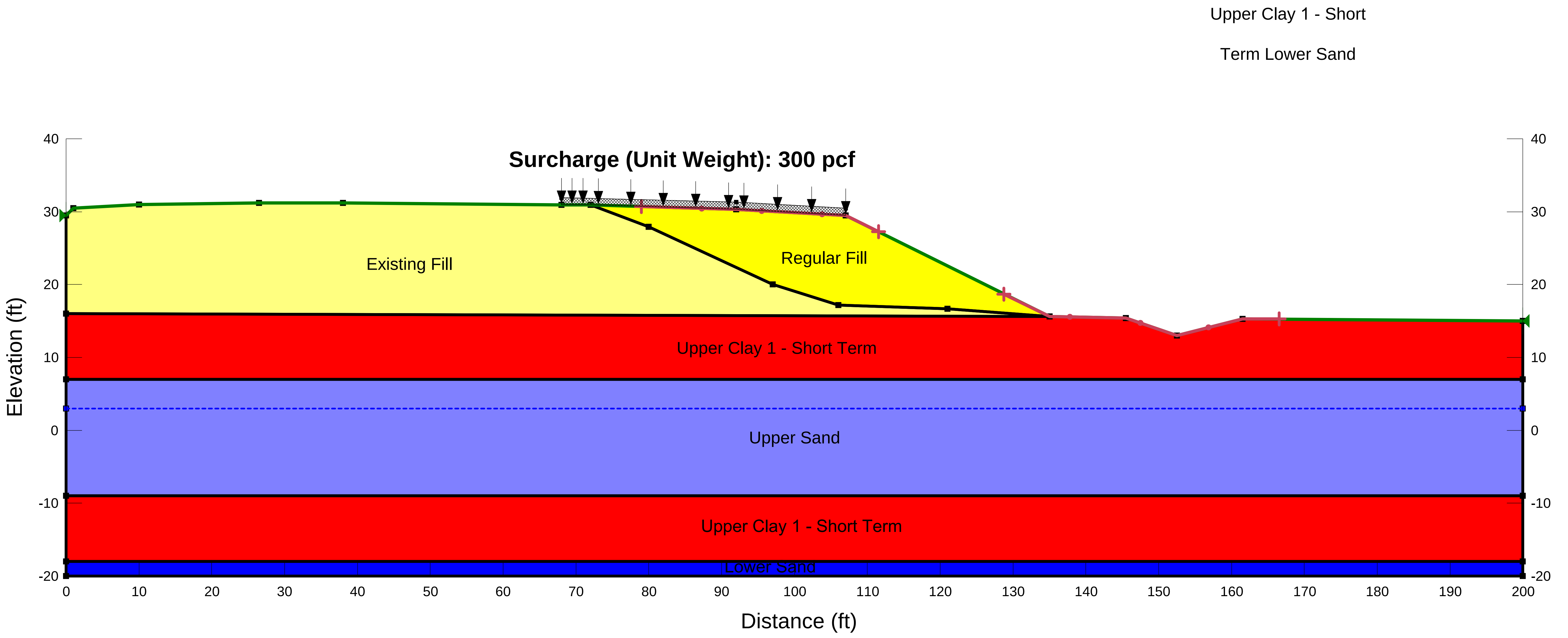
CPT_LOG:WITCHDUCK CPT LOGS.GPJ:8.30.003:061810:1/27/13

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 179+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B

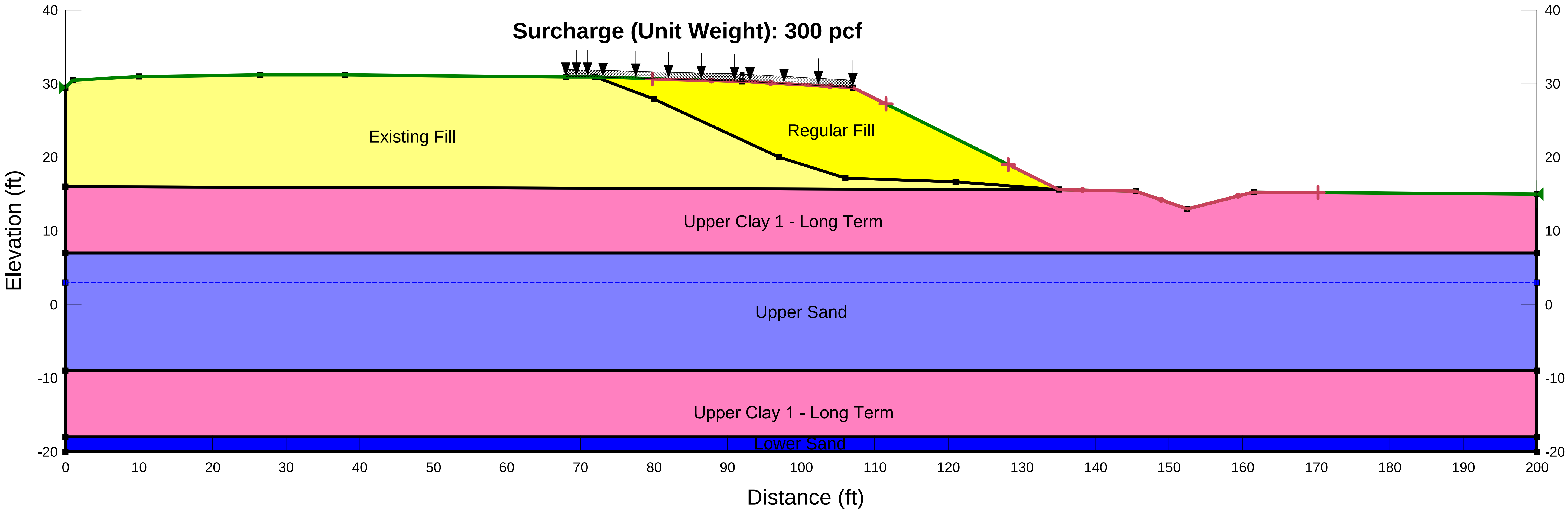


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 179+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B

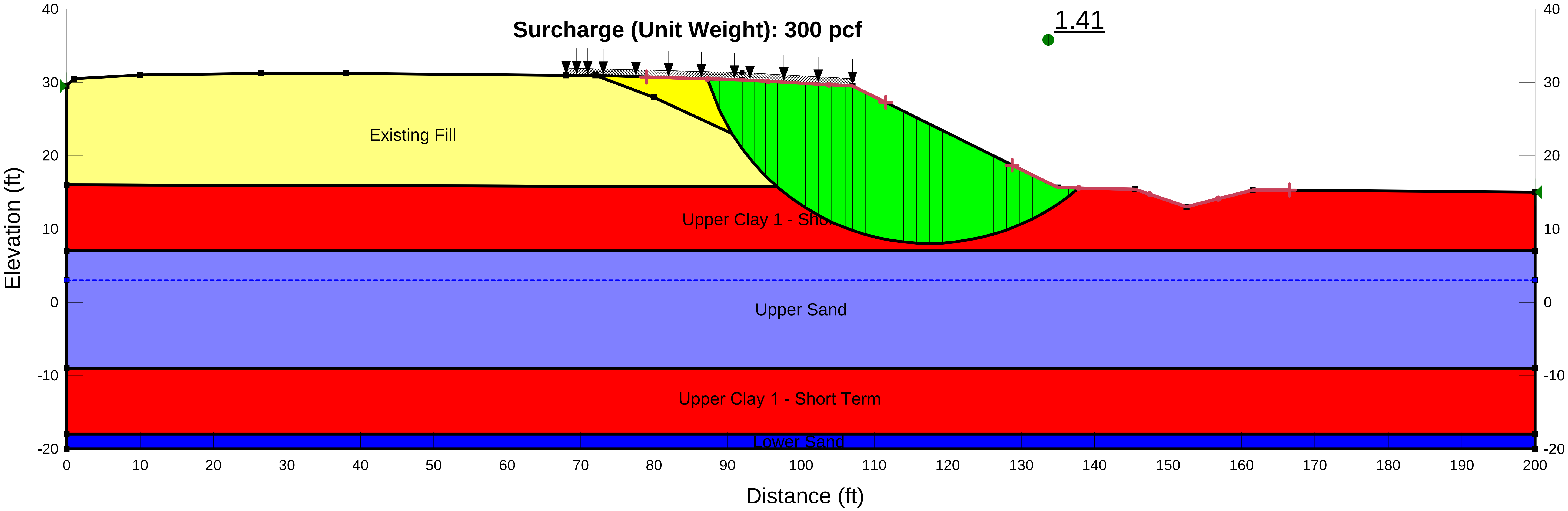


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 179+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B

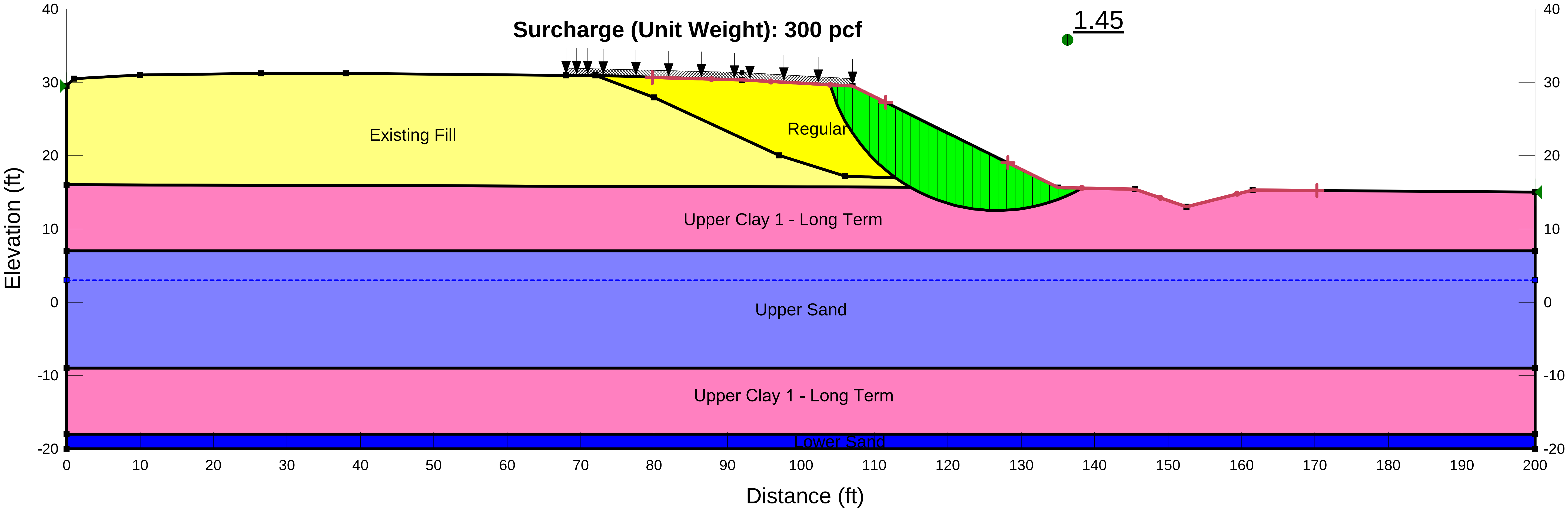


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 179+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

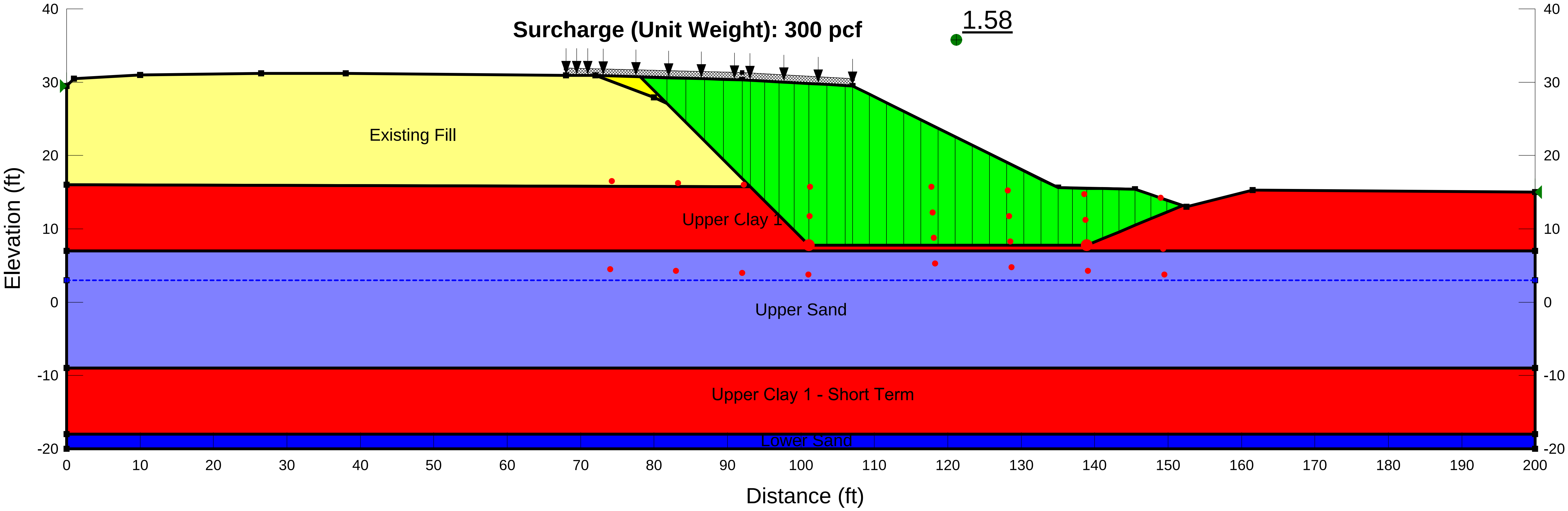


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 179+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B



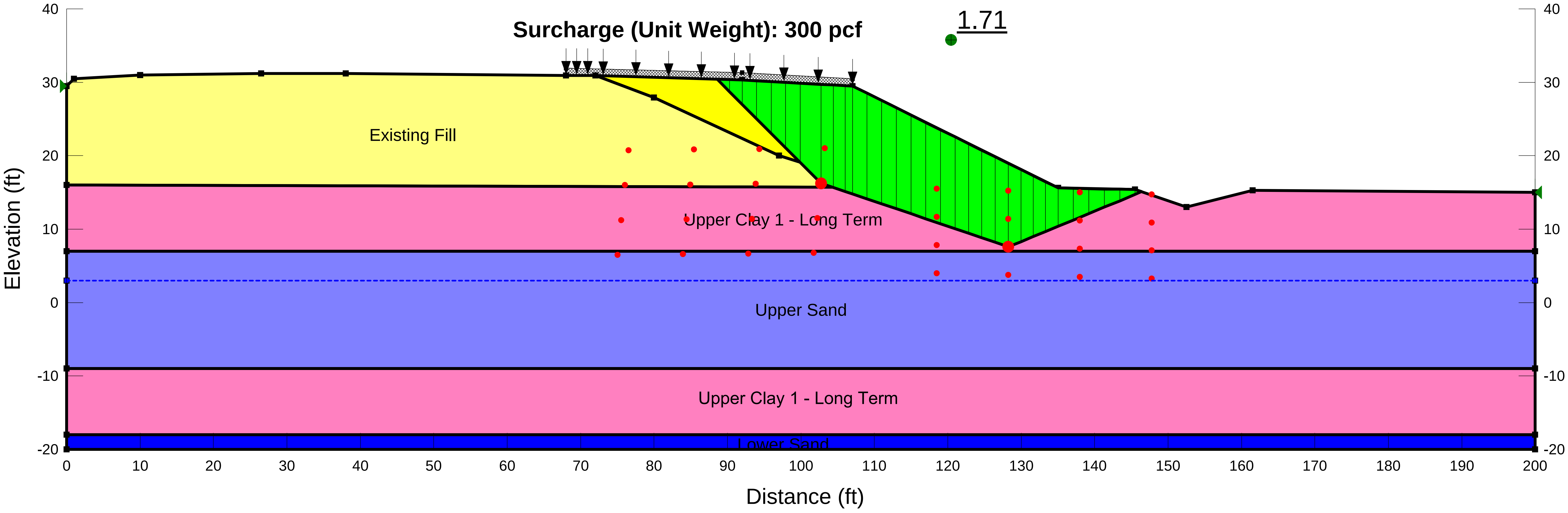
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

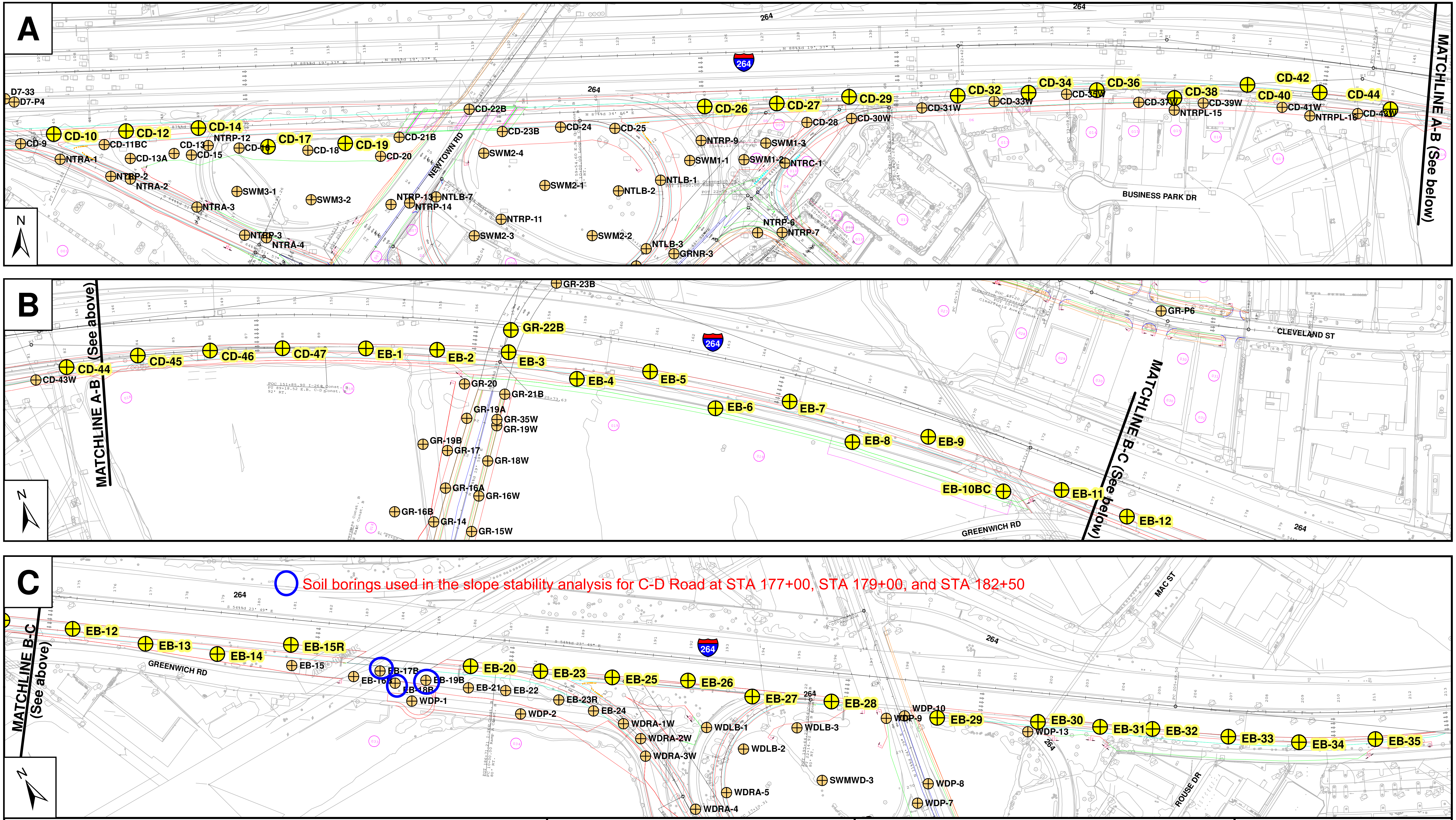
Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 179+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B



Slope Stability Analysis at
STATION 182+50



Soil borings used in the slope stability analysis for C-D Road at STA 177+00, STA 179+00, and STA 182+50

0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

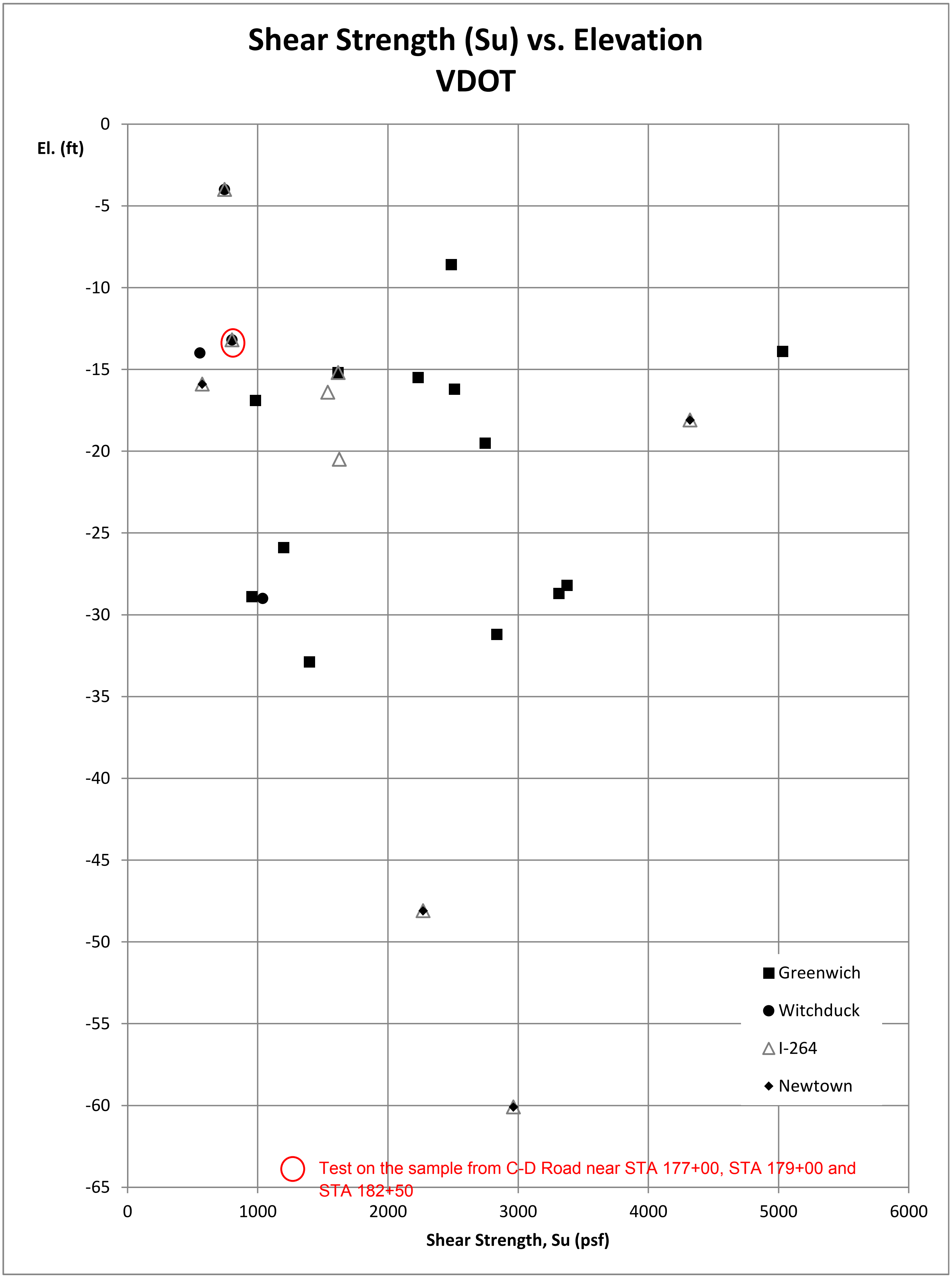
VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan

Shear Strength (Su) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
1000
2000
3000
4000
5000
6000
Shear Strength, Su (psf)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown
○ Test on the sample from C-D Road near STA 177+00, STA 179+00 and STA 182+50

CONE PENETROMETER TEST LOG

Virginia Department of Transportation

PROJECT #: 0264-134-102

LOCATION: VA Beach: PSA Witchduck

EB-17B

PAGE 1 OF 1

STATION: 183+52
LATITUDE: 36.840531° N
SURFACE ELEVATION: 16.3
BENCHMARK LOCATION:

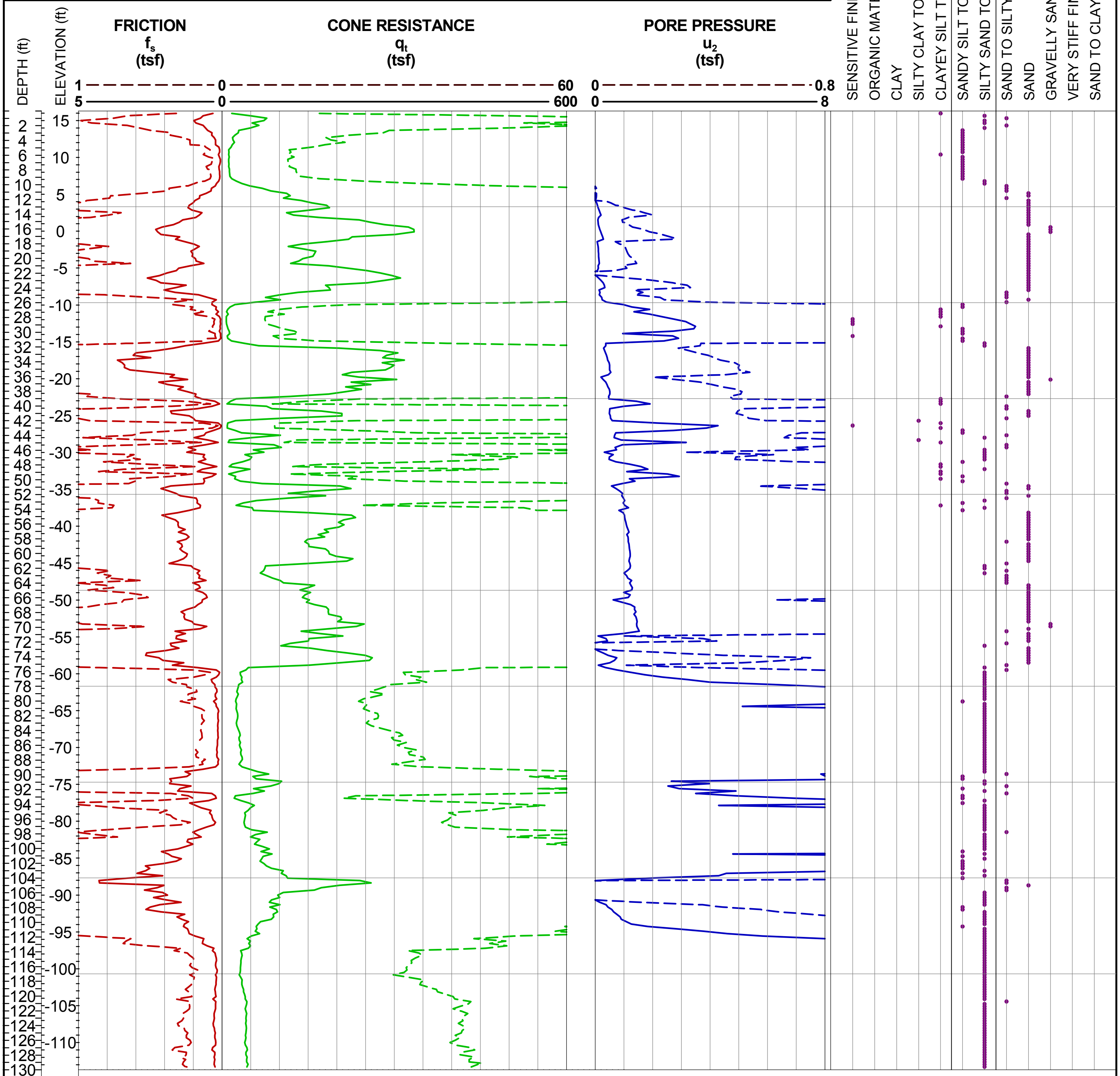
OFFSET: 118 ft RT
LONGITUDE: 76.163238° W
COORD. DATUM: NAD 83

DRILLER: Ron Stewart/MAD
CONE TYPE: Hogentogler Elec. Sub. Cone
CONE SIZE: 10 sq. cm
CONE ID No.: DSG1031

DATE(S) DRILLED:
01/18/11 - 01/18/11

LOGGER: HDR

SOIL BEHAVIOR TYPE *



* Campanella and Robertson (1983) Friction Ratio correlation

REMARKS: REFERENCE BASELINE: I-264 CD

PAGE 1 OF 1

EB-17B

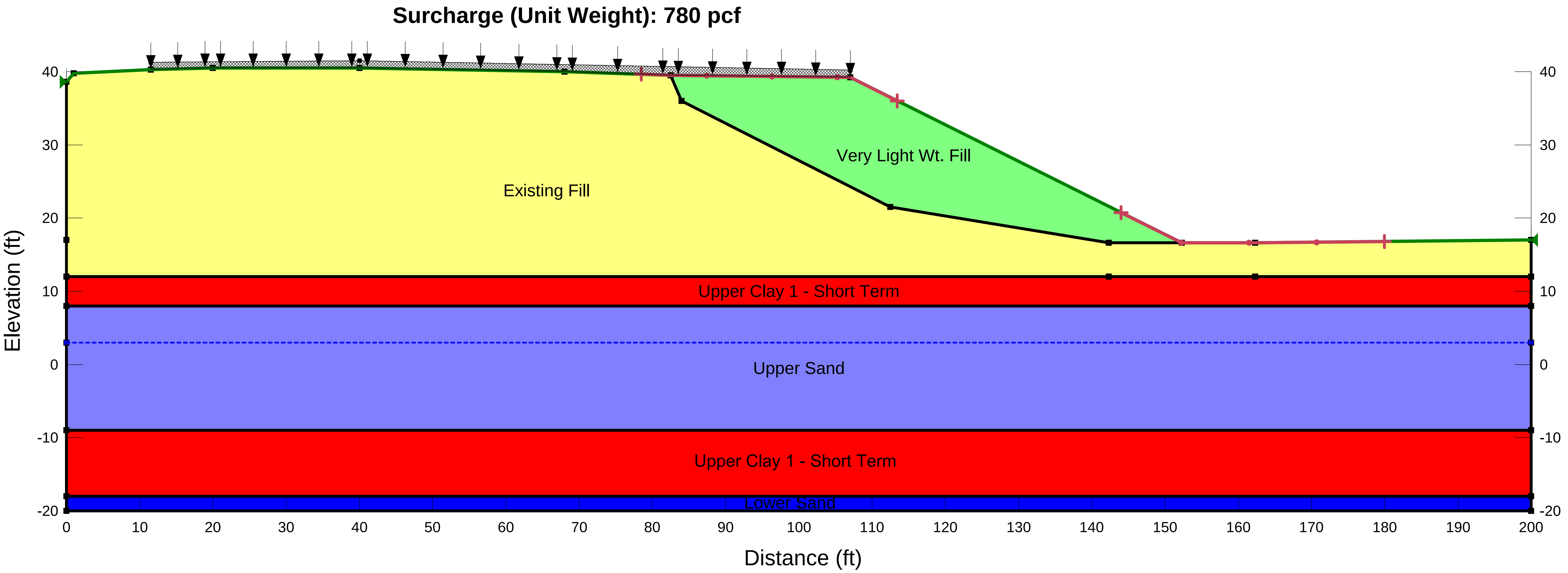
CPT_LOG:WITCHDUCK CPT LOGS.GPJ;8.30.003:061810:1/27/13

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Very Light Wt. Fill Unit Weight: 65 pcf Cohesion: 20 psf Phi: 35 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 182+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B

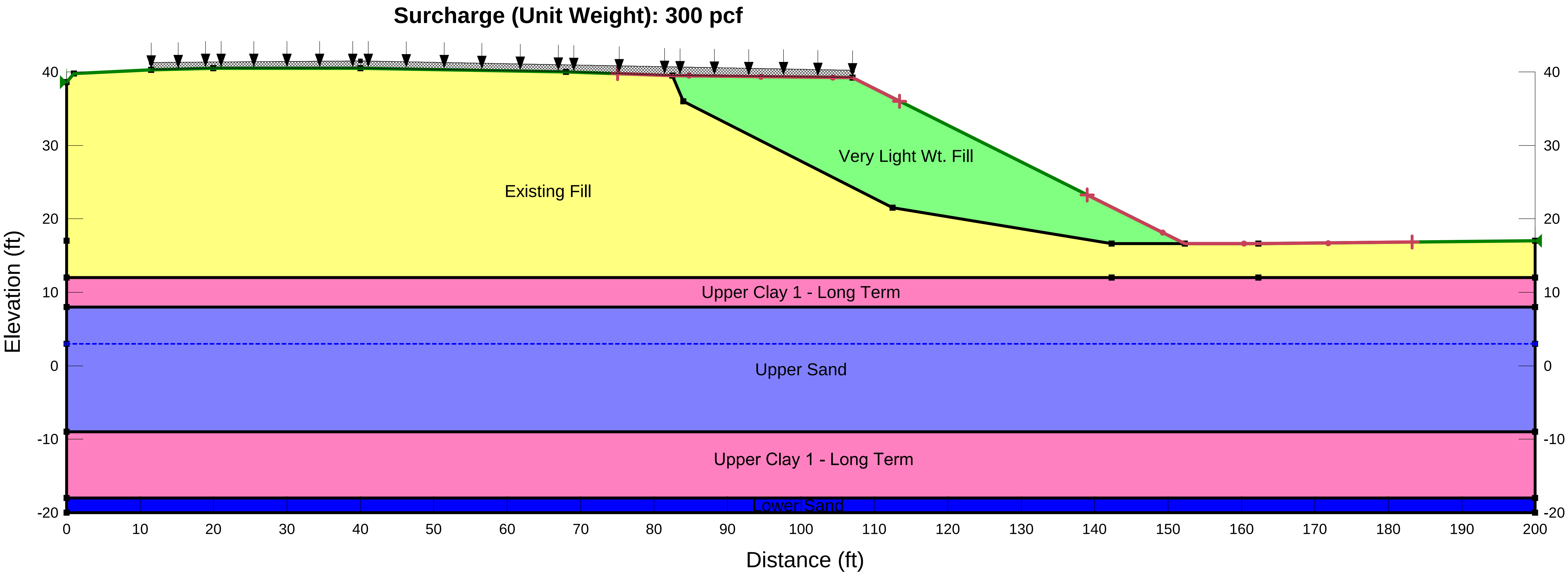


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Very Light Wt. Fill Unit Weight: 65 pcf Cohesion: 20 psf Phi: 35 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 182+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B

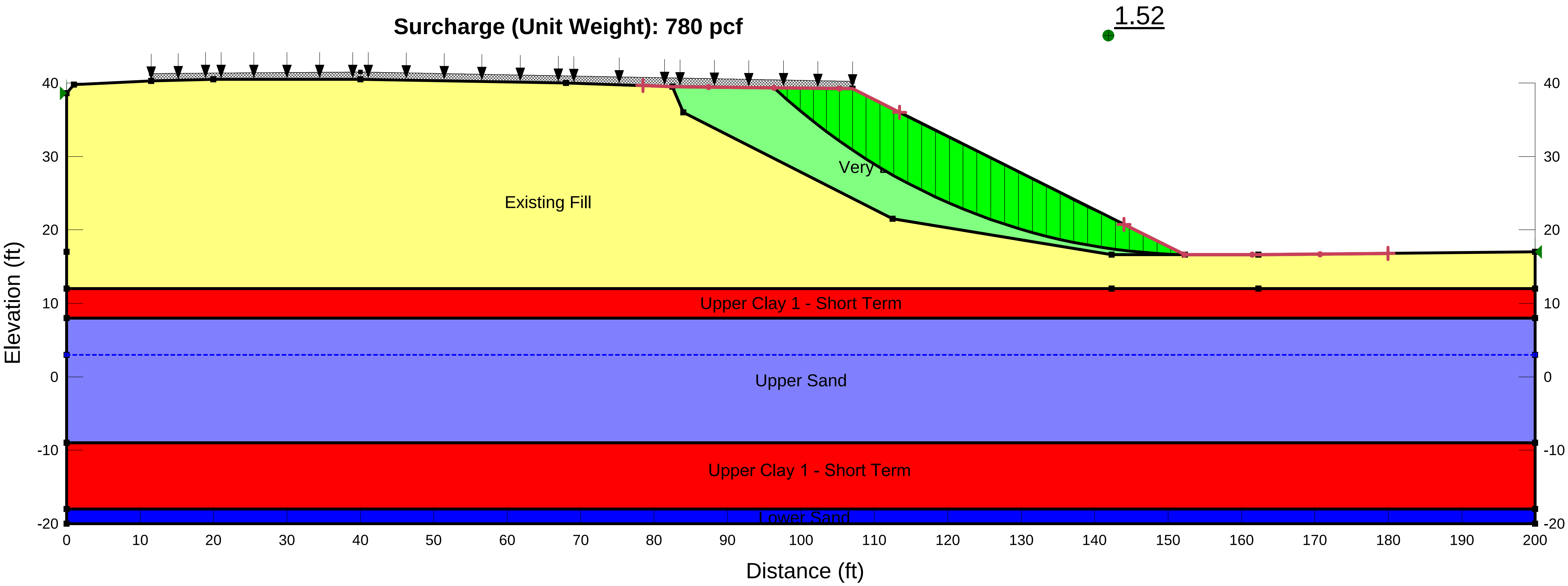


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Very Light Wt. Fill Unit Weight: 65 pcf Cohesion: 20 psf Phi: 35 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 182+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B



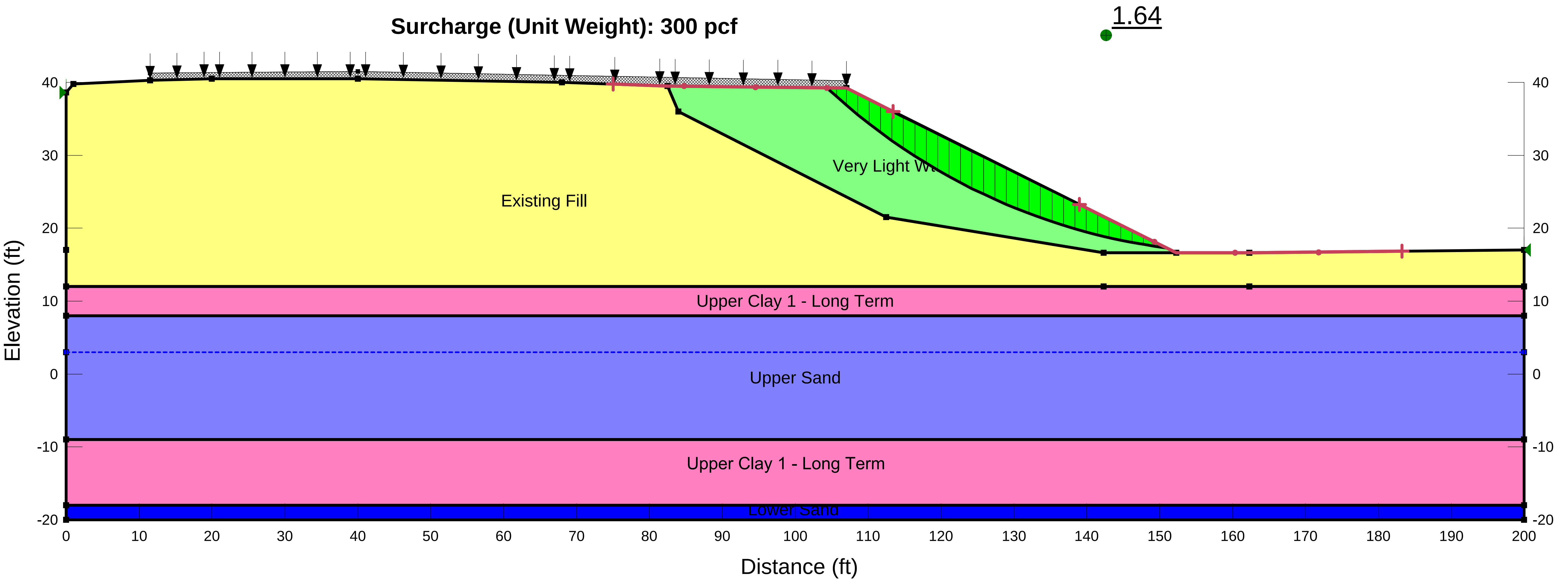
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 182+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Very Light Wt. Fill Unit Weight: 65 pcf Cohesion: 20 psf Phi: 35 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1



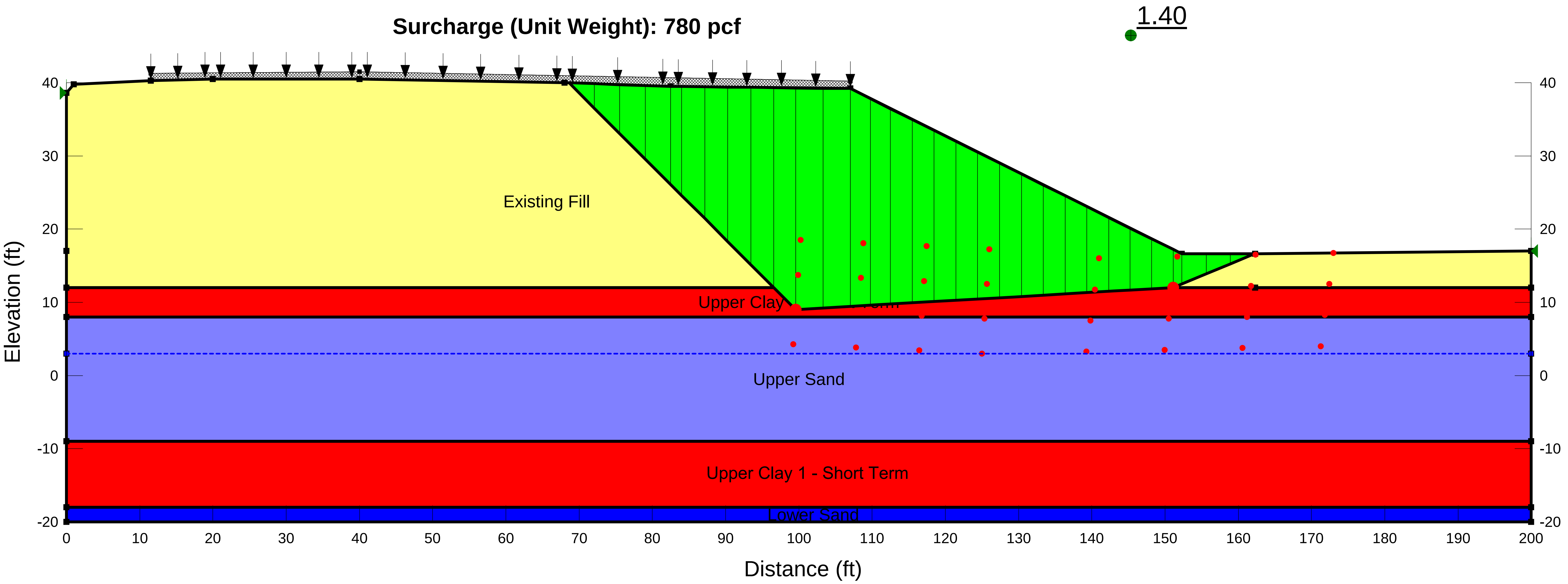
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Very Light Wt. Fill Unit Weight: 65 pcf Cohesion: 20 psf Phi: 35 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 182+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B

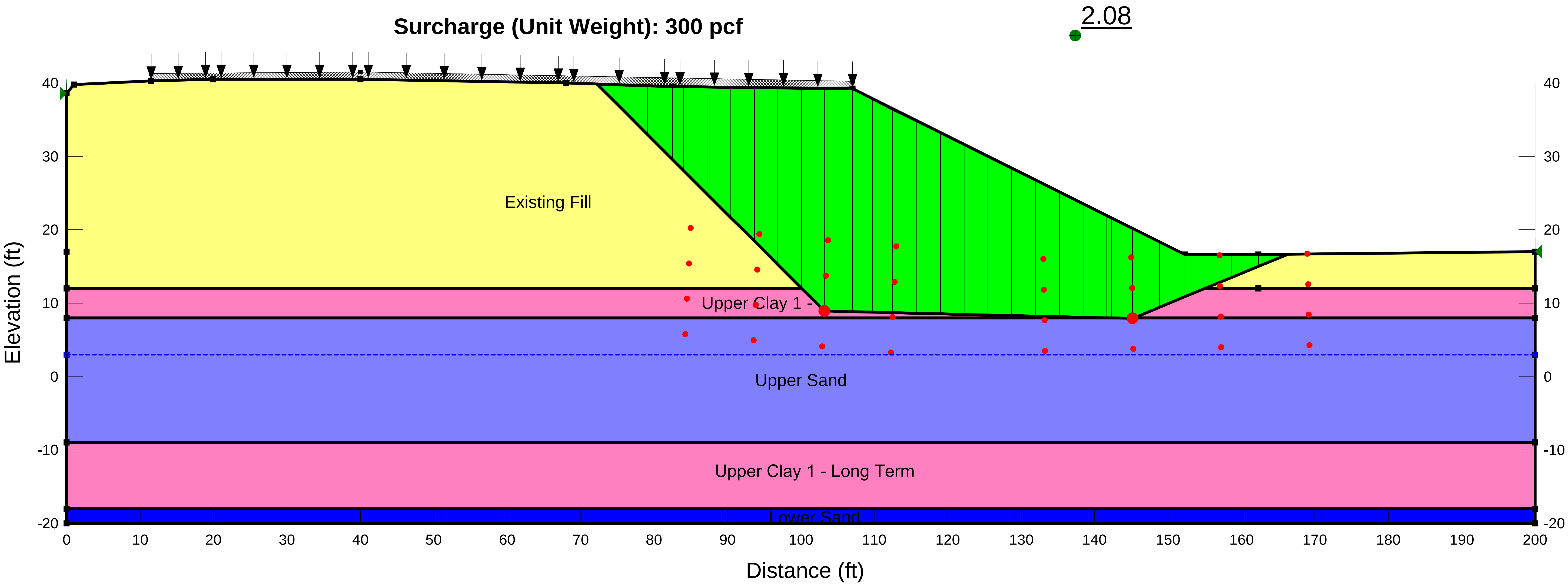


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

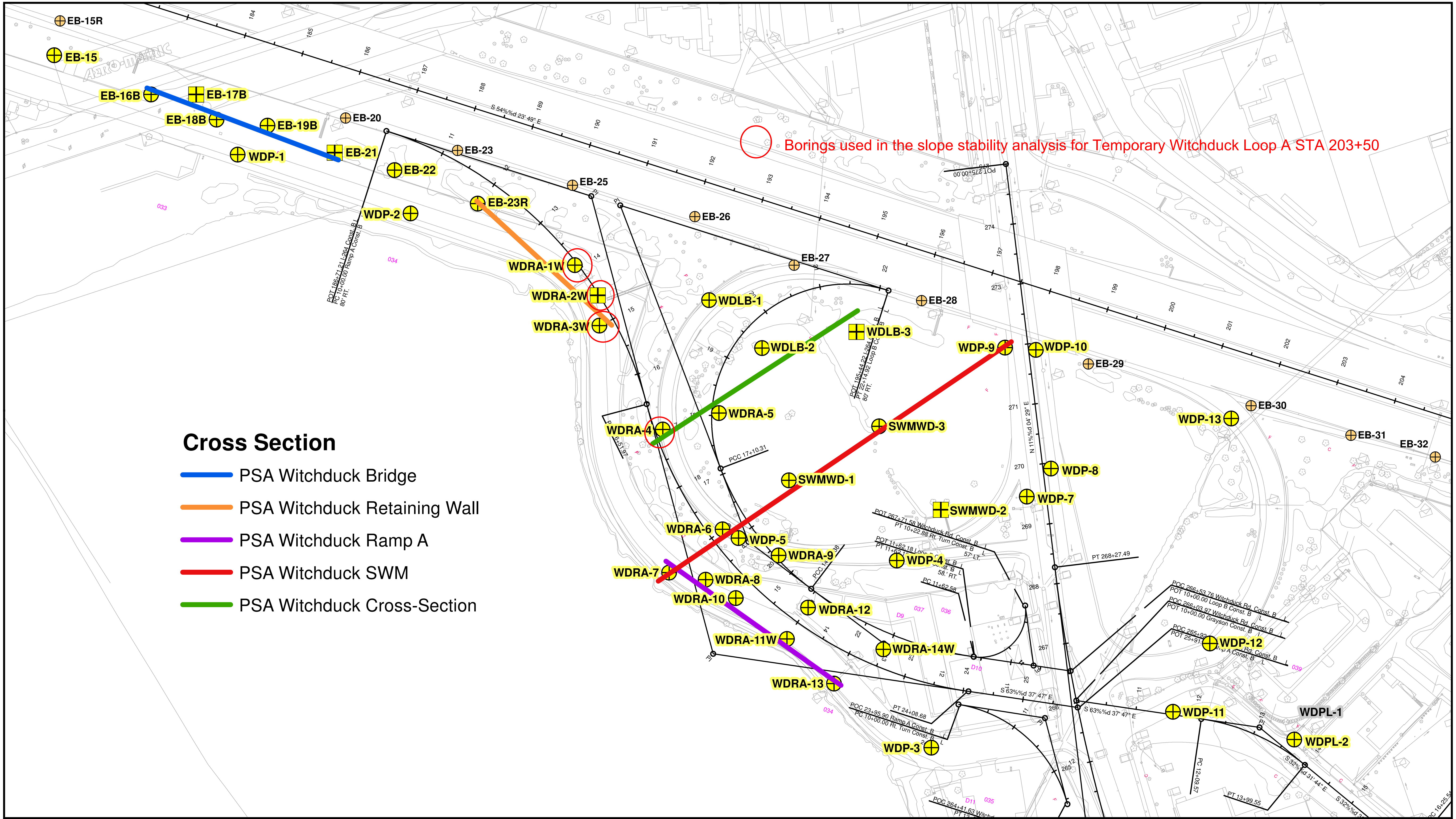
Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Very Light Wt. Fill Unit Weight: 65 pcf Cohesion: 20 psf Phi: 35 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

I-264 C-D Road
Analysis Location: Sta. 182+50
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: EB-17B, EB-18B, EB-19B



Slope Stability Analysis at

STATION 203+50


Borings used in the slope stability analysis for Temporary Witchduck Loop A STA 203+50

⊕	SPT Exploration
⊞	CPT Exploration
⊕	PSA I-264 CD Borings

Prepared by: HDR

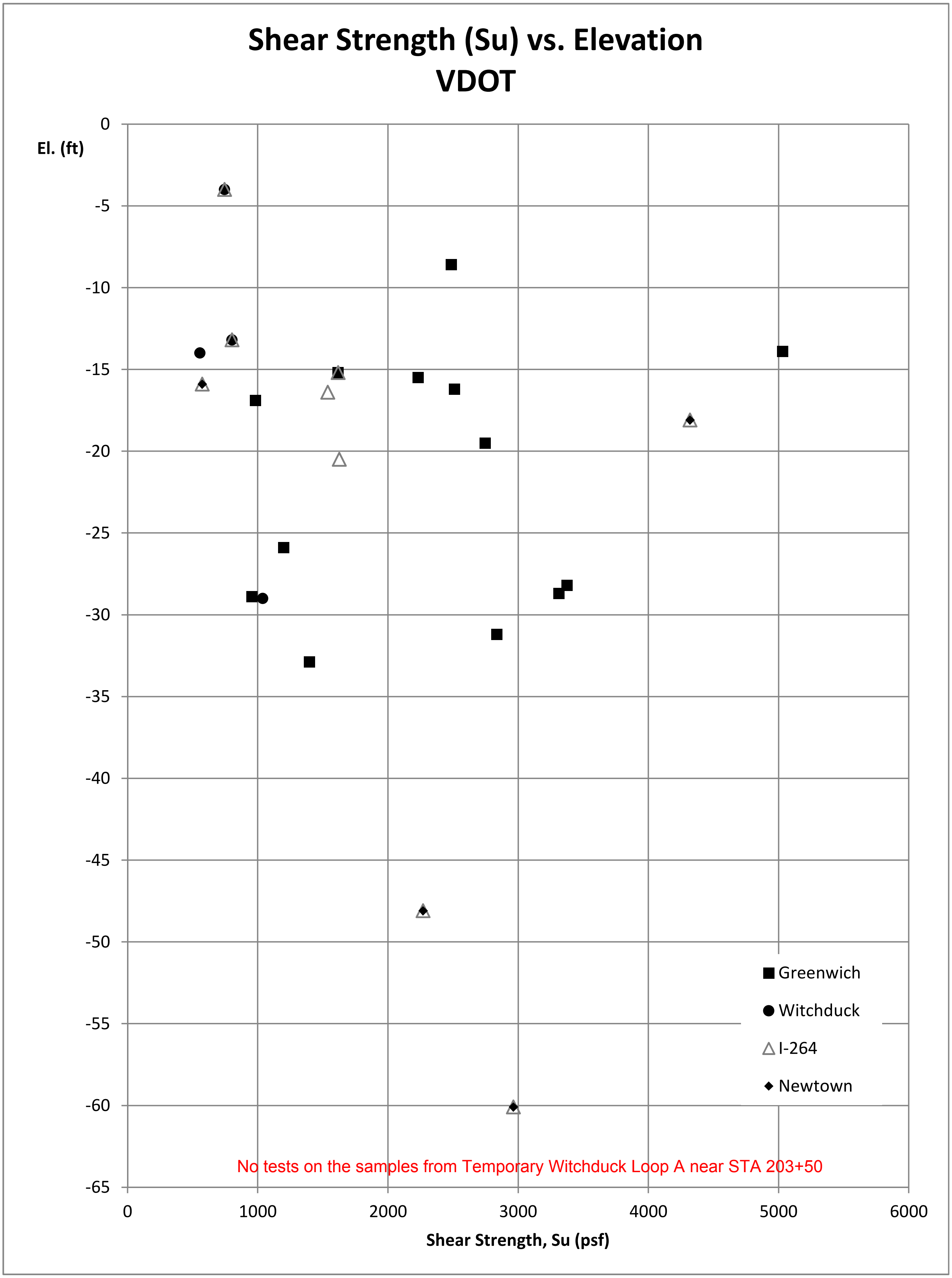
Date: February 13, 2013

VDOT Virginia Department of Transportation

Project 0264-134-102
City of Virginia Beach

Project Study Area
Witchduck

Drawing 4: Subsurface
Cross Section Locations


Shear Strength (Su) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
1000
2000
3000
4000
5000
6000
Shear Strength, Su (psf)
■ Greenwich
● Witchduck
△ I-264
◆ Newtown
No tests on the samples from Temporary Witchduck Loop A near STA 203+50

CONE PENETROMETER TEST LOG

PROJECT #: 0264-134-102
LOCATION: VA Beach: PSA Witchduck

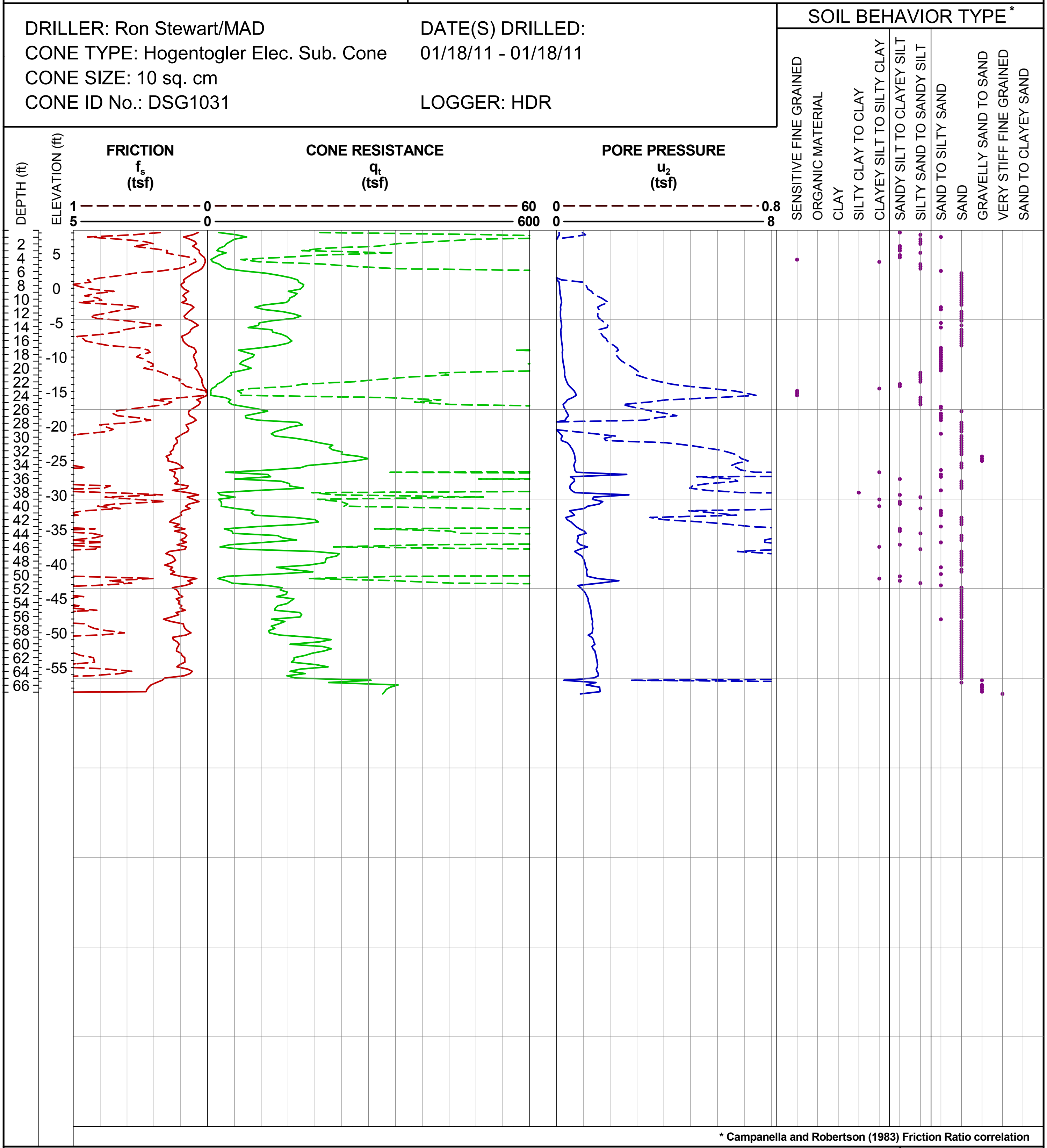
WDRA-2W
PAGE 1 OF 1

STATION: 14+53
OFFSET: 2 ft RT
LATITUDE: 36.839062° N
LONGITUDE: 76.161470° W
SURFACE ELEVATION: 8.4
COORD. DATUM: NAD 83
BENCHMARK LOCATION:

DRILLER: Ron Stewart/MAD
CONE TYPE: Hogentogler Elec. Sub. Cone
CONE SIZE: 10 sq. cm
CONE ID No.: DSG1031

DATE(S) DRILLED:
01/18/11 - 01/18/11

LOGGER: HDR



* Campanella and Robertson (1983) Friction Ratio correlation

REMARKS: REFERENCE BASELINE: RAMP A

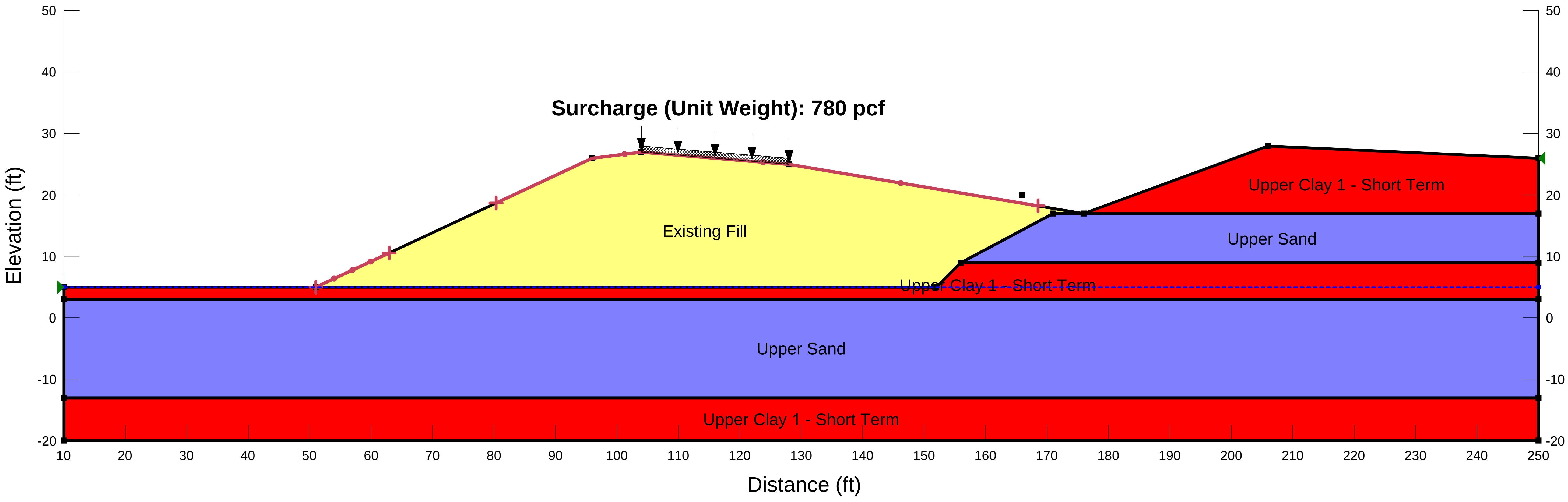
PAGE 1 OF 1
WDRA-2W

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill   Unit Weight: 125 pcf   Cohesion: 50 psf   Phi: 32 °   Piezometric Line: 1
Name: Upper Sand   Unit Weight: 115 pcf   Cohesion: 50 psf   Phi: 28 °   Piezometric Line: 1
Name: Upper Clay 1 - Short Term   Unit Weight: 112 pcf   Cohesion Spatial Fn: Upper Clay   Phi: 0 °   Piezometric Line: 1
Name: Upper Clay 2 - Short Term   Unit Weight: 112 pcf   Cohesion Spatial Fn: Upper Clay   Phi: 0 °   Piezometric Line: 1

Temporary Witchduck Loop A
Analysis Location: Sta. 203+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDRA-1W, 2W, 3W, 4

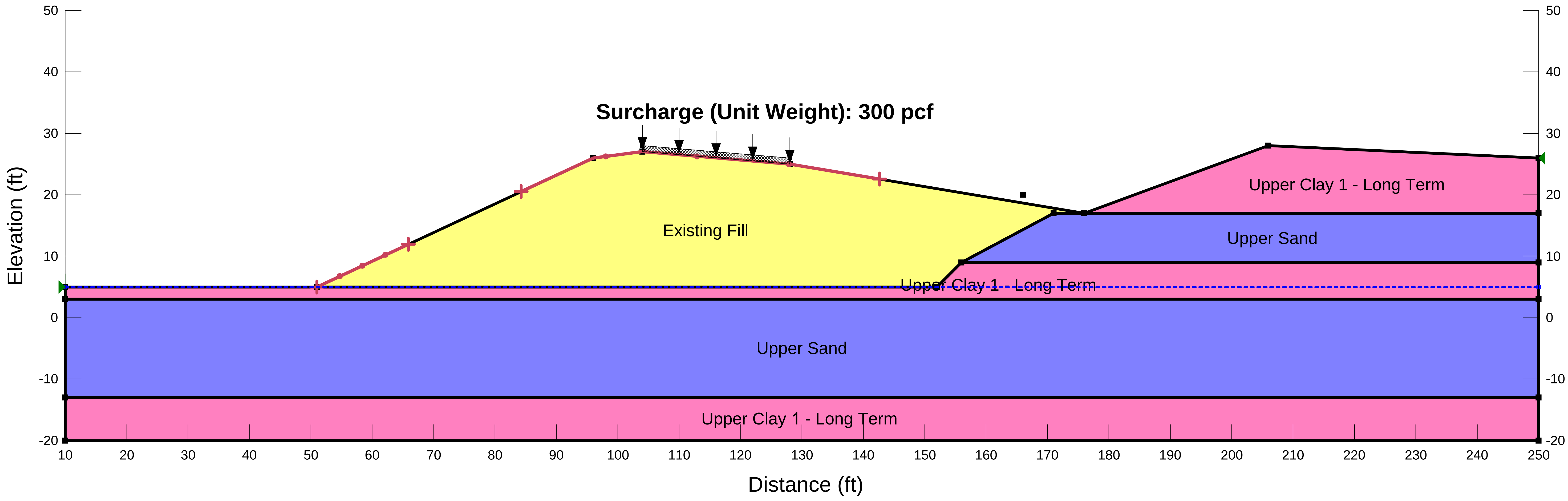


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 50 psf	Phi: 28 °	Piezometric Line: 1
Name: Upper Clay 1 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1
Name: Upper Clay 2 - Long Term	Unit Weight: 112 pcf	Cohesion: 0 psf	Phi: 23 °	Piezometric Line: 1

Temporary Witchduck Loop A
Analysis Location: Sta. 203+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDRA-1W, 2W, 3W, 4

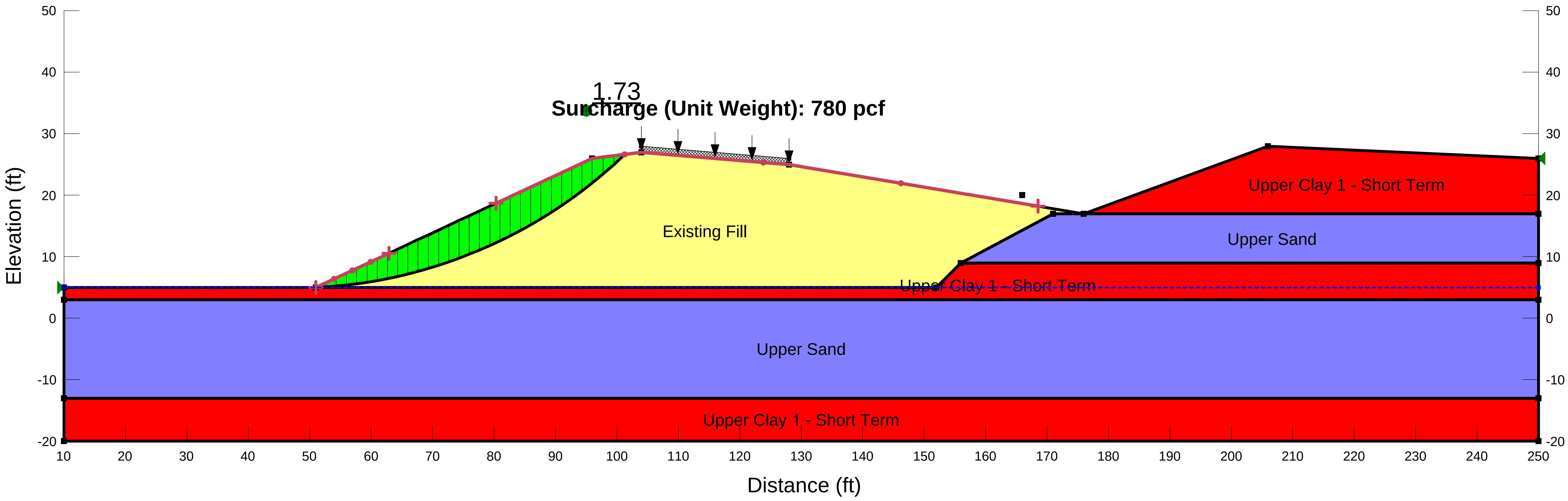


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 28 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Temporary Witchduck Loop A
Analysis Location: Sta. 203+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDRA-1W, 2W, 3W, 4



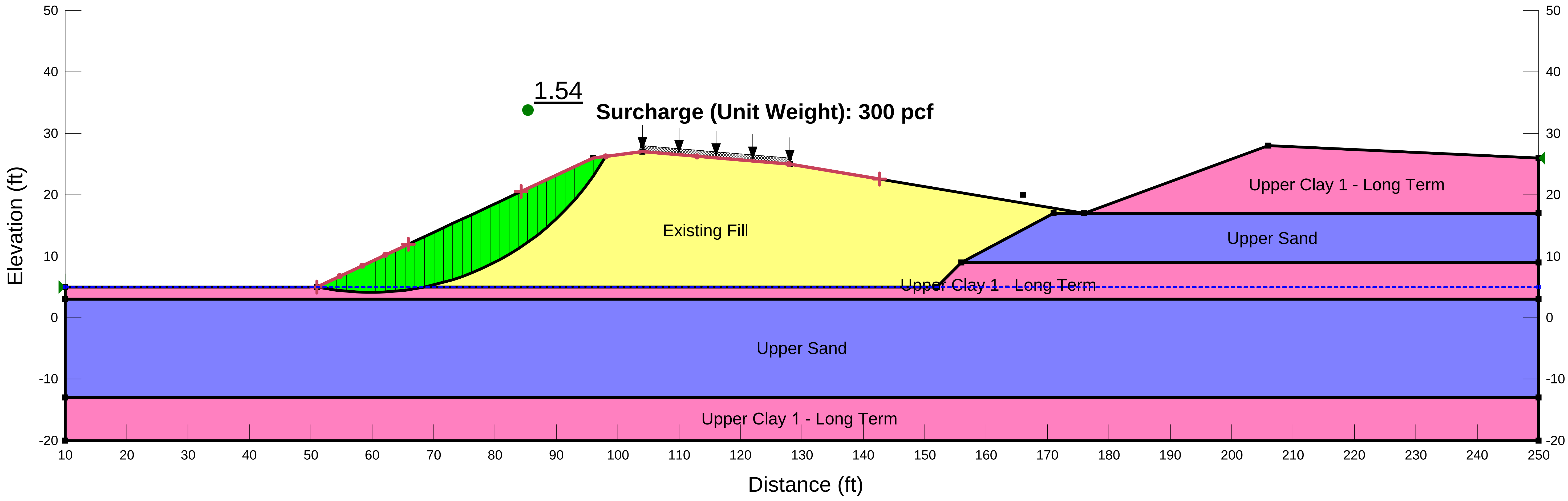
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 28 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

Temporary Witchduck Loop A
Analysis Location: Sta. 203+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDRA-1W, 2W, 3W, 4

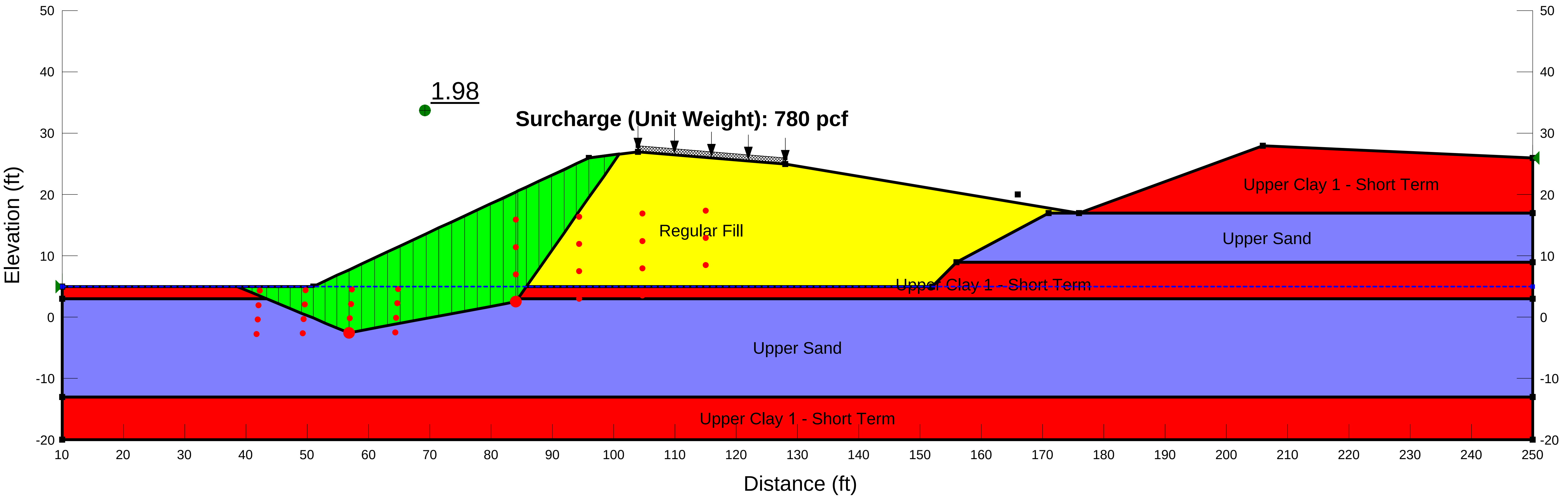


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 50 psf	Phi: 28 °	Piezometric Line: 1
Name: Upper Clay 1 - Short Term	Unit Weight: 112 pcf	Cohesion Spatial Fn: Upper Clay	Phi: 0 °	Piezometric Line: 1
Name: Upper Clay 2 - Short Term	Unit Weight: 112 pcf	Cohesion Spatial Fn: Upper Clay	Phi: 0 °	Piezometric Line: 1

Temporary Witchduck Loop A
Analysis Location: Sta. 203+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDRA-1W, 2W, 3W, 4

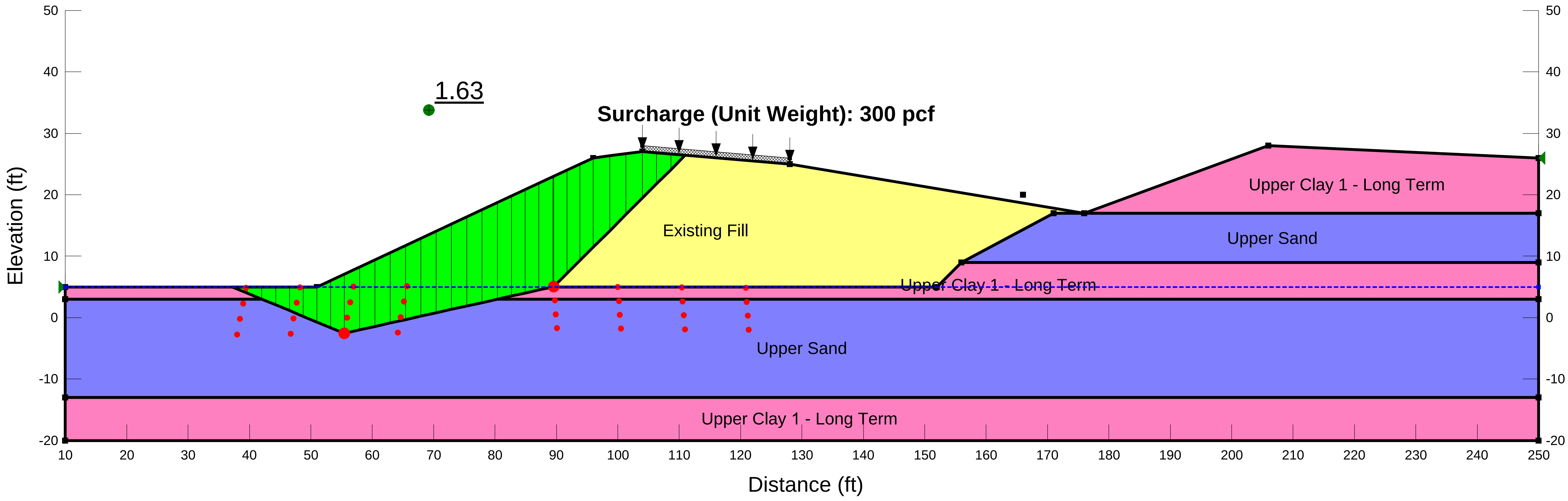


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

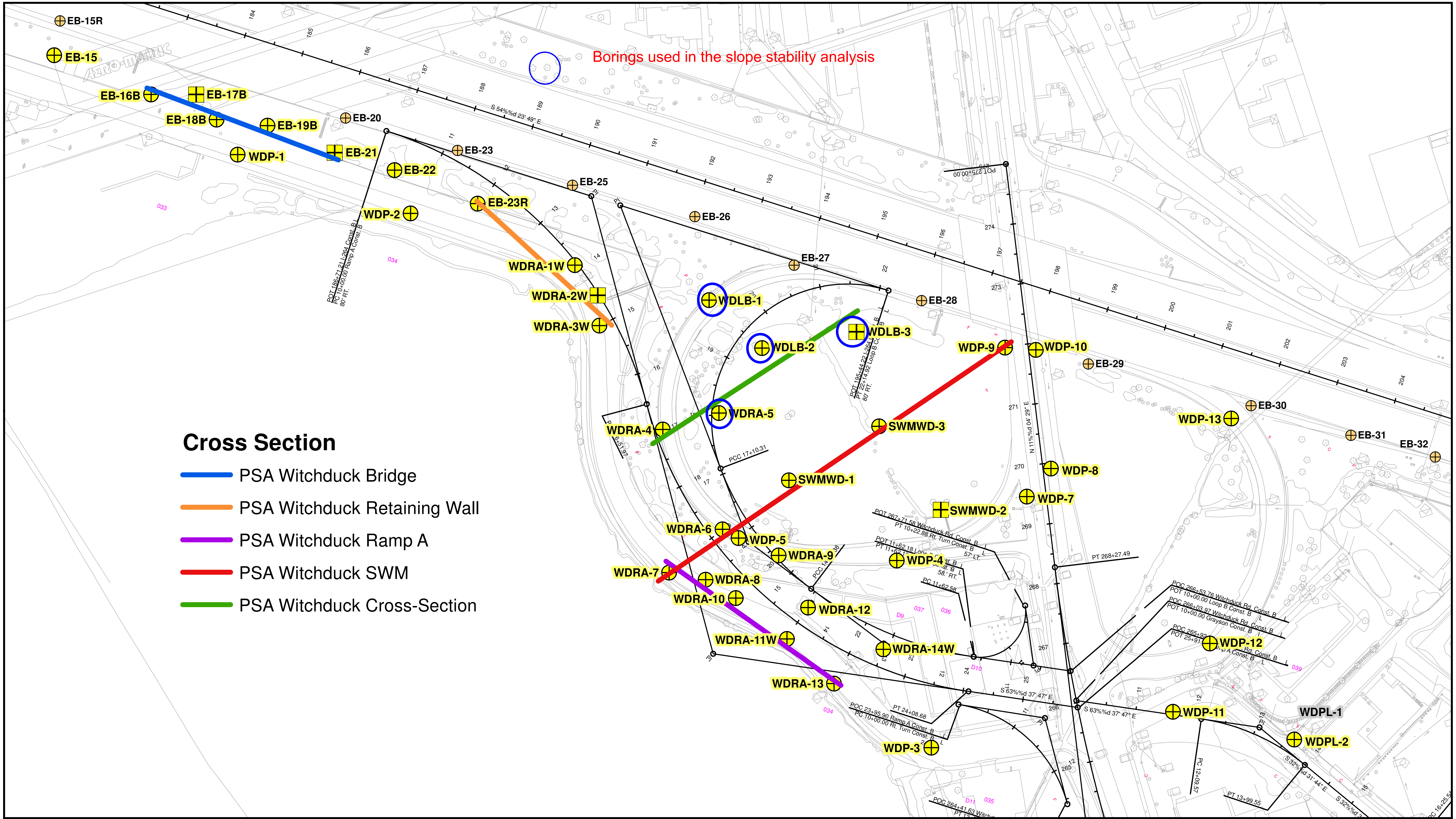
Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 28 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

Temporary Witchduck Loop A
Analysis Location: Sta. 203+50
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDRA-1W, 2W, 3W, 4



Slope Stability Analysis at
STATION 208+00



N

0 75 150 Feet

Scale: 1" = 150'

⊕ SPT Exploration

⊞ CPT Exploration

⊕ PSA I-264 CD Borings

Prepared by: HDR

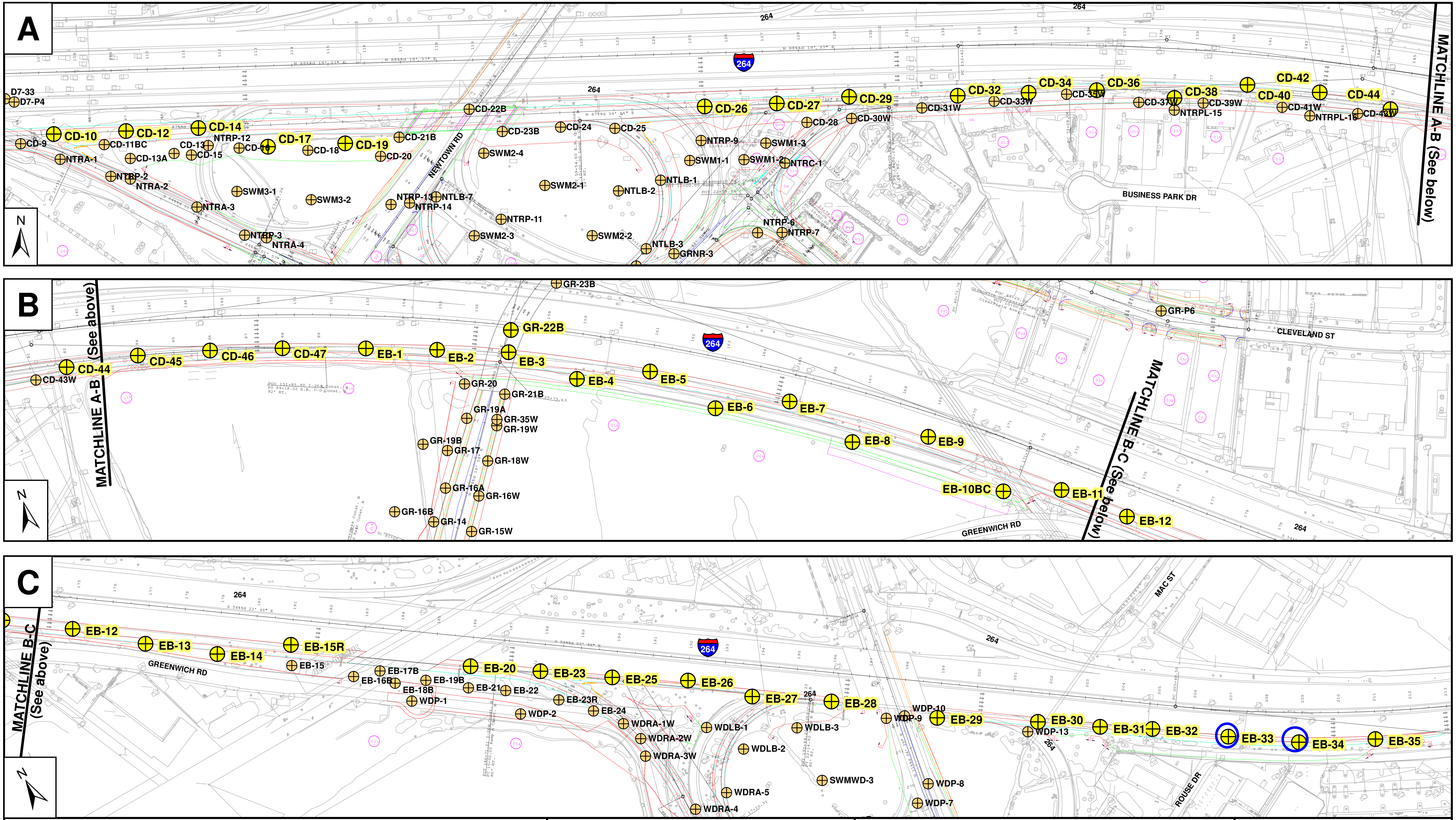
Date: February 13, 2013

VDOT Virginia Department of Transportation

Project 0264-134-102
City of Virginia Beach

Project Study Area
Witchduck

Drawing 4: Subsurface Cross Section Locations



0 125 250 Feet

⊕	SPT Exploration Locations
⊕	Borings in other PSAs

Prepared by: HDR

Date: November 2011

VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan

CONE PENETROMETER TEST LOG

Virginia Department of Transportation

PROJECT #: 0264-134-102

LOCATION: VA Beach: PSA Witchduck

WDLB-3

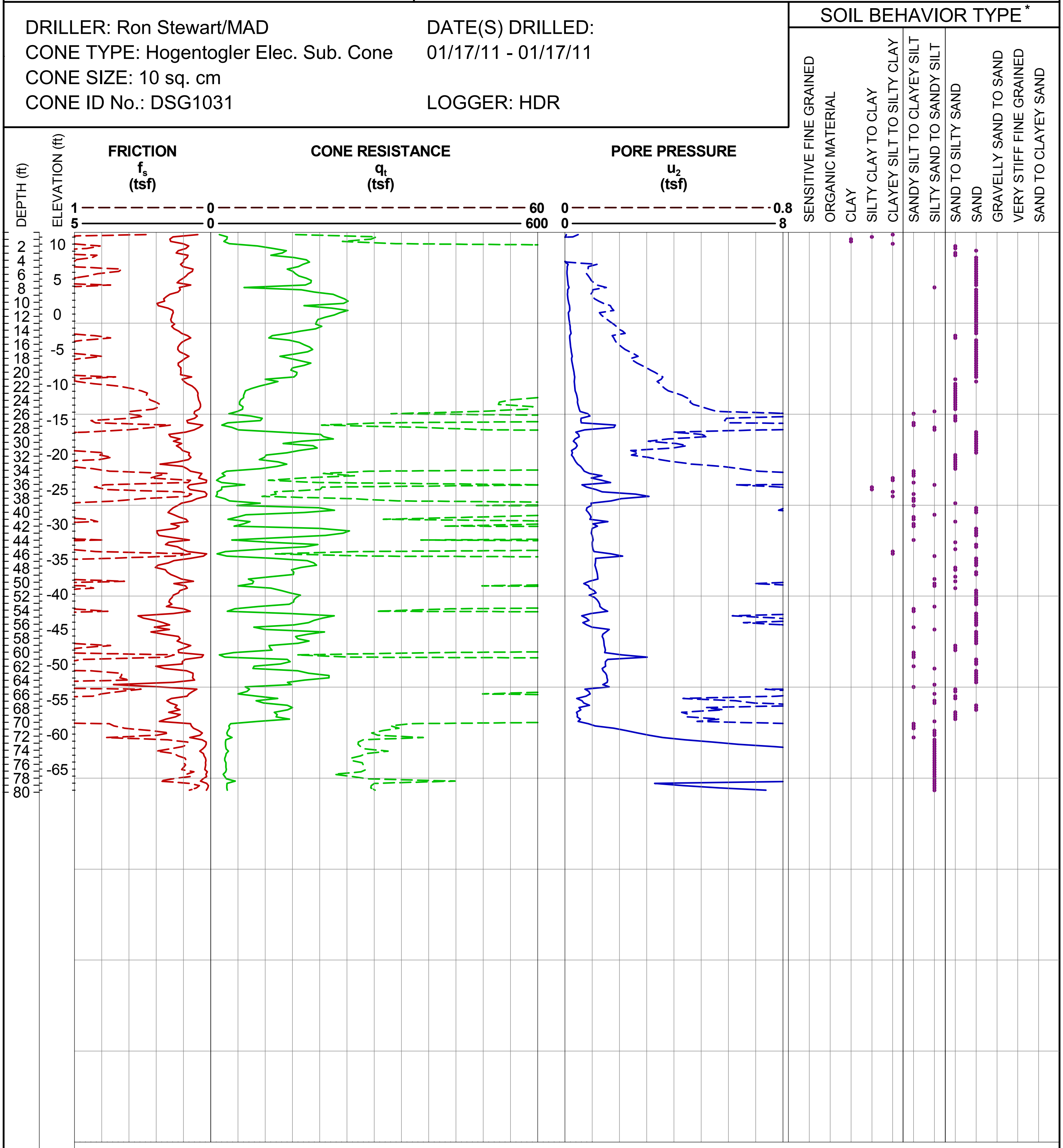
PAGE 1 OF 1

STATION: 21+69
OFFSET: 78 ft RT
LATITUDE: 36.838513° N
LONGITUDE: 76.160156° W
SURFACE ELEVATION: 11.7
COORD. DATUM: NAD 83
BENCHMARK LOCATION:

DRILLER: Ron Stewart/MAD
CONE TYPE: Hogentogler Elec. Sub. Cone
CONE SIZE: 10 sq. cm
CONE ID No.: DSG1031

DATE(S) DRILLED:
01/17/11 - 01/17/11

LOGGER: HDR



* Campanella and Robertson (1983) Friction Ratio correlation

REMARKS: REFERENCE BASELINE: LOOP B

PAGE 1 OF 1

WDLB-3

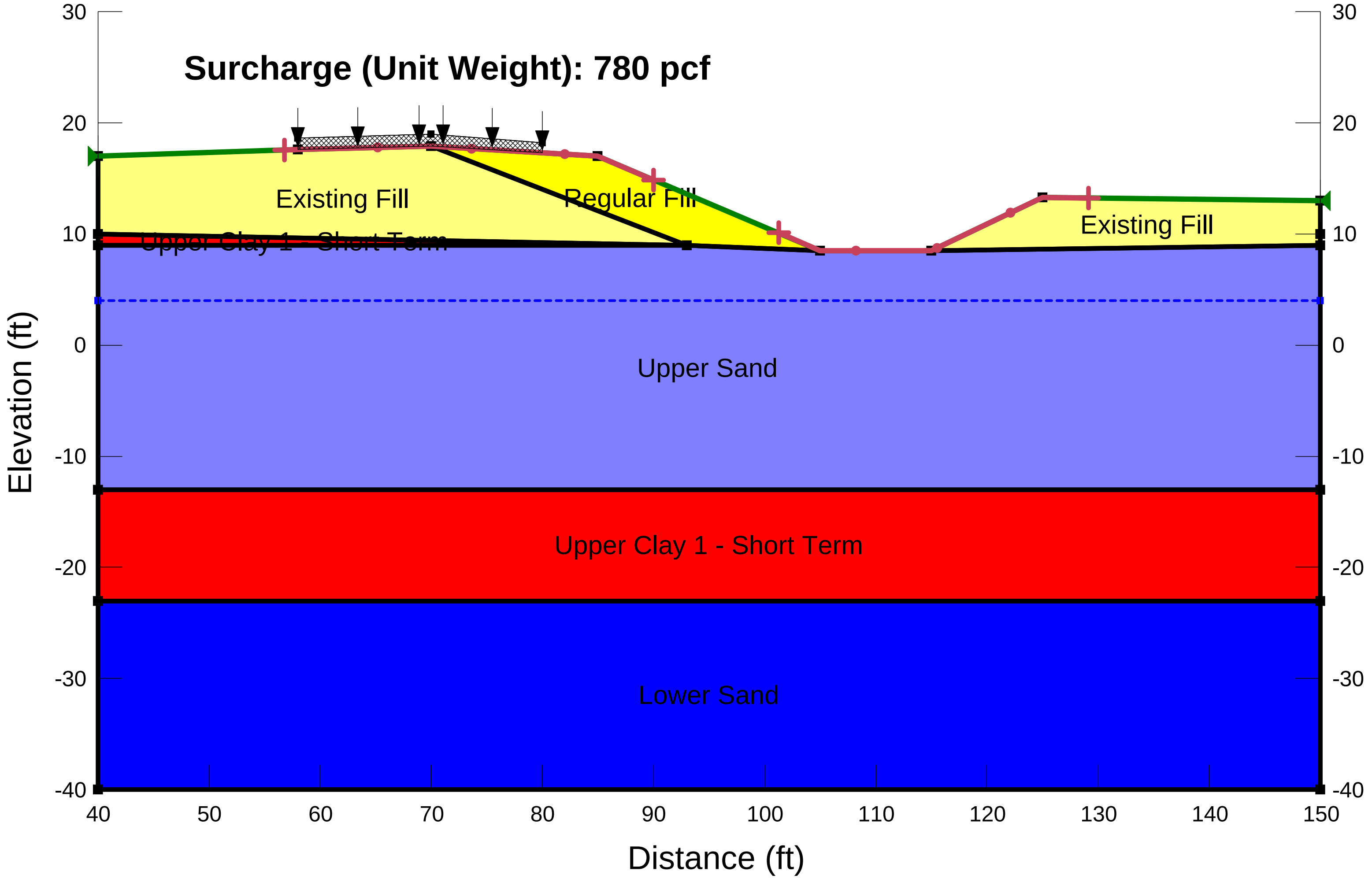
CPT_LOG:WITCHDUCK CPT LOGS.GPJ:8.30.003:061810:1/27/13

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 208+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: WDLB-1, 2, 3

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1



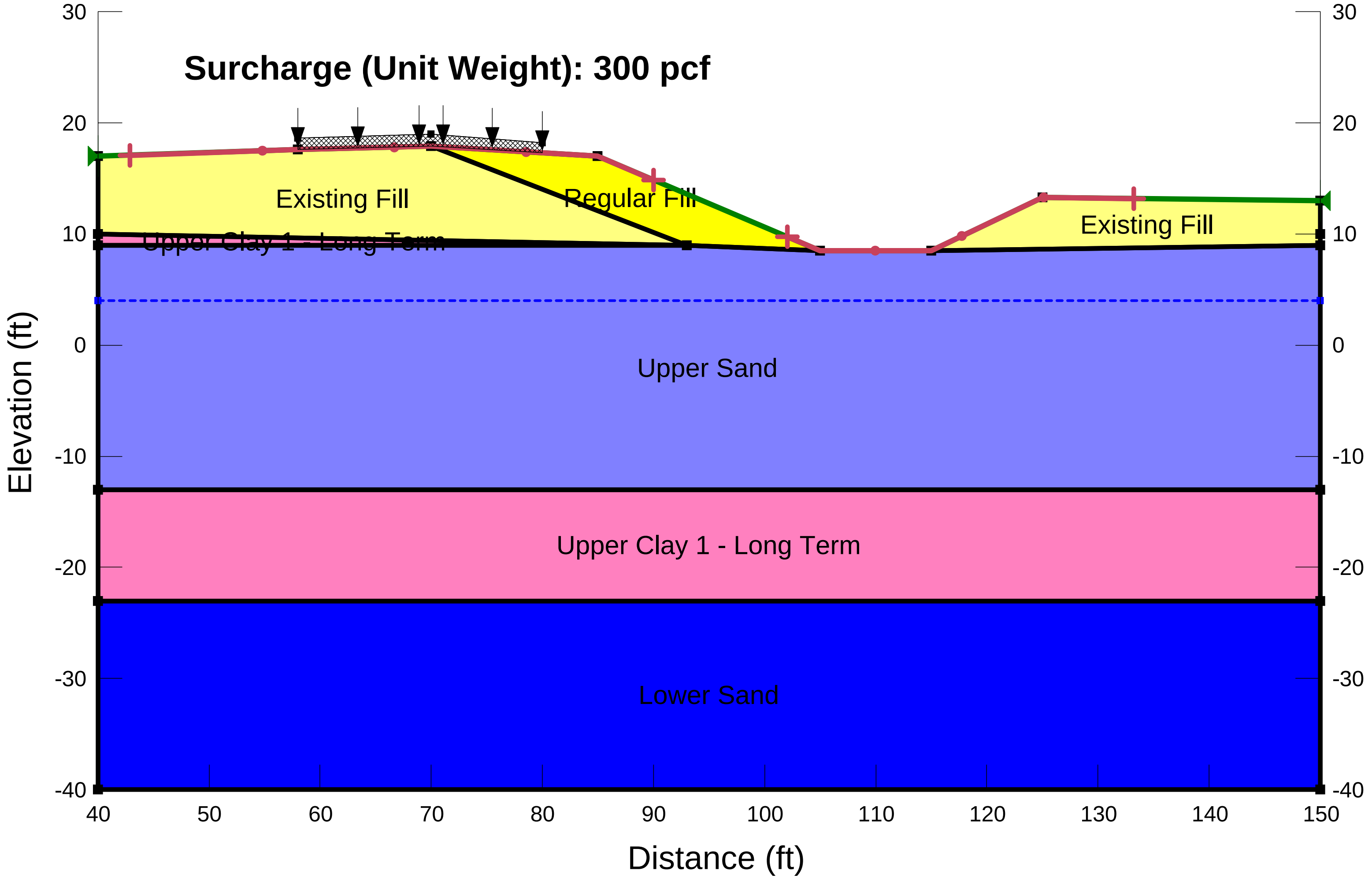
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 208+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: WDLB-1, 2, 3

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

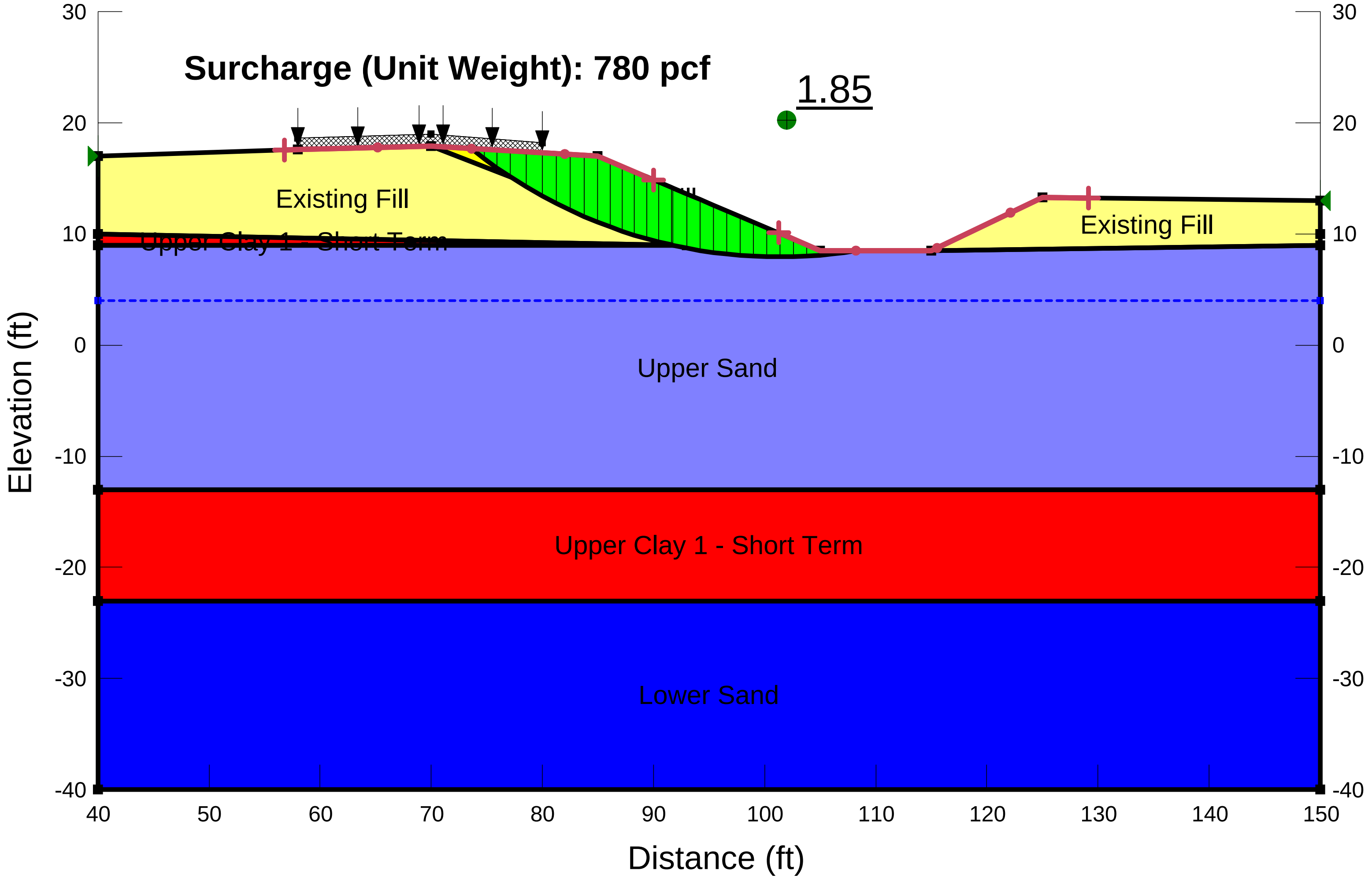


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 208+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: WDLB-1, 2, 3

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 0 psf	Phi: 30 °	Piezometric Line: 1
Name: Lower Sand	Unit Weight: 125 pcf	Cohesion: 0 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Clay 1 - Short Term	Unit Weight: 112 pcf	Cohesion Spatial Fn: Upper Clay	Phi: 0 °	Piezometric Line: 1



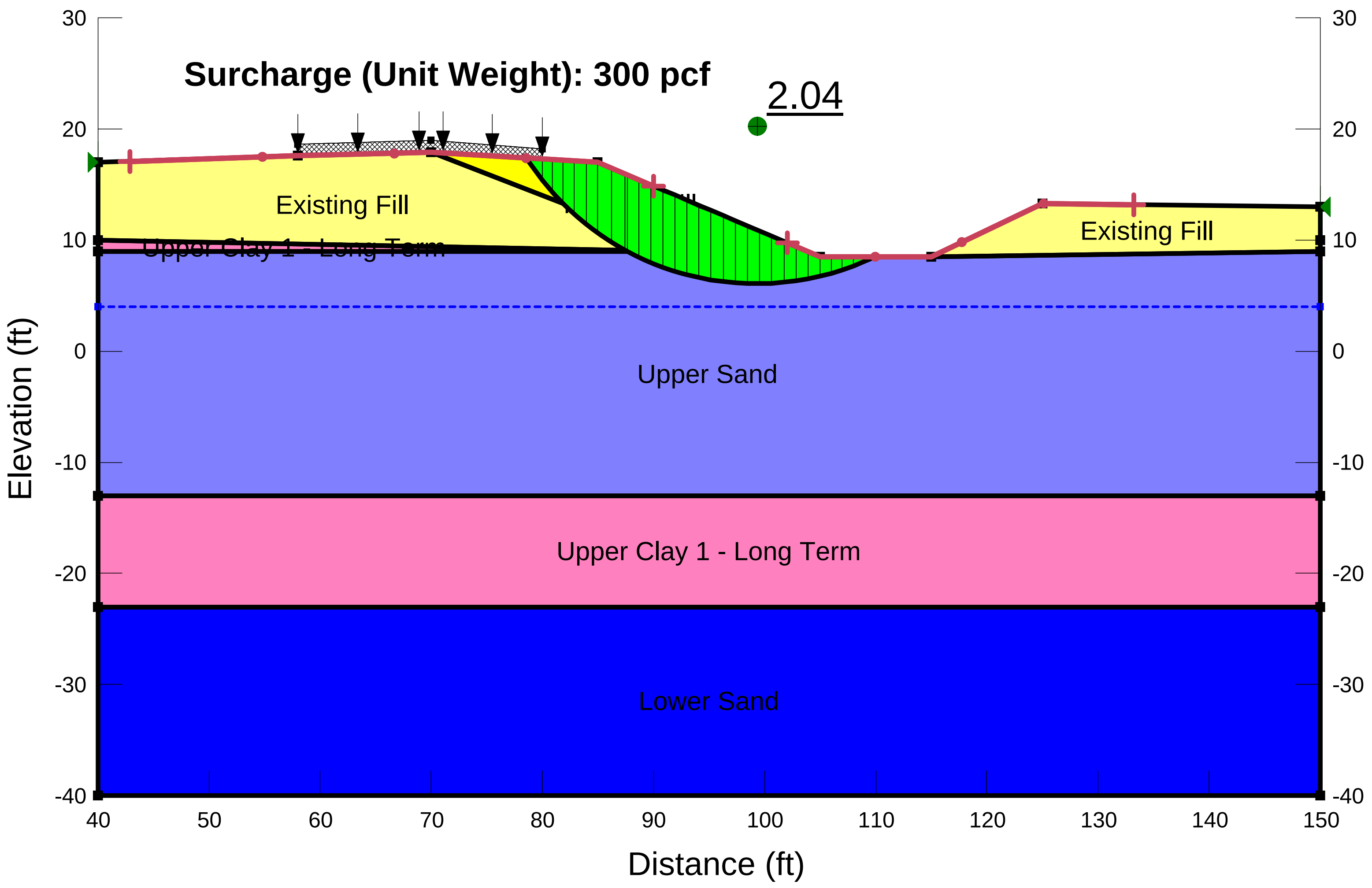
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 208+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: WDLB-1, 2, 3

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

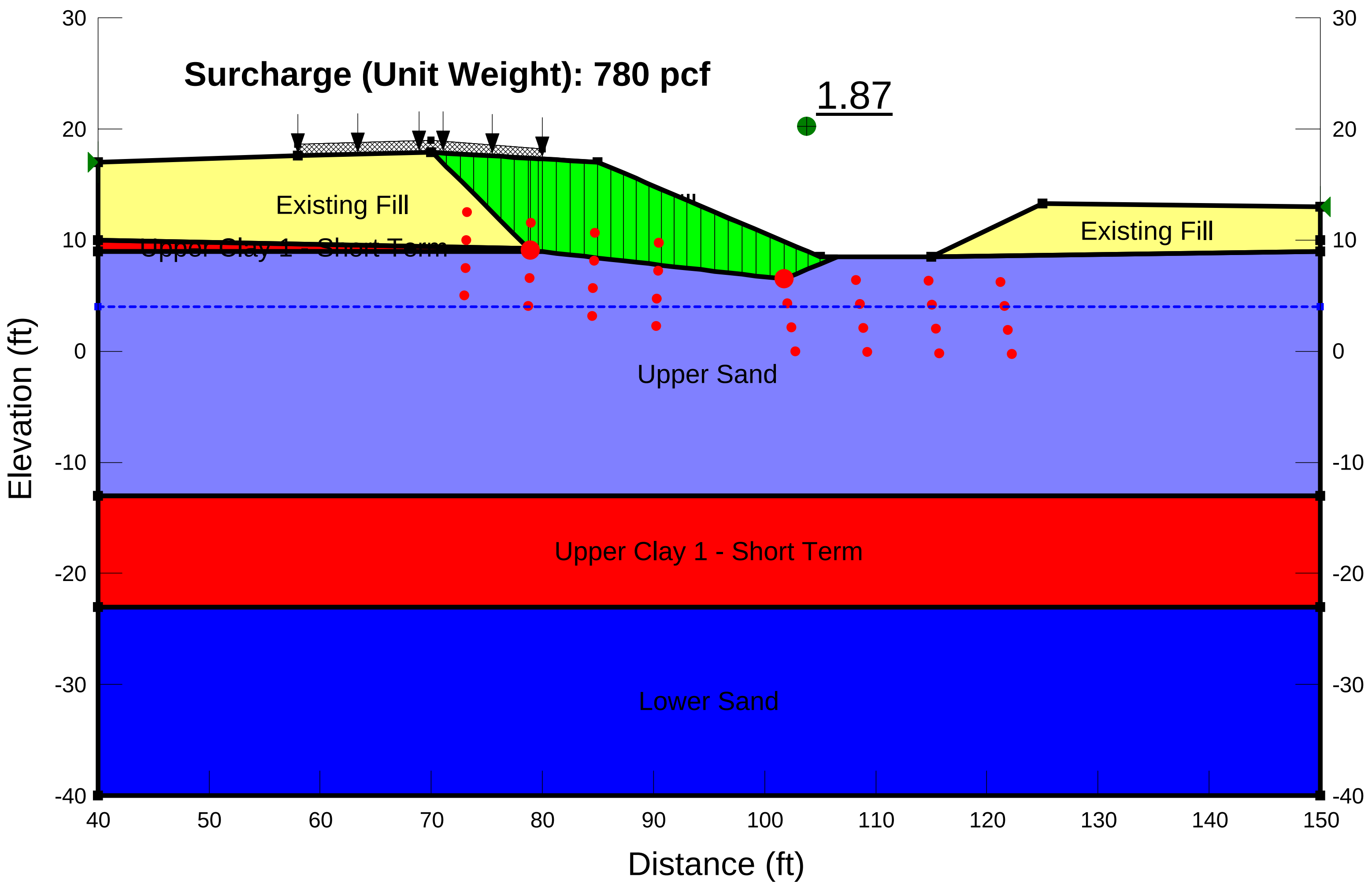


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 208+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: WDLB-1, 2, 3

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

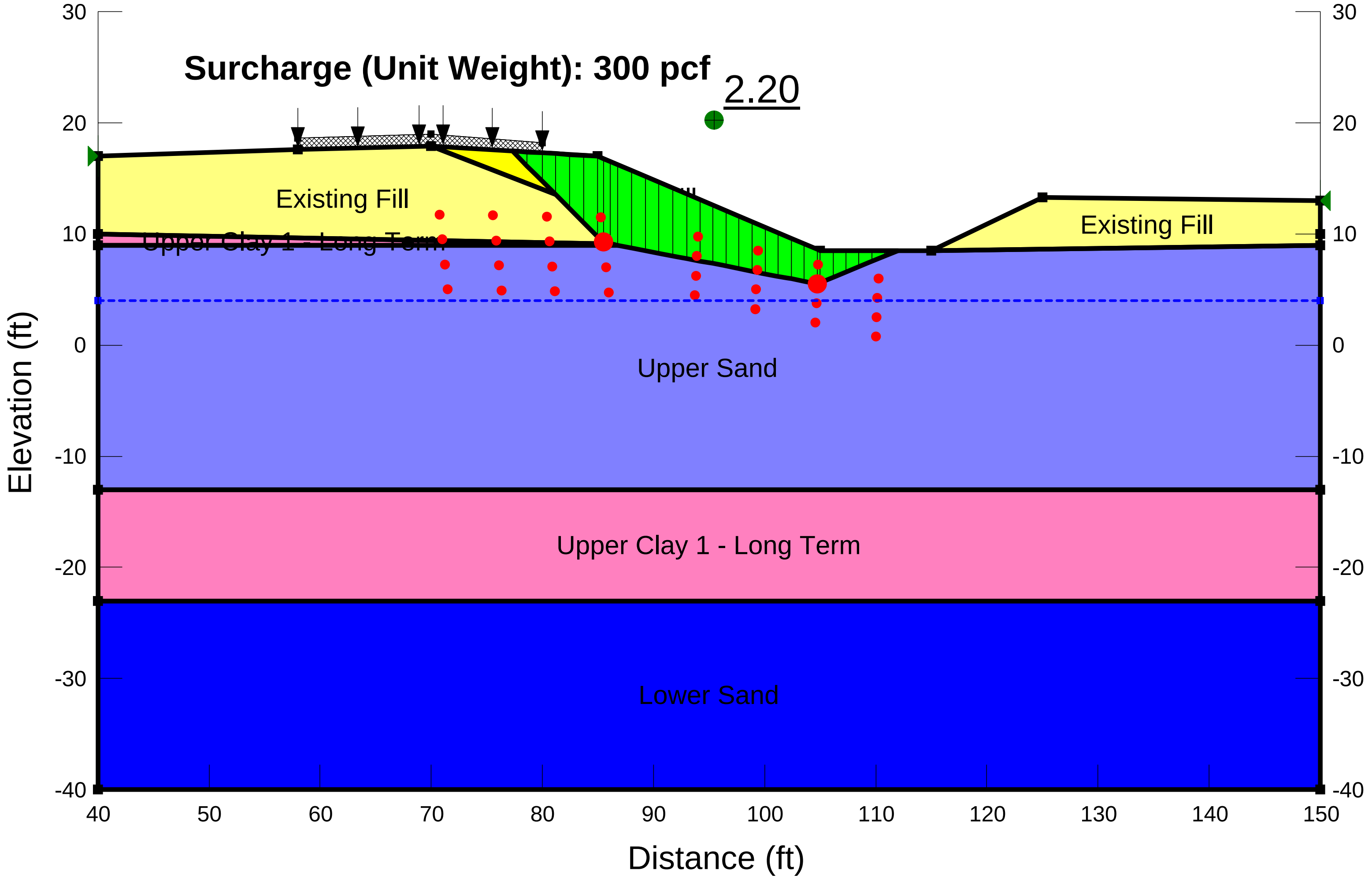


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

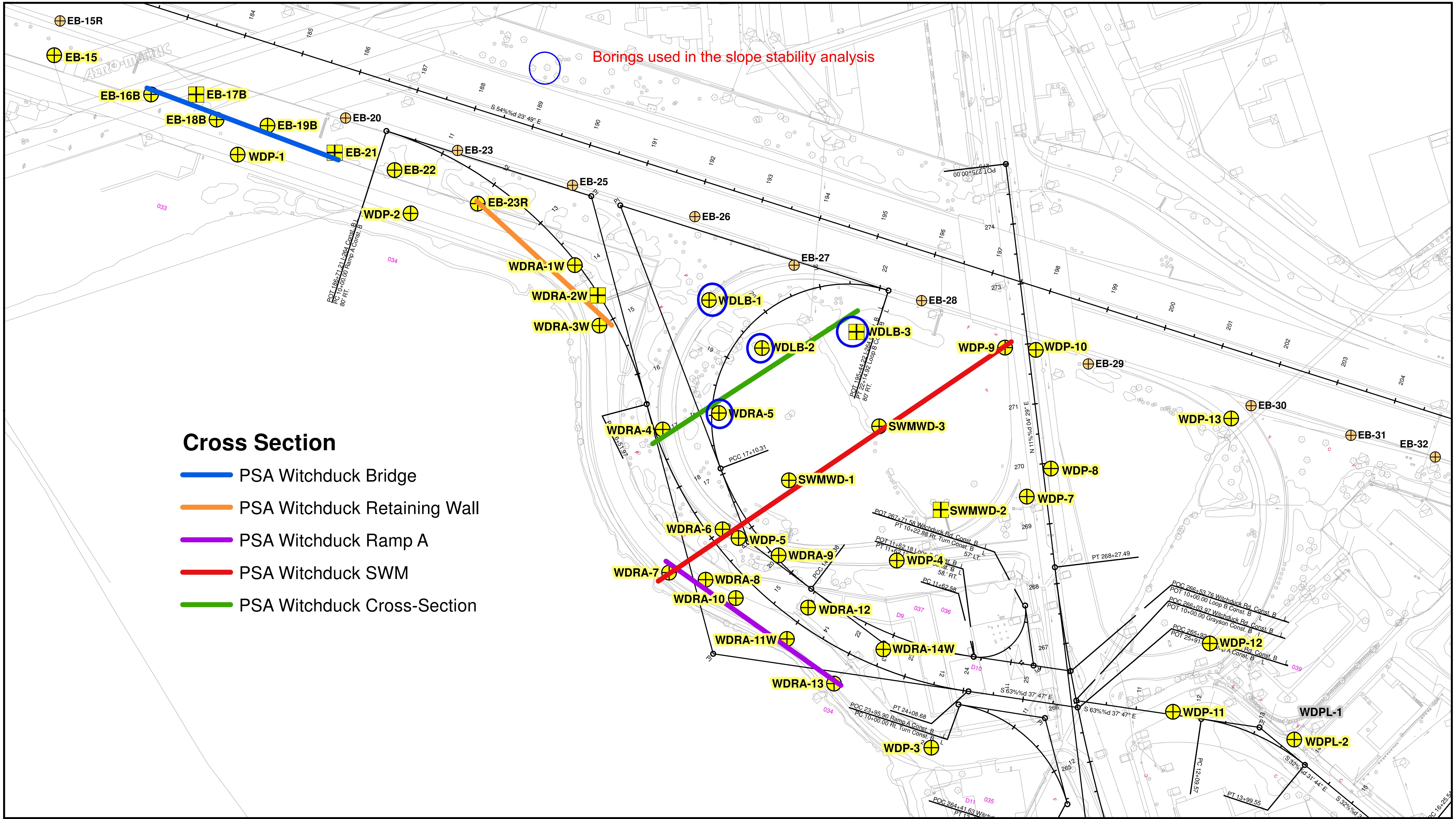
Long Term Global Stability Analysis

I-264 C-D Road
Analysis Location: Sta. 208+00
GER Used for Soil Parameters: PSA I264 CD
Borings Used for Profile: WDLB-1, 2, 3

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Lower Sand Unit Weight: 125 pcf Cohesion: 0 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1



Slope Stability Analysis at
STATION 407+66



N

0 75 150 Feet

Scale: 1" = 150'

⊕ SPT Exploration

⊞ CPT Exploration

⊕ PSA I-264 CD Borings

Prepared by: HDR

Date: February 13, 2013

VDOT Virginia Department of Transportation

Project 0264-134-102

City of Virginia Beach

Project Study Area
Witchduck

Drawing 4: Subsurface Cross Section Locations

CONE PENETROMETER TEST LOG

PROJECT #: 0264-134-102
LOCATION: VA Beach: PSA Witchduck

WDLB-3
PAGE 1 OF 1

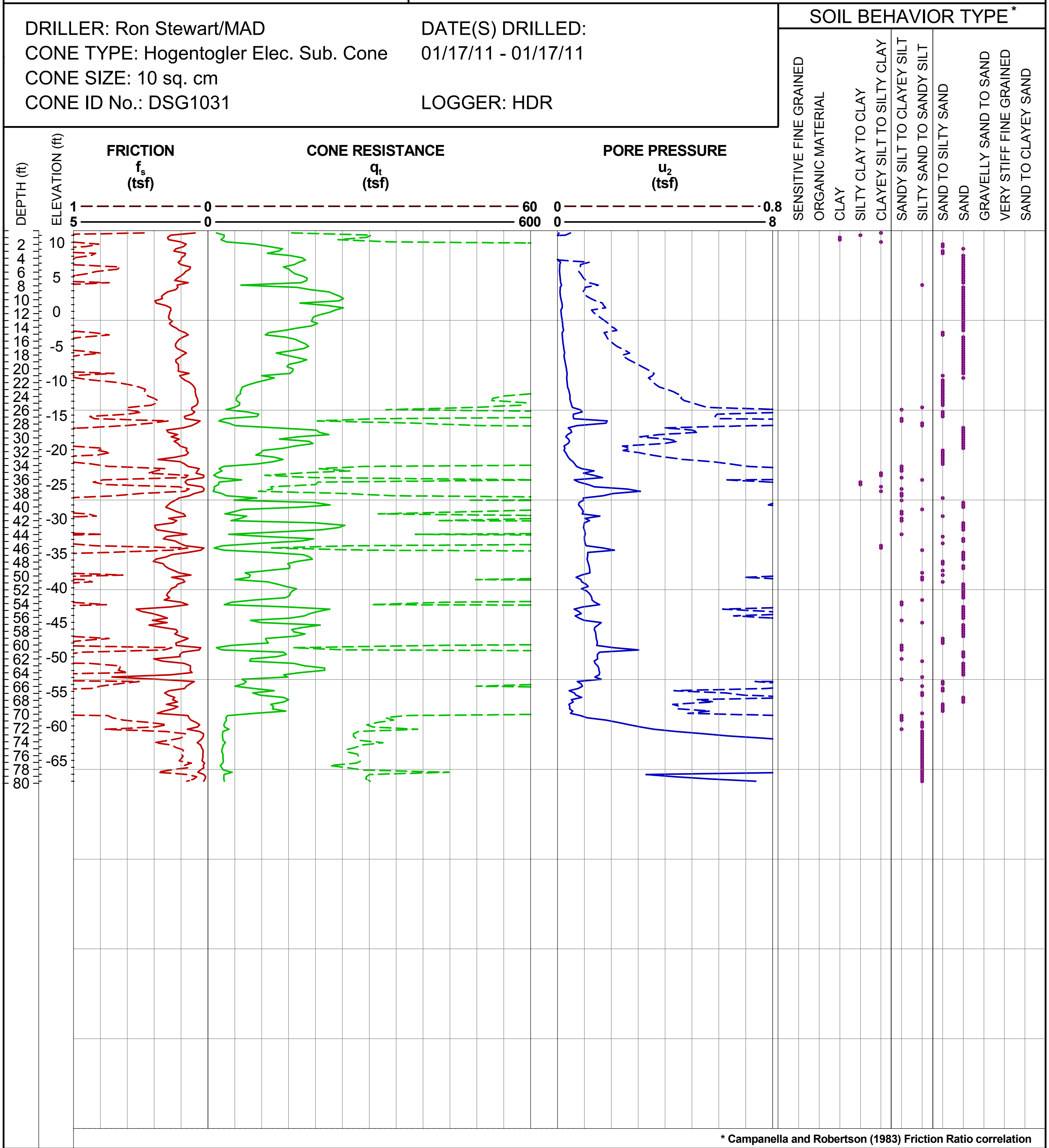
STATION: 21+69
LATITUDE: 36.838513° N
SURFACE ELEVATION: 11.7
BENCHMARK LOCATION:

OFFSET: 78 ft RT
LONGITUDE: 76.160156° W
COORD. DATUM: NAD 83

DRILLER: Ron Stewart/MAD
CONE TYPE: Hogentogler Elec. Sub. Cone
CONE SIZE: 10 sq. cm
CONE ID No.: DSG1031

DATE(S) DRILLED:
01/17/11 - 01/17/11

LOGGER: HDR



* Campanella and Robertson (1983) Friction Ratio correlation

REMARKS: REFERENCE BASELINE: LOOP B

PAGE 1 OF 1
WDLB-3

Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

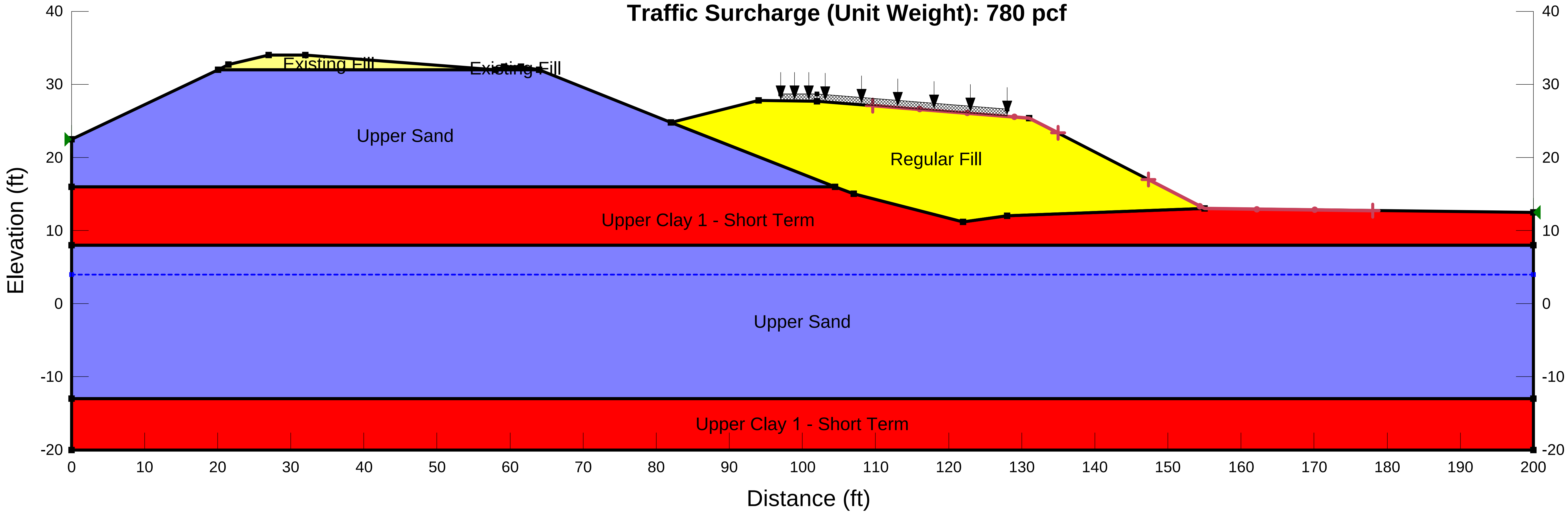
AECOM

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 28 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Temporary Witchduck Ramp B
Analysis Location: Sta. 407+66
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3

Traffic Surcharge (Unit Weight): 780 pcf



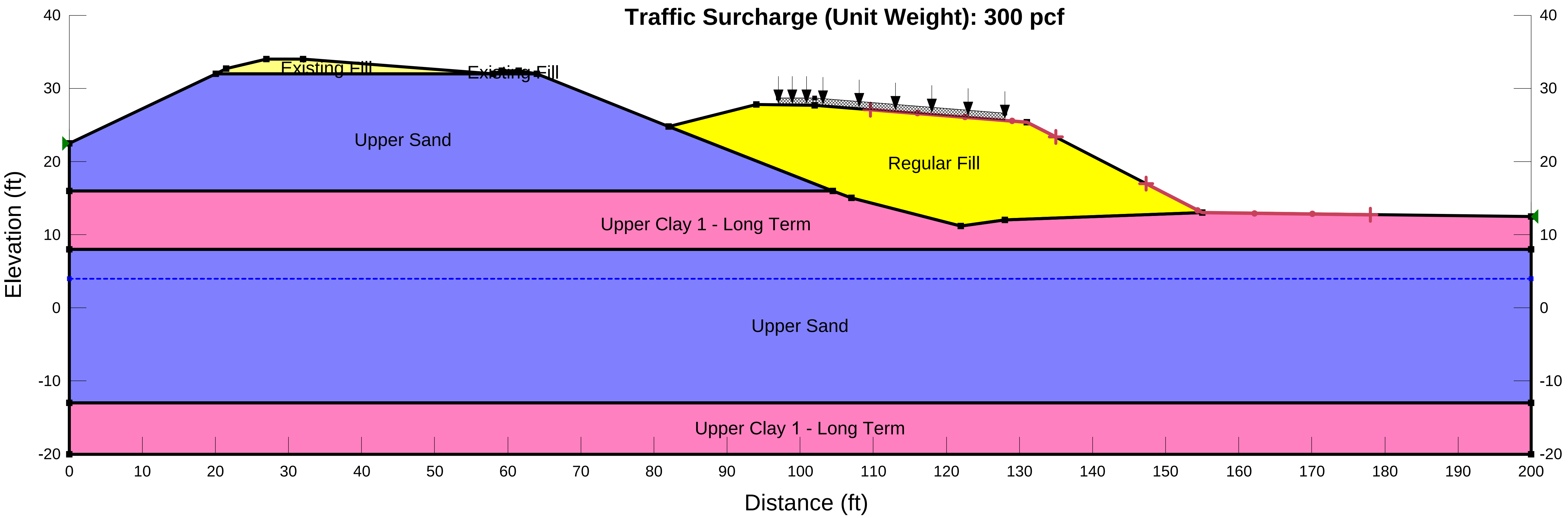
Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

AECOM

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 28 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

Temporary Witchduck Ramp B
Analysis Location: Sta. 407+66
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3

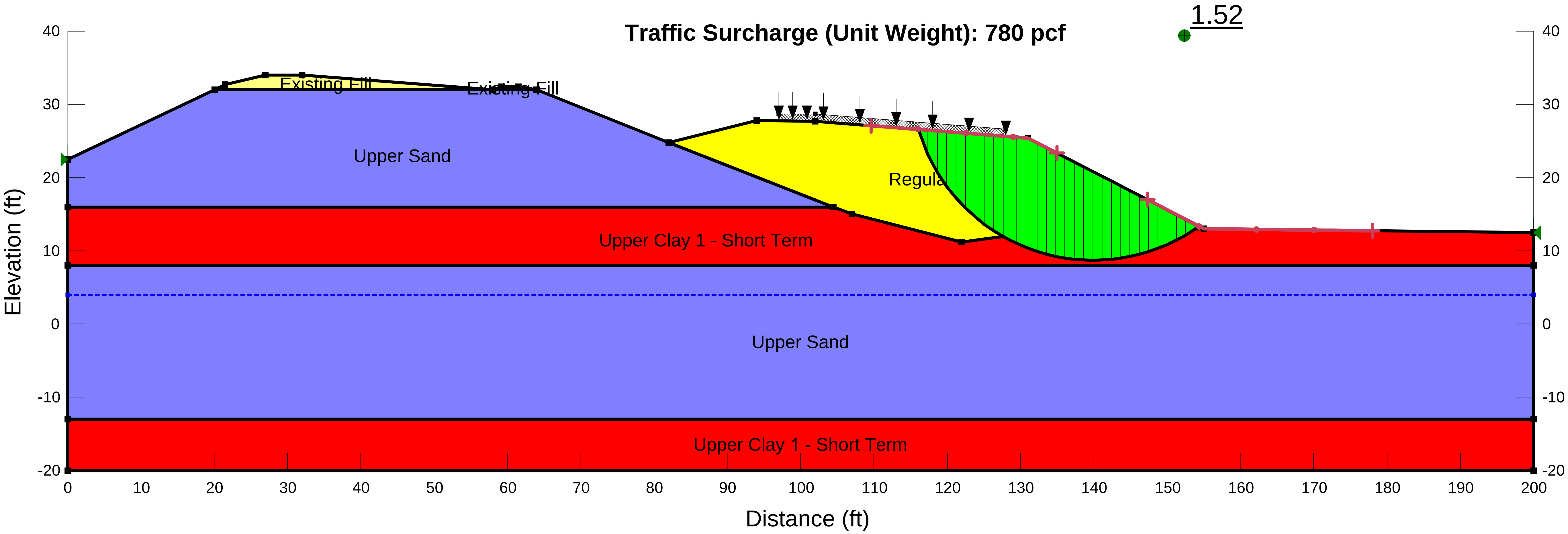


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 28 ° Piezometric Line: 1
Name: Upper Clay 1 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1
Name: Upper Clay 2 - Short Term Unit Weight: 112 pcf Cohesion Spatial Fn: Upper Clay Phi: 0 ° Piezometric Line: 1

Temporary Witchduck Ramp B
Analysis Location: Sta. 407+66
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3

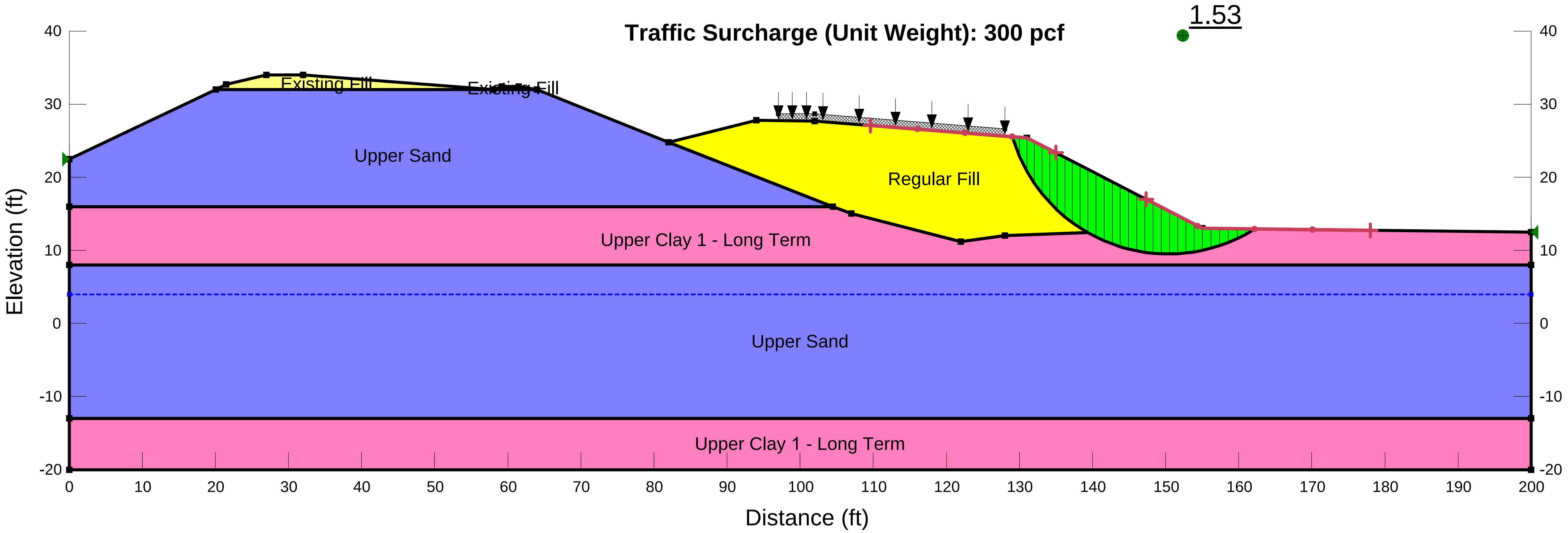


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

Name: Existing Fill   Unit Weight: 125 pcf   Cohesion: 50 psf   Phi: 32 °   Piezometric Line: 1
Name: Regular Fill   Unit Weight: 130 pcf   Cohesion: 50 psf   Phi: 34 °   Piezometric Line: 1
Name: Upper Sand   Unit Weight: 115 pcf   Cohesion: 50 psf   Phi: 28 °   Piezometric Line: 1
Name: Upper Clay 1 - Long Term   Unit Weight: 112 pcf   Cohesion: 0 psf   Phi: 23 °   Piezometric Line: 1
Name: Upper Clay 2 - Long Term   Unit Weight: 112 pcf   Cohesion: 0 psf   Phi: 23 °   Piezometric Line: 1

Temporary Witchduck Ramp B
Analysis Location: Sta. 407+66
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3

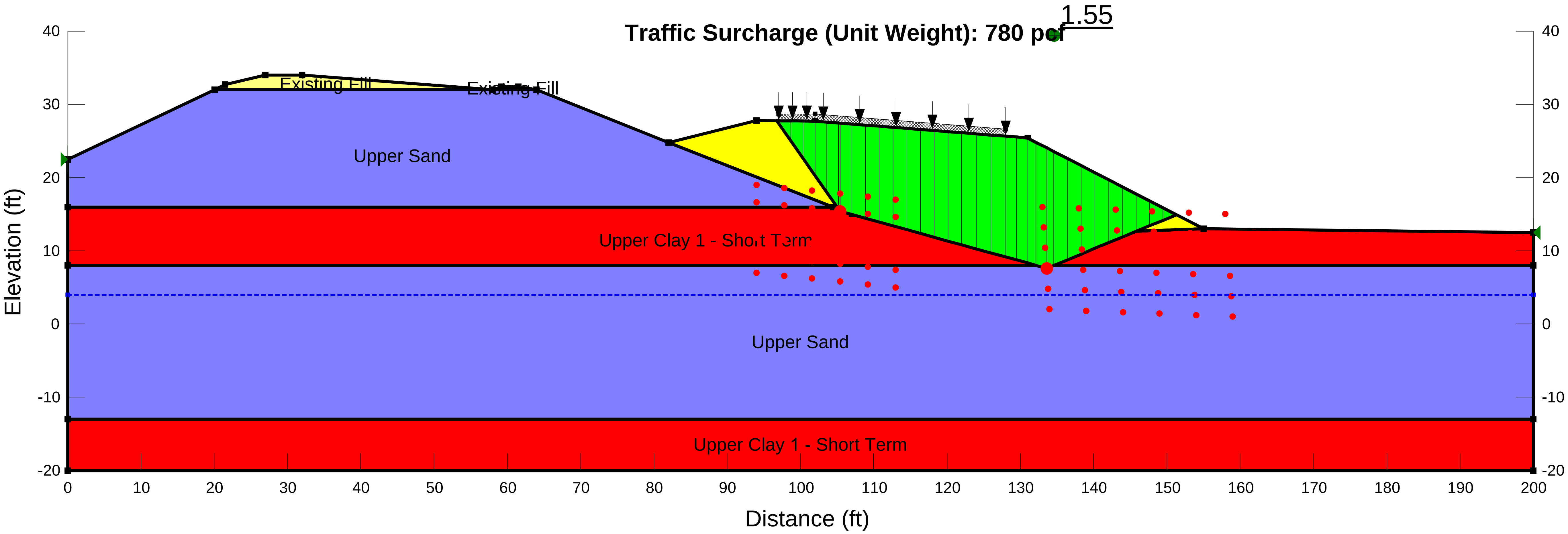


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Short Term Global Stability Analysis

Name: Existing Fill	Unit Weight: 125 pcf	Cohesion: 50 psf	Phi: 32 °	Piezometric Line: 1
Name: Regular Fill	Unit Weight: 130 pcf	Cohesion: 50 psf	Phi: 34 °	Piezometric Line: 1
Name: Upper Sand	Unit Weight: 115 pcf	Cohesion: 50 psf	Phi: 28 °	Piezometric Line: 1
Name: Upper Clay 1 - Short Term	Unit Weight: 112 pcf	Cohesion Spatial Fn: Upper Clay	Phi: 0 °	Piezometric Line: 1
Name: Upper Clay 2 - Short Term	Unit Weight: 112 pcf	Cohesion Spatial Fn: Upper Clay	Phi: 0 °	Piezometric Line: 1

Temporary Witchduck Ramp B
Analysis Location: Sta. 407+66
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3

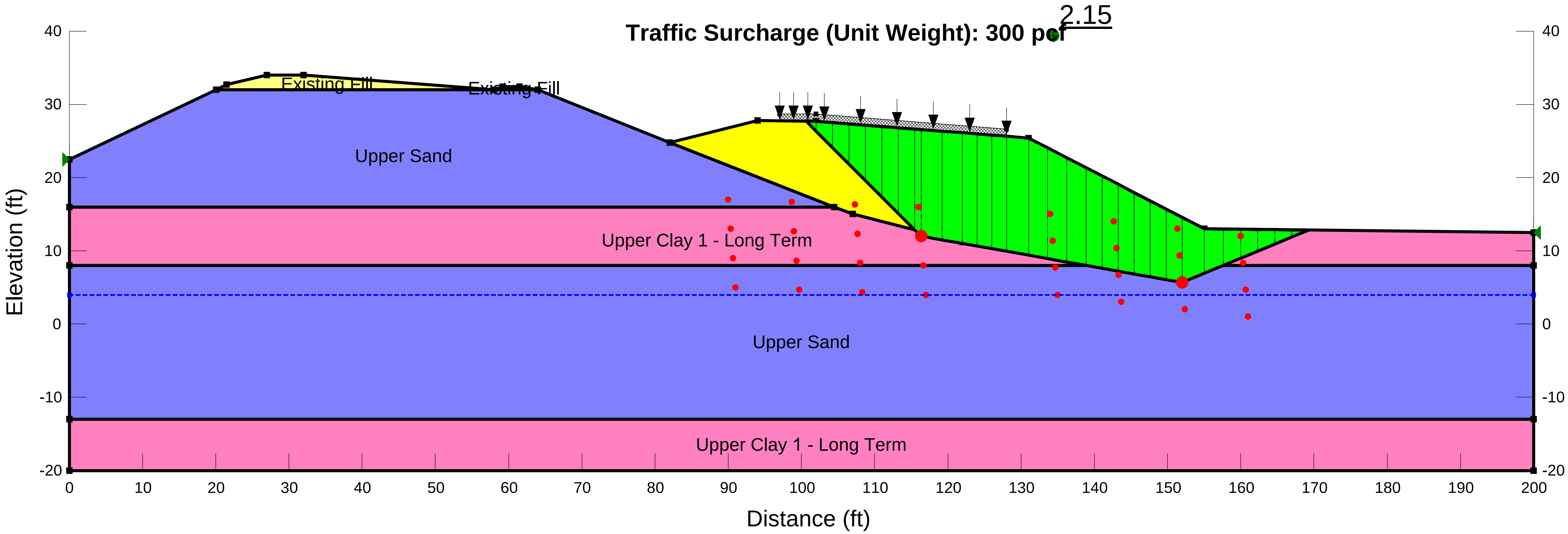


Project: I-264 Witchduck Roadway Improvements
Software: Geostudio 2007
Analysis Type: Slope Stability
Method of Analysis: Spencer Method

Long Term Global Stability Analysis

Name: Existing Fill Unit Weight: 125 pcf Cohesion: 50 psf Phi: 32 ° Piezometric Line: 1
Name: Regular Fill Unit Weight: 130 pcf Cohesion: 50 psf Phi: 34 ° Piezometric Line: 1
Name: Upper Sand Unit Weight: 115 pcf Cohesion: 50 psf Phi: 28 ° Piezometric Line: 1
Name: Upper Clay 1 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Upper Clay 2 - Long Term Unit Weight: 112 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1

Temporary Witchduck Ramp B
Analysis Location: Sta. 407+66
GER Used for Soil Parameters: PSA Witchduck
Borings Used for Profile: WDLB-1, WDLB-2, WDLB-3



Appendix C:

Settlement Calculations

URS

Job I-264 WITCHDUCK

Description IDEALIZED PROFILE

STA 53+00

Project No.

Computed by

Checked by

Page of

Sheet of

Date

Date

Reference

+30

EXISTING FILL $\gamma_m = 125$ pcf

Es' = 500,000 psf

+8

UPPER CLAY-1

$\gamma_m = 120$ pcf $C_\alpha = 0.003$

$C_c' = 0.12$ $C_v = 0.10$

$C_R' = 0.012$ OCR = 2.0

+6 ▽

+5

UPPER SAND $\gamma_m = 115$ pcf

Es' = 500,000 psf

−14

UPPER CLAY-2

$\gamma_m = 112$ pcf $C_\alpha' = 0.003$

$C_c' = 0.17$ $C_v = 0.10$

$C_R' = 0.014$ OCR = 2.0

−21

LOWER SAND $\gamma_m = 125$ pcf

Es' = 500,000 psf

−54

LOWER CLAY

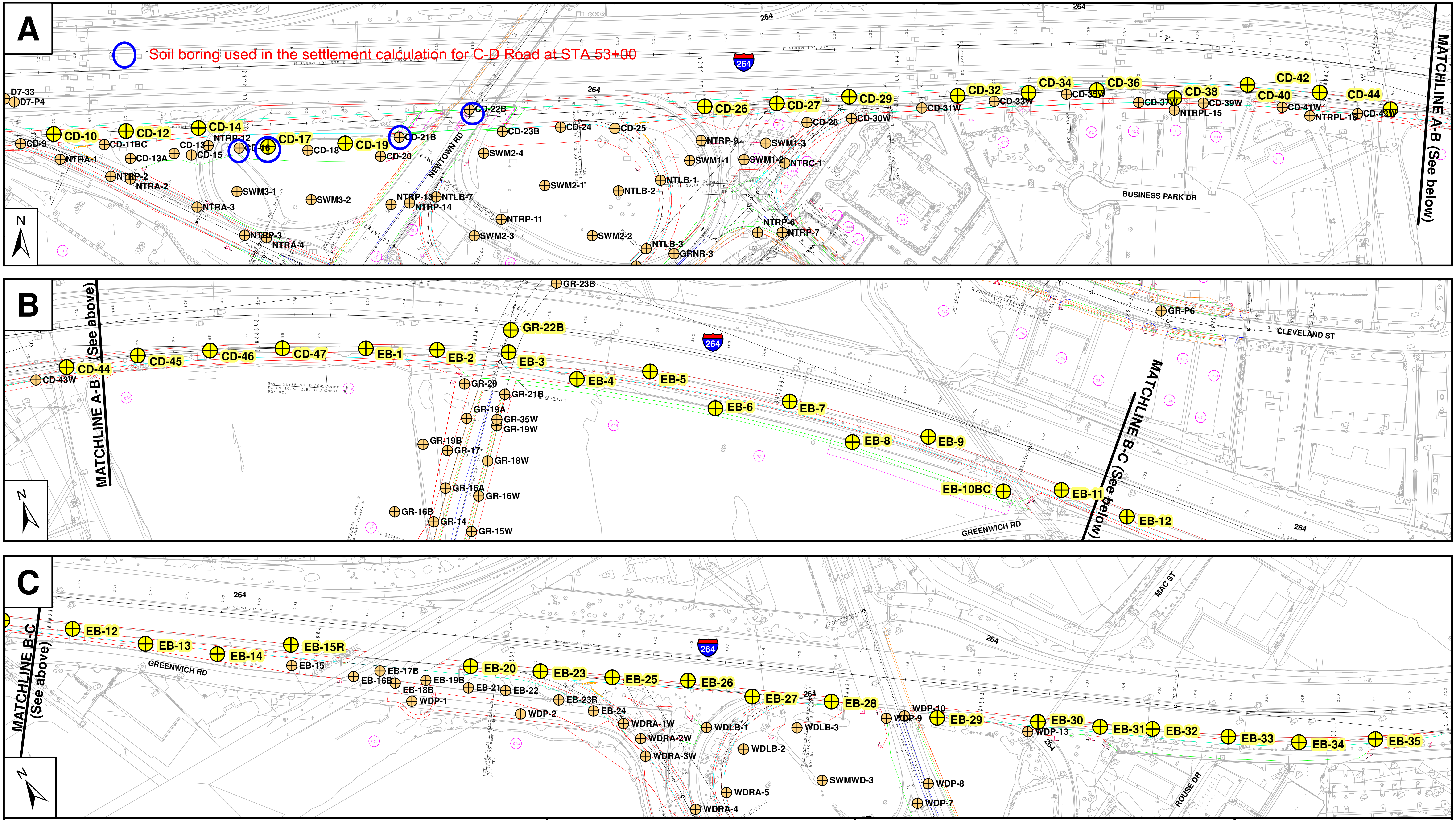
$\gamma_m = 118$ pcf $C_\alpha' = 0.0003$

$C_c' = 0.10$ $C_v = 0.14$

$C_R' = 0.012$ OCR = 2.0

−61

YORKTOWN



0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

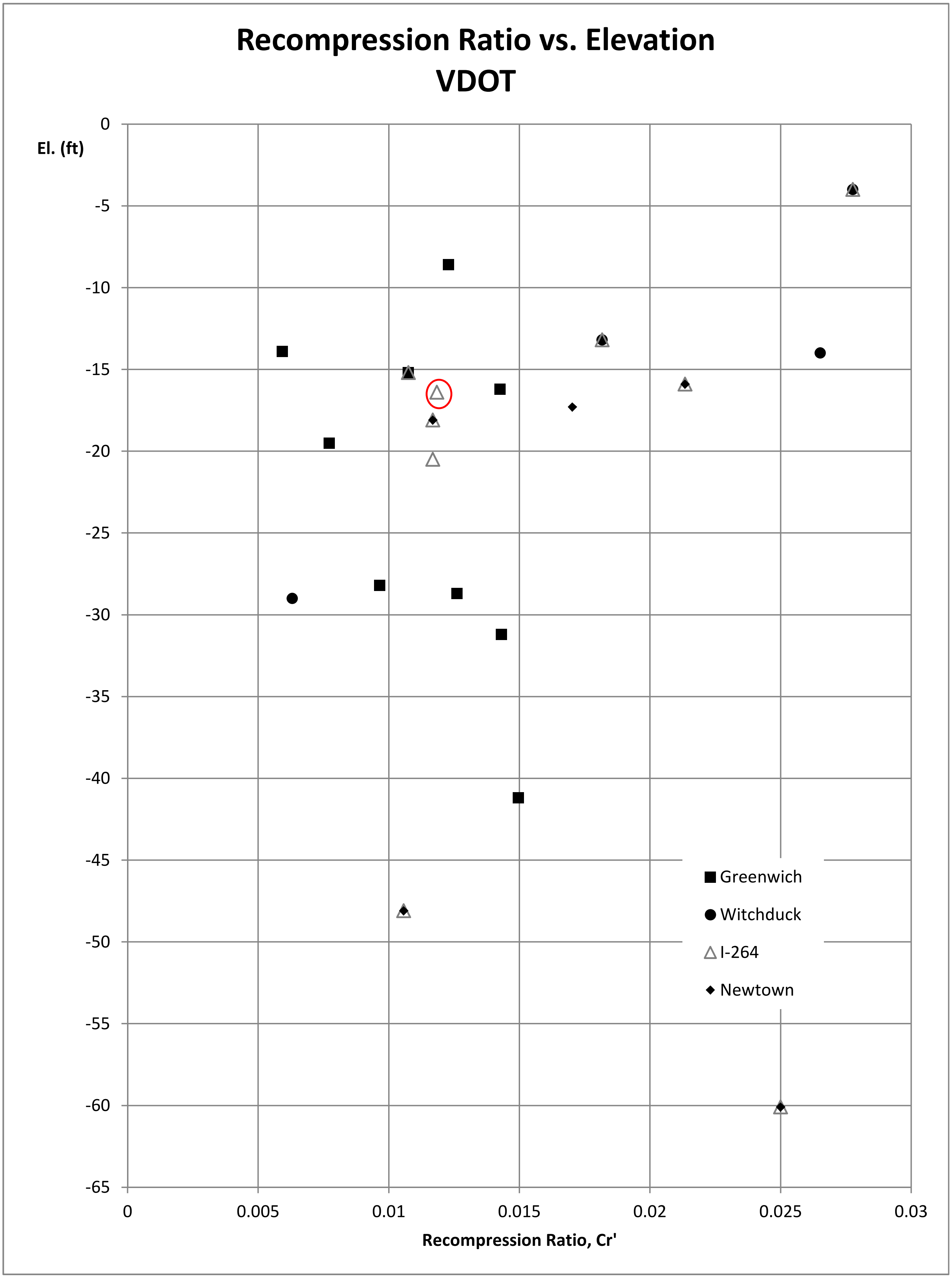
VDOT Virginia Department of Transportation

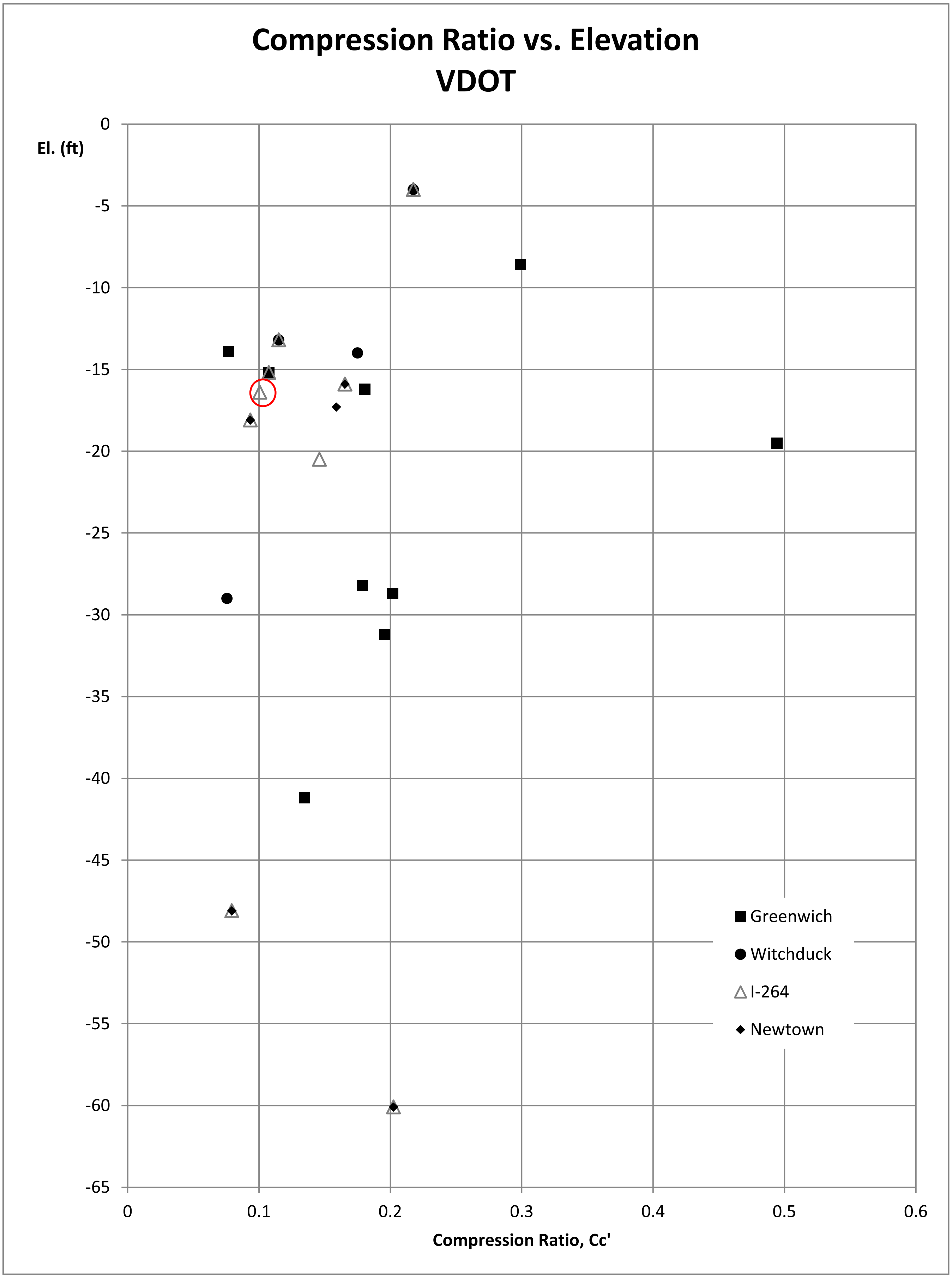
Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan


Recompression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.005
0.01
0.015
0.02
0.025
0.03
Recompression Ratio, Cr'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown


Compression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.1
0.2
0.3
0.4
0.5
0.6
Compression Ratio, Cc'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

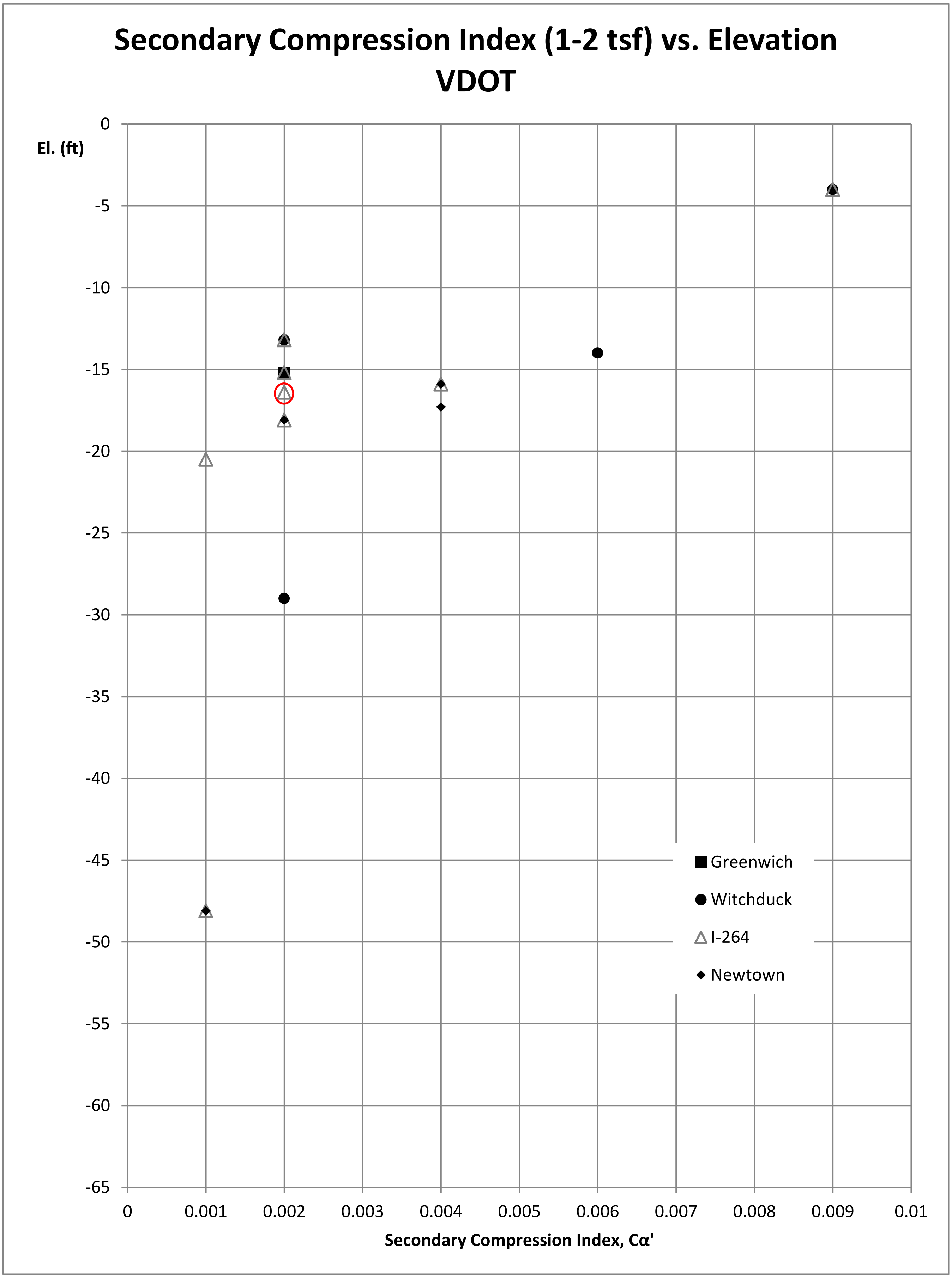

Secondary Compression Index (1-2 tsf) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
Secondary Compression Index, Cα'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

Table D-3

Typical Elastic Moduli

Soil	E_s, tsf
Clay	
Very soft clay	5 - 50
Soft clay	50 - 200
Medium clay	200 - 500
Stiff clay, silty clay	500 - 1000
Sandy clay	250 - 2000
Clay shale	1000 - 2000
Sand	
Loose sand	100 - 250
Dense sand	250 - 1000
Dense sand and gravel	1000 - 2000
Silty sand	250 - 2000

c. Laboratory Tests on Cohesive Soil. The elastic modulus is sensitive to soil disturbance which may increase pore water pressure and, therefore, decrease the effective stress in the specimen and reduce the stiffness and strength. Fissures, which may have little influence on field settlement, may reduce the measured modulus compared with the in situ modulus if confining pressures are not applied to the soil specimen.

(1) Initial hyperbolic tangent modulus. Triaxial unconsolidated undrained (Q or UU) compression tests may be performed on the best available undisturbed specimens at confining pressures equal to the total vertical overburden pressure σ_o for that specimen when in the field using the Q test procedure described in EM 1110-2-1906, Laboratory Soils Testing. An appropriate measure of E_s is the initial tangent modulus $E_{ti} = 1/a$ where a is the intercept of a plot of strain/deviator stress versus strain, Figure D-3 (item 14).

(2) Reload modulus. A triaxial consolidated undrained (R or CU) compression test may be performed on the best available undisturbed specimens. The specimen is initially fully consolidated to an isotropic confining pressure equal to the vertical overburden pressure σ_o for that specimen in the field. The R test procedure described in EM 1110-2-1906 may be used except as follows: stress is increased to the magnitude estimated for the field loading condition. The axial stress may then be reduced to zero and the cycle repeated until the reload curve shows no further increase in slope. The tangent modulus at 1/2 of the maximum applied stress is determined for each loading cycle and plotted versus the number of cycles, Figure D-4. An appropriate measure of E_s is the reload tangent modulus that approaches the asymptotic value at large cycles.

d. Field Tests. The elastic modulus may be estimated from empirical and semiempirical relationships based on results of field soil tests. Refer to

1-264 Witchduck Project, STA 53+00

PROJECT IDENTIFICATION

Title:	1-264 Witchduck Project, STA 53+00
Project Number:	-
Client:	
Designer:	AW
Station Number:	

Description:

STA 53+00, 28' max fill, no GI

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... ulations\Settlement\FOSSA\CD STA 53+00 updated.2ST
Original date and time of creating this file: Thu Jan 05 12:04:43 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 7 layers

	Wet Unit Weight, γ [lb/ft³]	**Poisson's Ratio μ**	**Description of Soil**
1	125.00	0.30	Layer 1 Existing Fill
2	120.00	0.50	Layer 2 Upper Clay
3	115.00	0.30	Layer 3 Upper Sand
4	112.00	0.50	Layer 4 Upper Clay
5	125.00	0.30	Layer 5 Lower Sand
6	118.00	0.50	Layer 6 Lower Clay
7	125.00	0.30	Layer 7 Yorktown

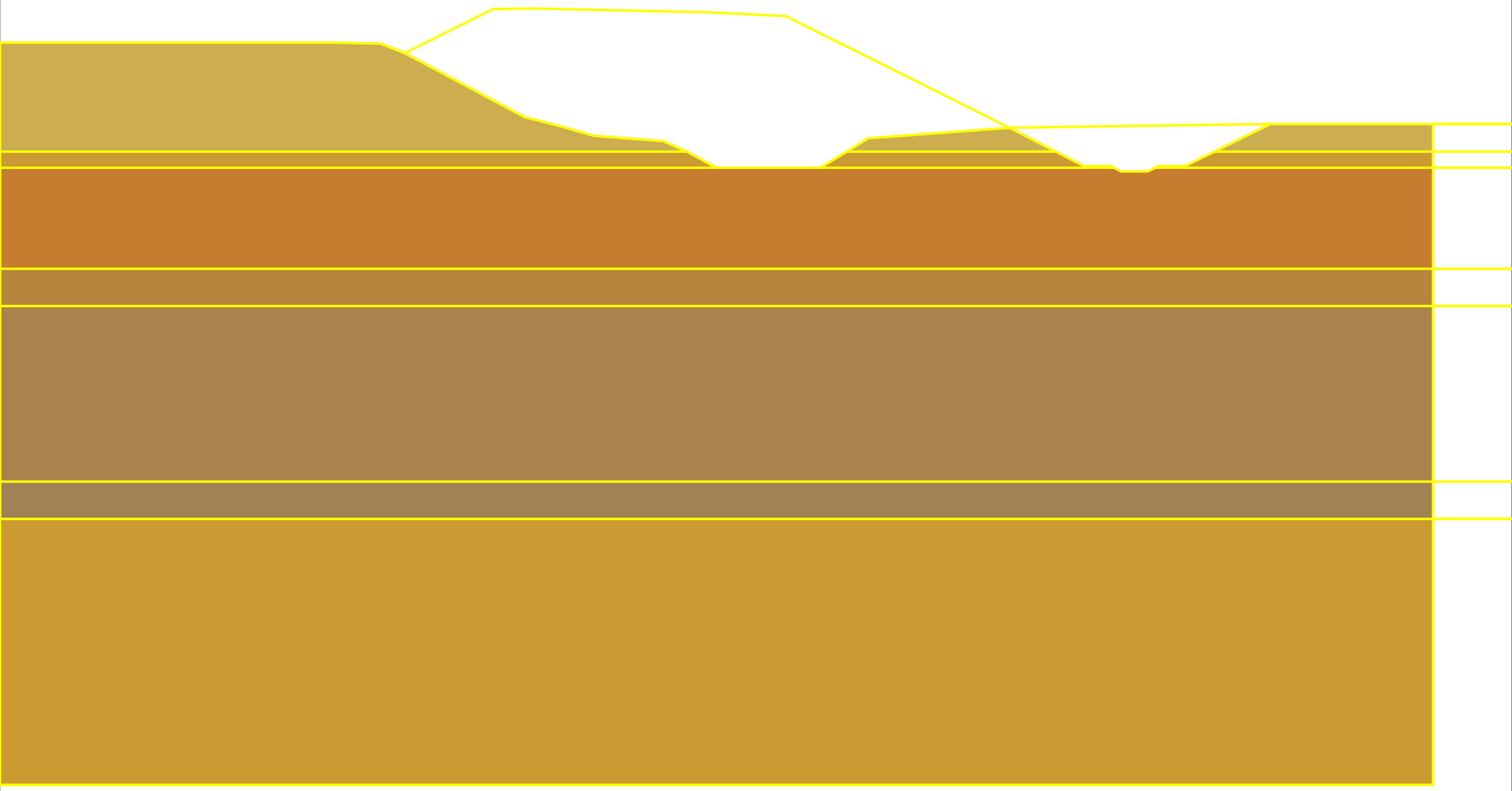
INPUT DATA – EMBANKMENT LAYERS -- 1 layers

	Wet Unit Weight, γ [lb/ft³]	**Description of Soil**
1	130.00	Proposed Fill

INPUT DATA OF WATER

Point #	**Coordinates (X, Z) :**	
	(X) [ft.]	**(Z) [ft.]**
1	0.00	6.00
2	1000.00	6.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :	CREEP Ca/Cc
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	0.0250
3	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	0.0176
5	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	0.0017
7	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Secondary Comprassion (Creep) : Settlement is calculated at t2/t1 = 40.0

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	50.00	0.00	1	750000	0.3000	-0.0029	28.50	28.47	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0020			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0306			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
2	53.67	0.00	1	750000	0.3000	-0.0029	28.42	28.38	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0047			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0356			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
3	57.35	0.00	1	750000	0.3000	-0.0026	28.34	28.29	0.05
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0084			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0411			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
4	61.02	0.00	1	750000	0.3000	-0.0014	27.49	27.43	0.06
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0130			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0469			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
5	64.69	0.00	1	750000	0.3000	0.0020	25.86	25.79	0.07
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0185			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0532			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
6	68.37	0.00	1	750000	0.3000	0.0073	23.90	23.81	0.09
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0249			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0596			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
7	72.04	0.00	1	750000	0.3000	0.0121	21.94	21.83	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0319			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0663			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
8	75.71	0.00	1	750000	0.3000	0.0154	19.99	19.86	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0392			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0730			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
9	79.39	0.00	1	750000	0.3000	0.0167	18.03	17.88	0.14
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0465			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0796			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
10	83.06	0.00	1	750000	0.3000	0.0160	16.07	15.91	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0535			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0861			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
11	86.73	0.00	1	750000	0.3000	0.0144	14.32	14.15	0.17
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0599			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0923			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
12	90.41	0.00	1	750000	0.3000	0.0133	13.40	13.22	0.18
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0656			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0982			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
13	94.08	0.00	1	750000	0.3000	0.0117	12.41	12.22	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0707			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1035			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
14	97.76	0.00	1	750000	0.3000	0.0096	11.36	11.16	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0750			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1083			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
15	101.43	0.00	1	750000	0.3000	0.0082	10.81	10.61	0.20
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0788			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1124			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
16	105.10	0.00	1	750000	0.3000	0.0075	10.53	10.33	0.21
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0820			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1158			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
17	108.78	0.00	1	750000	0.3000	0.0068	10.25	10.04	0.21
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0846			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1185			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
18	112.45	0.00	1	750000	0.3000	0.0060	9.80	9.59	0.21
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0868			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1203			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
19	116.12	0.00	1	750000	0.3000	0.0000	8.17	7.96	0.21
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0884			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1213			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
20	119.80	0.00	1	750000	0.3000	0.0000	6.20	5.99	0.21
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0893			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1214			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
21	123.47	0.00	1	750000	0.3000	0.0000	5.00	4.79	0.21
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0895			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1206			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
22	127.14	0.00	1	750000	0.3000	0.0000	5.00	4.79	0.21
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0885			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1188			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
23	130.82	0.00	1	750000	0.3000	0.0000	5.00	4.80	0.20
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0863			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1162			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
24	134.49	0.00	1	750000	0.3000	0.0000	5.00	4.80	0.20
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0829			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1128			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
25	138.16	0.00	1	750000	0.3000	0.0000	5.00	4.81	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0782			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1085			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
26	141.84	0.00	1	750000	0.3000	0.0000	5.20	5.03	0.18
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0723			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1035			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
27	145.51	0.00	1	750000	0.3000	0.0000	7.41	7.24	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0657			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0980			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
28	149.18	0.00	1	750000	0.3000	0.0040	9.68	9.52	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0585			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0919			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
29	152.86	0.00	1	750000	0.3000	0.0049	10.68	10.54	0.14
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0510			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0854			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
30	156.53	0.00	1	750000	0.3000	0.0039	10.96	10.83	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0434			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0787			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
31	160.20	0.00	1	750000	0.3000	0.0034	11.23	11.12	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0361			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0719			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
32	163.88	0.00	1	750000	0.3000	0.0027	11.51	11.41	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0292			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0651			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
33	167.55	0.00	1	750000	0.3000	0.0019	11.79	11.70	0.08
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0228			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0584			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
34	171.22	0.00	1	750000	0.3000	0.0011	12.06	11.99	0.07
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0170			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0520			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
35	174.90	0.00	1	750000	0.3000	0.0004	12.34	12.28	0.06
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0120			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0458			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
36	178.57	0.00	1	750000	0.3000	-0.0002	12.52	12.47	0.05
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0078			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0400			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
37	182.24	0.00	1	750000	0.3000	-0.0006	12.57	12.54	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0045			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0347			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
38	185.92	0.00	1	750000	0.3000	-0.0009	12.63	12.60	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0018			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0297			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
39	189.59	0.00	1	750000	0.3000	-0.0010	12.68	12.66	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0002			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0252			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
40	193.27	0.00	1	750000	0.3000	-0.0010	12.73	12.71	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0016			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0212			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
41	196.94	0.00	1	750000	0.3000	-0.0010	12.78	12.77	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0027			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0176			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
42	200.61	0.00	1	750000	0.3000	-0.0009	12.84	12.83	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0034			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0144			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E $[lb/ft^2]$	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
43	204.29	0.00	1	750000	0.3000	-0.0009	12.89	12.88	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0038			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0116			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
44	207.96	0.00	1	750000	0.3000	-0.0008	12.94	12.94	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0041			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0091			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
45	211.63	0.00	1	750000	0.3000	-0.0008	12.99	12.99	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0043			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0070			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
46	215.31	0.00	1	750000	0.3000	-0.0007	13.05	13.05	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0043			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0051			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
47	218.98	0.00	1	750000	0.3000	-0.0007	13.10	13.10	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0043			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0035			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
48	222.65	0.00	1	750000	0.3000	-0.0006	13.15	13.15	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0043			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0022			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
49	226.33	0.00	1	750000	0.3000	-0.0006	13.20	13.20	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0042			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0010			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ^{2}]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
50	230.00	0.00	1	750000	0.3000	-0.0005	13.20	13.20	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0041			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0000			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	116.00	0.00	8.22	0.68	7.54

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

SECONDARY SETTLEMENT (Creep), Ss -- Total Secondary Compression (Creep) = 0.050 ft.

Layer #	Underging Consolidation	Cc / (1+e0)	C-alpha/ (1+e0)	e-zero	H [ft.]	t1/t2	Settlement Ss [ft.]
1	No	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	0.1200	0.0030	N/A	3.00	40.0	0.014
3	No	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	0.1700	0.0030	N/A	7.00	40.0	0.034
5	No	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	0.1000	0.0002	N/A	7.00	40.0	0.002
7	No	N/A	N/A	N/A	N/A	N/A	N/A

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	50.00	28.50	Layer 1 Existing Fill
	2	59.00	28.30	
	3	63.50	26.50	
	4	86.00	14.50	
	5	92.00	13.00	
	6	99.00	11.00	
	7	112.00	10.00	
	8	116.50	8.00	
	9	122.00	5.00	
	10	141.50	5.00	
	11	146.50	8.00	
	12	150.50	10.50	
	13	177.00	12.50	
	14	226.00	13.20	
2	1	50.00	8.00	Layer 2 Upper Clay
	2	59.00	8.00	
	3	63.50	8.00	
	4	86.00	8.00	
	5	92.00	8.00	
	6	99.00	8.00	
	7	112.00	8.00	
	8	116.50	8.00	
	9	122.00	5.00	
	10	141.50	5.00	
	11	146.50	8.00	
	12	150.50	8.00	
	13	177.00	8.00	
	14	226.00	8.00	
3	1	0.00	5.00	Layer 3 Upper Sand
	2	116.50	5.00	
	3	122.00	5.00	
	4	141.50	5.00	
	5	146.50	5.00	
	6	1000.00	5.00	
4	1	0.00	-14.00	Layer 4 Upper Clay
	2	1000.00	-14.00	
5	1	0.00	-21.00	Layer 5 Lower Sand
	2	1000.00	-21.00	
6	1	0.00	-54.00	Layer 6 Lower Clay
	2	1000.00	-54.00	
7	1	0.00	-61.00	Layer 7 Yorktown
	2	1000.00	-61.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 59.00 [ft]	1	59.00	28.30	Proposed Fill
	X2 = 226.00 [ft]	2	63.50	26.50	
		3	80.00	34.80	
		4	88.00	34.90	
		5	120.00	34.20	
		6	135.00	33.50	
		7	177.00	12.50	
		8	191.00	5.30	
		9	196.00	5.30	
		10	198.00	4.30	
		11	203.00	4.30	
		12	205.00	5.30	
		13	210.00	5.30	
		14	226.00	13.20	

1-264 Witchduck Project, STA 53+00

PROJECT IDENTIFICATION

Title:	1-264 Witchduck Project, STA 53+00
Project Number:	-
Client:	
Designer:	AS
Station Number:	

Description:

STA 53+00, 28' max fill, 6' surcharge + PVD

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: Q:\Project ..... A 53+00 with 6' surcharge + PVD updated 1-6-17.2ST
Original date and time of creating this file: Thu Jan 05 12:04:43 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 7 layers

	Wet Unit Weight, γ [lb/ft³]	**Poisson's Ratio μ**	**Description of Soil**
1	125.00	0.30	Layer 1 Existing Fill
2	120.00	0.50	Layer 2 Upper Clay
3	115.00	0.30	Layer 3 Upper Sand
4	112.00	0.50	Layer 4 Upper Clay
5	125.00	0.30	Layer 5 Lower Sand
6	118.00	0.50	Layer 6 Lower Clay
7	125.00	0.30	Layer 7 Yorktown

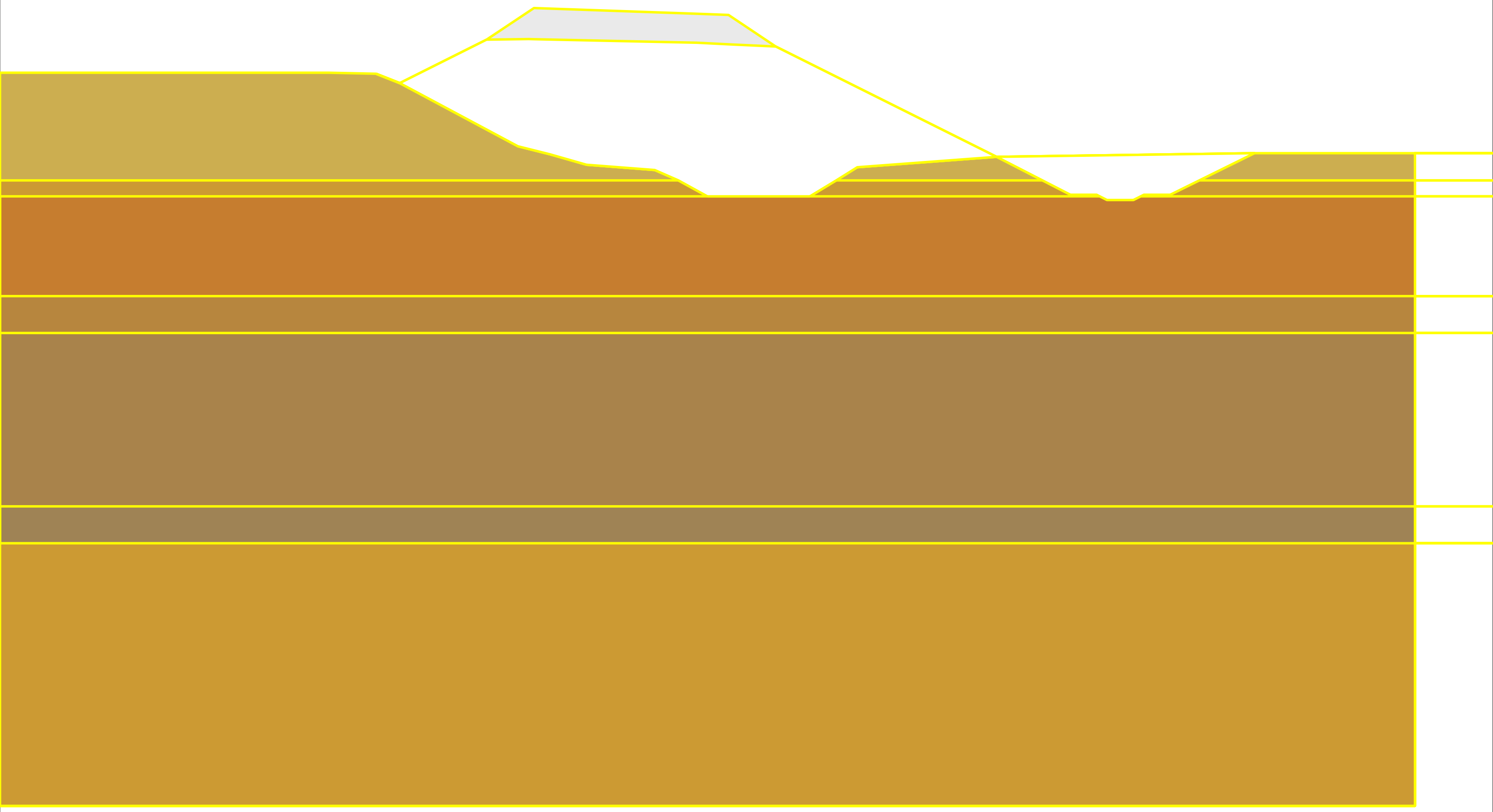
INPUT DATA – EMBANKMENT LAYERS -- 2 layers

	Wet Unit Weight, γ [lb/ft³]	**Description of Soil**
1	130.00	Proposed Fill
2	130.00	Surcharge

INPUT DATA OF WATER

Point #	**Coordinates (X, Z) : (X) [ft.]**	**(Z) [ft.]**
1	0.00	6.00
2	1000.00	6.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :	PVD through Layer No/Yes	Ch=Coeff. for horiz. drainage [ft ²/day]
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	Yes	0.2153
3	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	Yes	0.2153
5	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	No	0.2153
7	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

PVD : Triangle Pattern where D = 1.05 x 5.00 = 5.25 ft.
dw = 2 x (a + b) / 3.14 = 2.607 inch --> F(n) = 2.44. Fs for disturbance = 0.000
and Fr' = 0.050

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	0.00	0.00	1	750000	0.3000	-0.0010	28.50	28.51	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0045			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0013			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
2	5.10	0.00	1	750000	0.3000	-0.0011	28.50	28.51	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0047			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0000			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
3	10.20	0.00	1	750000	0.3000	-0.0013	28.50	28.50	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0048			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0016			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
4	15.31	0.00	1	750000	0.3000	-0.0014	28.50	28.50	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0050			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0036			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
5	20.41	0.00	1	750000	0.3000	-0.0016	28.50	28.50	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0050			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0061			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
6	25.51	0.00	1	750000	0.3000	-0.0019	28.50	28.50	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0049			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0092			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
7	30.61	0.00	1	750000	0.3000	-0.0021	28.50	28.49	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0046			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0129			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
8	35.71	0.00	1	750000	0.3000	-0.0024	28.50	28.49	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0039			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0175			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
9	40.82	0.00	1	750000	0.3000	-0.0028	28.50	28.48	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0027			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0229			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
10	45.92	0.00	1	750000	0.3000	-0.0031	28.50	28.47	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0006			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0293			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
11	51.02	0.00	1	750000	0.3000	-0.0034	28.48	28.44	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0026			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0368			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
12	56.12	0.00	1	750000	0.3000	-0.0033	28.36	28.31	0.05
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0075			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0452			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
13	61.22	0.00	1	750000	0.3000	-0.0019	27.41	27.34	0.07
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0144			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0547			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
14	66.33	0.00	1	750000	0.3000	0.0036	24.99	24.90	0.09
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0235			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0649			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
15	71.43	0.00	1	750000	0.3000	0.0111	22.27	22.15	0.12
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0346			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0757			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
16	76.53	0.00	1	750000	0.3000	0.0166	19.55	19.40	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0468			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0867			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
17	81.63	0.00	1	750000	0.3000	0.0182	16.83	16.65	0.18
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0594			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0975			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
18	86.73	0.00	1	750000	0.3000	0.0171	14.32	14.12	0.20
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0711			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1078			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
19	91.84	0.00	1	750000	0.3000	0.0158	13.04	12.83	0.21
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0814			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1171			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
20	96.94	0.00	1	750000	0.3000	0.0119	11.59	11.36	0.23
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0897			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1251			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
21	102.04	0.00	1	750000	0.3000	0.0102	10.77	10.53	0.24
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0960			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1315			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
22	107.14	0.00	1	750000	0.3000	0.0095	10.37	10.13	0.25
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.1005			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1361			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
23	112.24	0.00	1	750000	0.3000	0.0073	9.89	9.64	0.25
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.1033			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1388			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
24	117.35	0.00	1	750000	0.3000	0.0000	7.54	7.29	0.24
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.1043			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1393			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
25	122.45	0.00	1	750000	0.3000	0.0000	5.00	4.76	0.24
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.1033			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1377			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
26	127.55	0.00	1	750000	0.3000	0.0000	5.00	4.77	0.23
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0996			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1340			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
27	132.65	0.00	1	750000	0.3000	0.0000	5.00	4.78	0.22
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0933			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1285			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
28	137.76	0.00	1	750000	0.3000	0.0000	5.00	4.79	0.21
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0849			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1212			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
29	142.86	0.00	1	750000	0.3000	0.0000	5.81	5.63	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0745			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1126			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
30	147.96	0.00	1	750000	0.3000	0.0021	8.91	8.74	0.17
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0633			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1029			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
31	153.06	0.00	1	750000	0.3000	0.0048	10.69	10.54	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0517			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0924			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
32	158.16	0.00	1	750000	0.3000	0.0038	11.08	10.95	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0406			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0818			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
33	163.27	0.00	1	750000	0.3000	0.0027	11.46	11.36	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0303			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0711			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
34	168.37	0.00	1	750000	0.3000	0.0016	11.85	11.76	0.08
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0211			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0608			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
35	173.47	0.00	1	750000	0.3000	0.0005	12.23	12.17	0.07
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0134			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0512			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
36	178.57	0.00	1	750000	0.3000	-0.0004	12.52	12.47	0.05
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0072			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0423			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
37	183.67	0.00	1	750000	0.3000	-0.0008	12.60	12.56	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0027			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0344			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
38	188.78	0.00	1	750000	0.3000	-0.0011	12.67	12.64	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0005			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0274			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
39	193.88	0.00	1	750000	0.3000	-0.0011	12.74	12.72	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0025			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0213			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
40	198.98	0.00	1	750000	0.3000	-0.0010	12.81	12.80	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0037			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0162			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
41	204.08	0.00	1	750000	0.3000	-0.0009	12.89	12.88	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0044			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0119			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
42	209.18	0.00	1	750000	0.3000	-0.0009	12.96	12.96	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0048			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0084			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
43	214.29	0.00	1	750000	0.3000	-0.0008	13.03	13.03	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0049			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0055			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
44	219.39	0.00	1	750000	0.3000	-0.0007	13.11	13.11	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0049			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0031			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
45	224.49	0.00	1	750000	0.3000	-0.0007	13.18	13.18	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0048			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0012			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
46	229.59	0.00	1	750000	0.3000	-0.0006	13.20	13.21	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0046			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0003			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
47	234.69	0.00	1	750000	0.3000	-0.0005	13.20	13.21	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0044			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0015			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
48	239.80	0.00	1	750000	0.3000	-0.0005	13.20	13.21	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0042			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0025			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
49	244.90	0.00	1	750000	0.3000	-0.0005	13.20	13.21	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0040			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0032			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
50	250.00	0.00	1	750000	0.3000	-0.0004	13.20	13.21	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0037			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0038			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	0.00	0.00	28.50	0.00	28.50
2	5.10	0.00	28.50	0.00	28.50
3	10.20	0.00	28.50	0.00	28.50
4	15.31	0.00	28.50	0.00	28.50
5	20.41	0.00	28.50	0.00	28.50
6	25.51	0.00	28.50	0.01	28.49
7	30.61	0.00	28.50	0.01	28.49
8	35.71	0.00	28.50	0.01	28.49
9	40.82	0.00	28.50	0.01	28.49
10	45.92	0.00	28.50	0.01	28.49
11	51.02	0.00	28.48	0.01	28.46
12	56.12	0.00	28.36	0.02	28.35
13	61.22	0.00	27.41	0.02	27.39
14	66.33	0.00	24.99	0.03	24.97
15	71.43	0.00	22.27	0.03	22.24
16	76.53	0.00	19.55	0.08	19.47
17	81.63	0.00	16.83	0.18	16.65
18	86.73	0.00	14.32	0.29	14.03
19	91.84	0.00	13.04	0.37	12.67
20	96.94	0.00	11.59	0.46	11.13
21	102.04	0.00	10.77	0.53	10.24
22	107.14	0.00	10.37	0.57	9.81
23	112.24	0.00	9.89	0.61	9.28
24	117.35	0.00	7.54	0.76	6.78
25	122.45	0.00	5.00	0.47	4.53

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
26	127.55	0.00	5.00	0.46	4.54
27	132.65	0.00	5.00	0.45	4.55
28	137.76	0.00	5.00	0.42	4.58
29	142.86	0.00	5.81	0.56	5.26
30	147.96	0.00	8.91	0.51	8.40
31	153.06	0.00	10.69	0.34	10.36
32	158.16	0.00	11.08	0.26	10.82
33	163.27	0.00	11.46	0.18	11.29
34	168.37	0.00	11.85	0.10	11.75
35	173.47	0.00	12.23	0.04	12.20
36	178.57	0.00	12.52	0.03	12.49
37	183.67	0.00	12.60	0.02	12.57
38	188.78	0.00	12.67	0.02	12.65
39	193.88	0.00	12.74	0.02	12.73
40	198.98	0.00	12.81	0.01	12.80
41	204.08	0.00	12.89	0.01	12.88
42	209.18	0.00	12.96	0.01	12.95
43	214.29	0.00	13.03	0.01	13.02
44	219.39	0.00	13.11	0.01	13.10
45	224.49	0.00	13.18	0.01	13.17
46	229.59	0.00	13.20	0.00	13.20
47	234.69	0.00	13.20	0.00	13.20
48	239.80	0.00	13.20	0.00	13.20
49	244.90	0.00	13.20	0.00	13.20
50	250.00	0.00	13.20	0.00	13.20

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	50.00	28.50	Layer 1 Existing Fill
	2	59.00	28.30	
	3	63.50	26.50	
	4	86.00	14.50	
	5	92.00	13.00	
	6	99.00	11.00	
	7	112.00	10.00	
	8	116.50	8.00	
	9	122.00	5.00	
	10	141.50	5.00	
	11	146.50	8.00	
	12	150.50	10.50	
	13	177.00	12.50	
	14	226.00	13.20	
2	1	50.00	8.00	Layer 2 Upper Clay
	2	59.00	8.00	
	3	63.50	8.00	
	4	86.00	8.00	
	5	92.00	8.00	
	6	99.00	8.00	
	7	112.00	8.00	
	8	116.50	8.00	
	9	122.00	5.00	
	10	141.50	5.00	
	11	146.50	8.00	
	12	150.50	8.00	
	13	177.00	8.00	
	14	226.00	8.00	
3	1	0.00	5.00	Layer 3 Upper Sand
	2	116.50	5.00	
	3	122.00	5.00	
	4	141.50	5.00	
	5	146.50	5.00	
	6	1000.00	5.00	
4	1	0.00	-14.00	Layer 4 Upper Clay
	2	1000.00	-14.00	
5	1	0.00	-21.00	Layer 5 Lower Sand
	2	1000.00	-21.00	
6	1	0.00	-54.00	Layer 6 Lower Clay
	2	1000.00	-54.00	
7	1	0.00	-61.00	Layer 7 Yorktown
	2	1000.00	-61.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 59.00 [ft]	1	59.00	28.30	Proposed Fill
	X2 = 226.00 [ft]	2	63.50	26.50	
		3	80.00	34.80	
		4	88.00	34.90	
		5	120.00	34.20	
		6	135.00	33.50	
		7	177.00	12.50	
		8	191.00	5.30	
		9	196.00	5.30	
		10	198.00	4.30	
		11	203.00	4.30	
		12	205.00	5.30	
		13	210.00	5.30	
		14	226.00	13.20	
2	X1 = 59.00 [ft]	1	59.00	28.30	Surcharge
	X2 = 226.00 [ft]	2	63.50	26.50	
		3	80.00	34.80	
		4	89.00	40.80	
		5	126.00	39.50	
		6	135.00	33.50	
		7	177.00	12.50	
		8	191.00	5.30	
		9	196.00	5.30	
		10	198.00	4.30	
		11	203.00	4.30	
		12	205.00	5.30	
		13	210.00	5.30	
		14	226.00	13.20	

```
                              STA 53+00 with 6' surcharge + PVD_90 days
    Results of Condolidation After 90.0 days.   (With PVD's)
  ======================================================================

------------------------------------------------------------------------------------
-
   Layer          PVD installed         Uv         Uh         Uave.   Sc-ult     Sc(t)
 Undergoing       Through Layer:
Consolidation
    NO / YES          NO / YES          [%]        [%]         [%]    [ft]       [ft]
------------------------------------------------------------------------------------
-
   1    NO             N/A               N/A        N/A        N/A        N/A        N/A
   2   YES             YES            100.00      88.91     100.00      0.364      0.364
   3    NO             N/A               N/A        N/A        N/A        N/A        N/A
   4   YES             YES             87.97      88.91      98.67      0.389      0.384
   5    NO             N/A               N/A        N/A        N/A        N/A        N/A
   6   YES              NO             94.52       0.00      94.52      0.015      0.014
   7    NO             N/A               N/A        N/A        N/A        N/A        N/A
```

```
                     STA 53+00 with 6' surcharge + PVD_120 days
    Results of Condolidation After 120.0 days.   (With PVD's)
  ========================================================================

-------------------------------------------------------------------------------------
-
   Layer         PVD installed         Uv        Uh        Uave.   Sc-ult     Sc(t)
 Undergoing      Through Layer:
Consolidation
    NO / YES         NO / YES          [%]       [%]        [%]    [ft]      [ft]
-------------------------------------------------------------------------------------
-
   1    NO              N/A              N/A       N/A       N/A       N/A       N/A
   2   YES              YES           100.00     94.67    100.00     0.364     0.364
   3    NO              N/A              N/A       N/A       N/A       N/A       N/A
   4   YES              YES            93.87     94.67     99.67     0.389     0.388
   5    NO              N/A              N/A       N/A       N/A       N/A       N/A
   6   YES               NO            97.77      0.00     97.77     0.015     0.015
   7    NO              N/A              N/A       N/A       N/A       N/A       N/A
```

Estimation of Secondary Settlement

Project Name:	**Witchduck I-64/264 Interchange - STA 53+00 with 6' surcharge**
Date:	1/9/2017
Calculated by:	AW
Checked by:	

Project Life = **20** **years**

CASE II: Surcharge

Height of surcharge = **6** **feet**

Surcharge unit weight = **130** **pcf** (if surcharge placed below water, enter bouyant unit weight)

S No.	Clay Layer	Thickness (ft)	C_α' (NC, strain based)	t_{90} ^{3} (years)	Final Effective stress at layer midpoint^4 (psf)	Effective stress decrease due to surcharge removal (psf)	AAOS^5	C_α' (surcharge)/ C_α' (NC) ^{6}	C_α' (surcharge)^6	Secondary Settlement (ft)
1	UC-1	3	0.003	0.25	3560	780	22%	0.40	0.0012	0.01
2	UC	7	0.003	0.25	4850.6	780	16%	0.54	0.0016	0.02
3	LC	7	0.0003	0.25	7284.6	780	11%	0.73	0.0002	0.00

TOTAL SECONDARY SETTLEMENT = **0.03 ft**

or

0.38 in

Notes

1 C_α' (NC, strain based) is the coefficient of secondary settlement without the effect of oversolidation or surcharge.

2 t_{90} is the time to complete 90% primary consolidation.

3 t_{90} with surcharge might be less due to the use of wick drains.

4 The "final effective stress at layer mid point" is the effective stress after the removal of the surcharge.

5 AAOS is the Adjusted Amount of Surcharge, which is the effective stress reduction caused by surcharge removal.
It is calculated as stress decrease due to surcharge removal divided by final effective stress at the depth of interest.

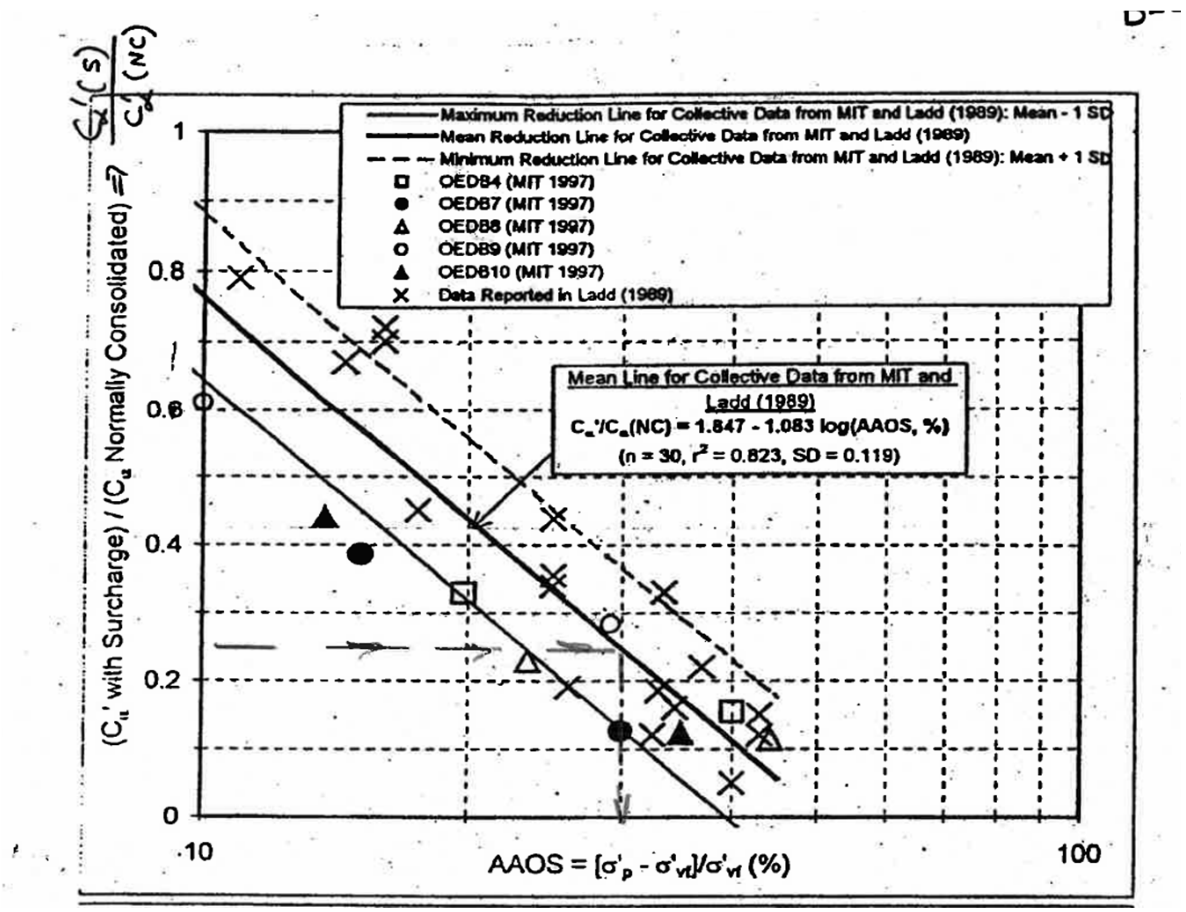
6 C_α' (surcharge) is the reduced coefficient of secondary settlement due to the application of surcharge.
This is estimated based on Ladd (1989) correlation shown in page 2.

7 Secondary settlement was calculated using the following equation:

$$S_{sec} = H.C'_{\propto}.\log(\frac{t_{project\ life}}{t_{90}})$$

8 It is assumed that surcharge, if placed, will be removed at 90% primary consolidation.

Ladd, 1989



Cα'(s) / Cα'(NC) ⇒
Maximum Reduction Line for Collective Data from MIT and Ladd (1989): Mean - 1 SD
Mean Reduction Line for Collective Data from MIT and Ladd (1989)
Minimum Reduction Line for Collective Data from MIT and Ladd (1989): Mean + 1 SD
□ OEDB4 (MIT 1997)
● OEDB7 (MIT 1997)
△ OEDB8 (MIT 1997)
○ OEDB9 (MIT 1997)
▲ OEDB10 (MIT 1997)
× Data Reported in Ladd (1989)
Mean Line for Collective Data from MIT and Ladd (1989)
Cα'/Cα(NC) = 1.847 - 1.083 log(AAOS, %)
(n = 30, r² = 0.823, SD = 0.119)
(Cα' with Surcharge) / (Cα Normally Consolidated)
1
0.8
0.6
0.4
0.2
0
10
100
AAOS = [σ'p - σ'vf]/σ'vf (%)

URS

Job 1-264 WITCHDUCK
Description IDEALIZED PROFILE

Project No.
Computed by
Checked by

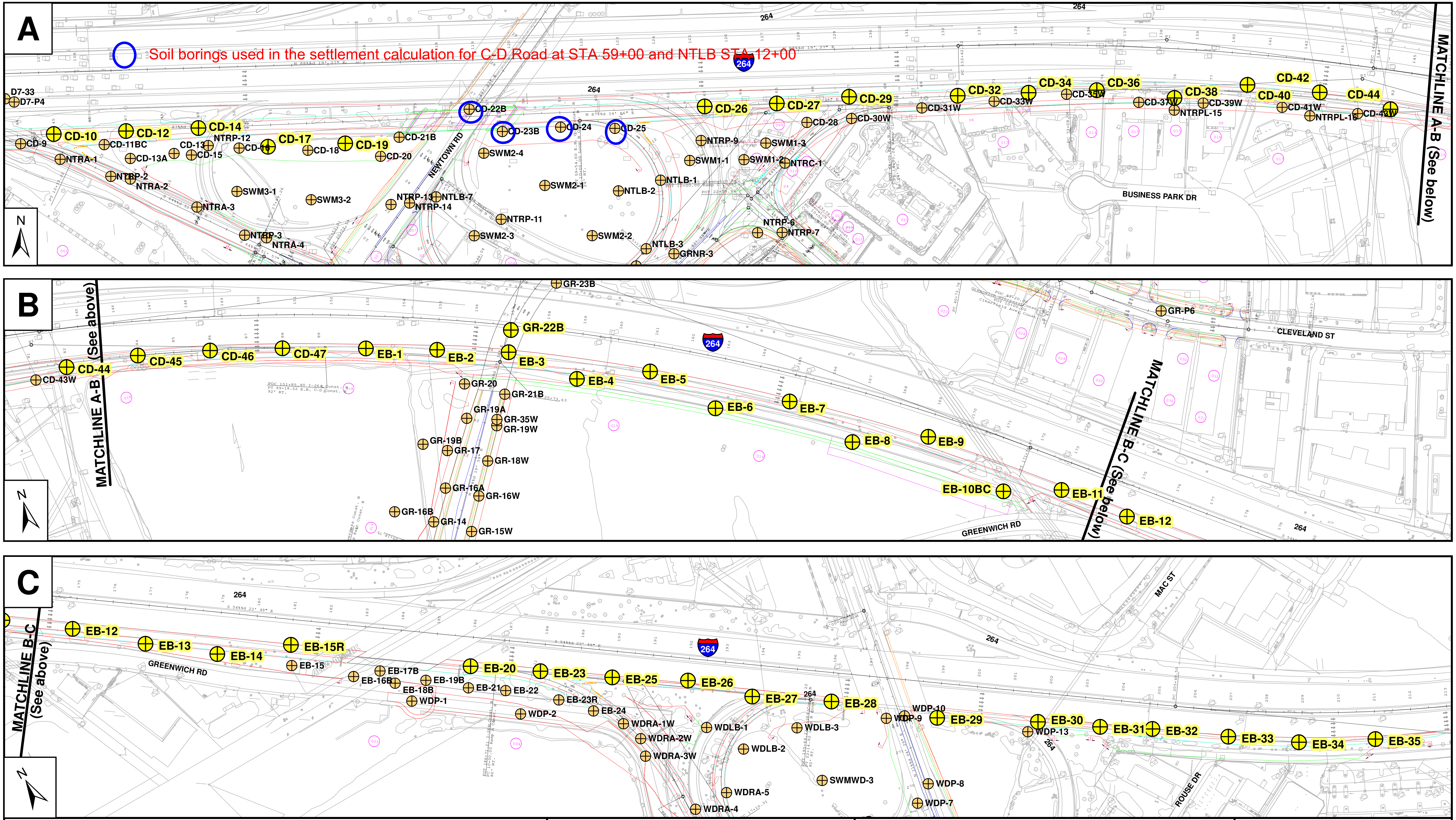
Page ____ of ____
Sheet ____ of ____
Date
Date
Reference

STA 59+00 ℄ NTLB

+13				
UPPER CLAY-1	γ_m=120 pcf	C_c'=0.12 C_R'=0.012 C_v=0.10	C_α=0.003 OCR=2.0	
+10 ▽				
UPPER SAND	γ_m = 115 pcf Es' = 500,000 psf			
-11				
UPPER CLAY-2	γ_m=112 pcf	C_c'=0.17 C_R'=0.014 C_v=0.10	C_α=0.003 OCR=1.5	
-19				
LOWER SAND	γ_m = 125 pcf Es' = 500,000 psf			
-41				
LOWER CLAY	γ_m=118 pcf	C_c'=0.10 C_R'=0.012 C_v=0.14	C_α=0.0003 OCR=2.0	
-55				
YORKTOWN	γ=125 pcf			

Based on

CD-22B, 23, 24, 25


Soil borings used in the settlement calculation for C-D Road at STA 59+00 and NTLB STA 12+00

0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

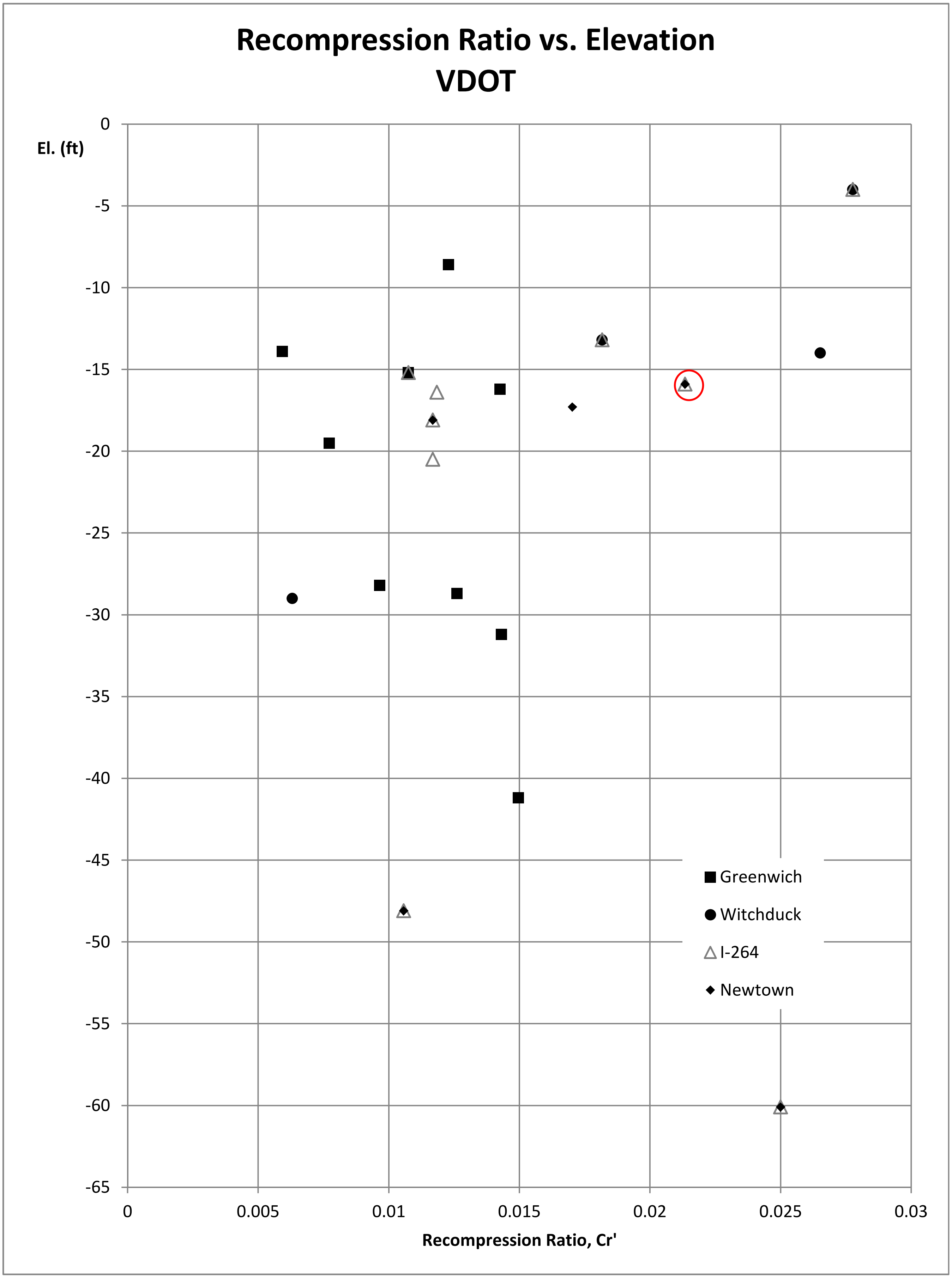
VDOT Virginia Department of Transportation

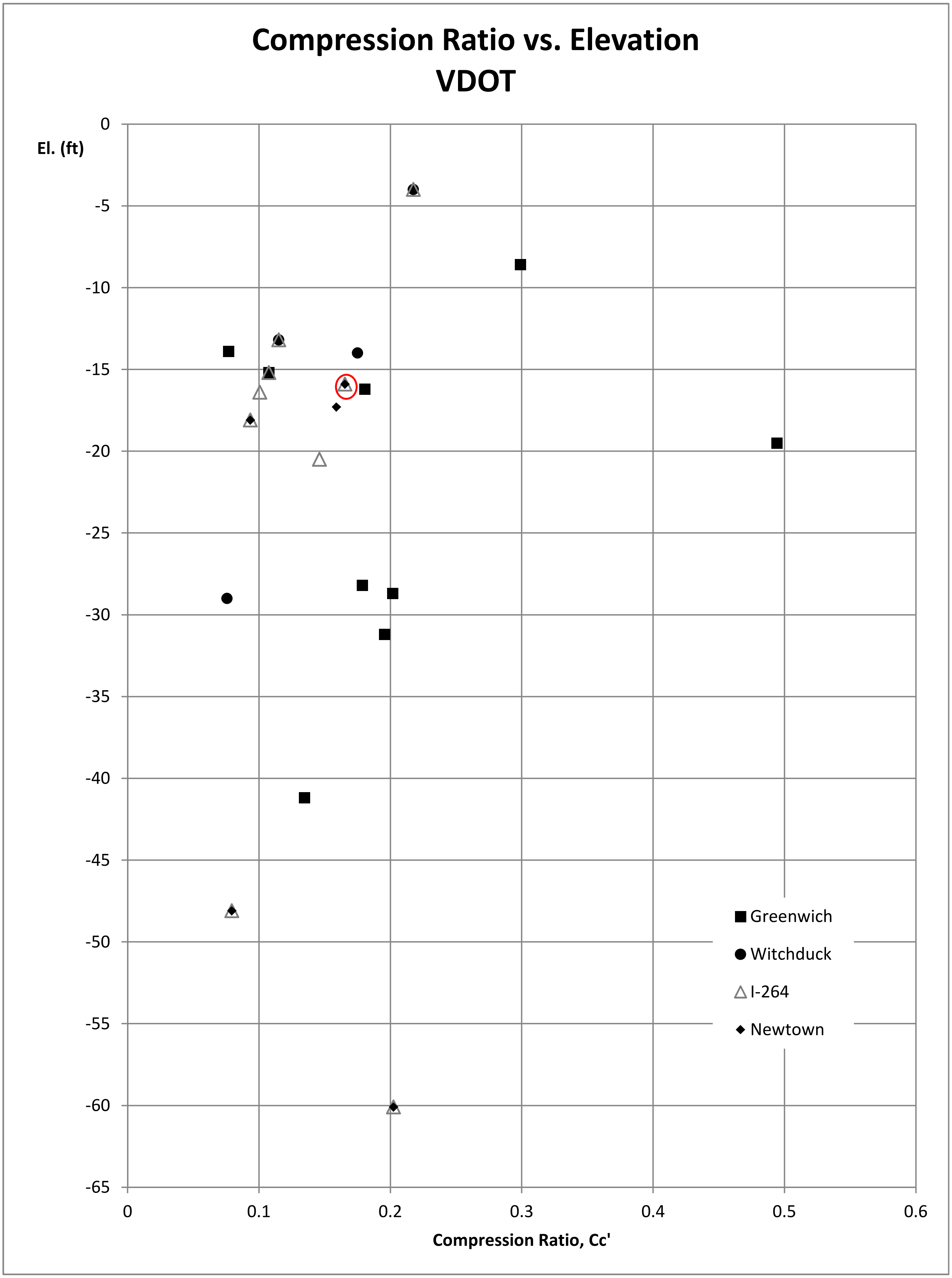
Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan


Recompression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.005
0.01
0.015
0.02
0.025
0.03
Recompression Ratio, Cr'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown


Compression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.1
0.2
0.3
0.4
0.5
0.6
Compression Ratio, Cc'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

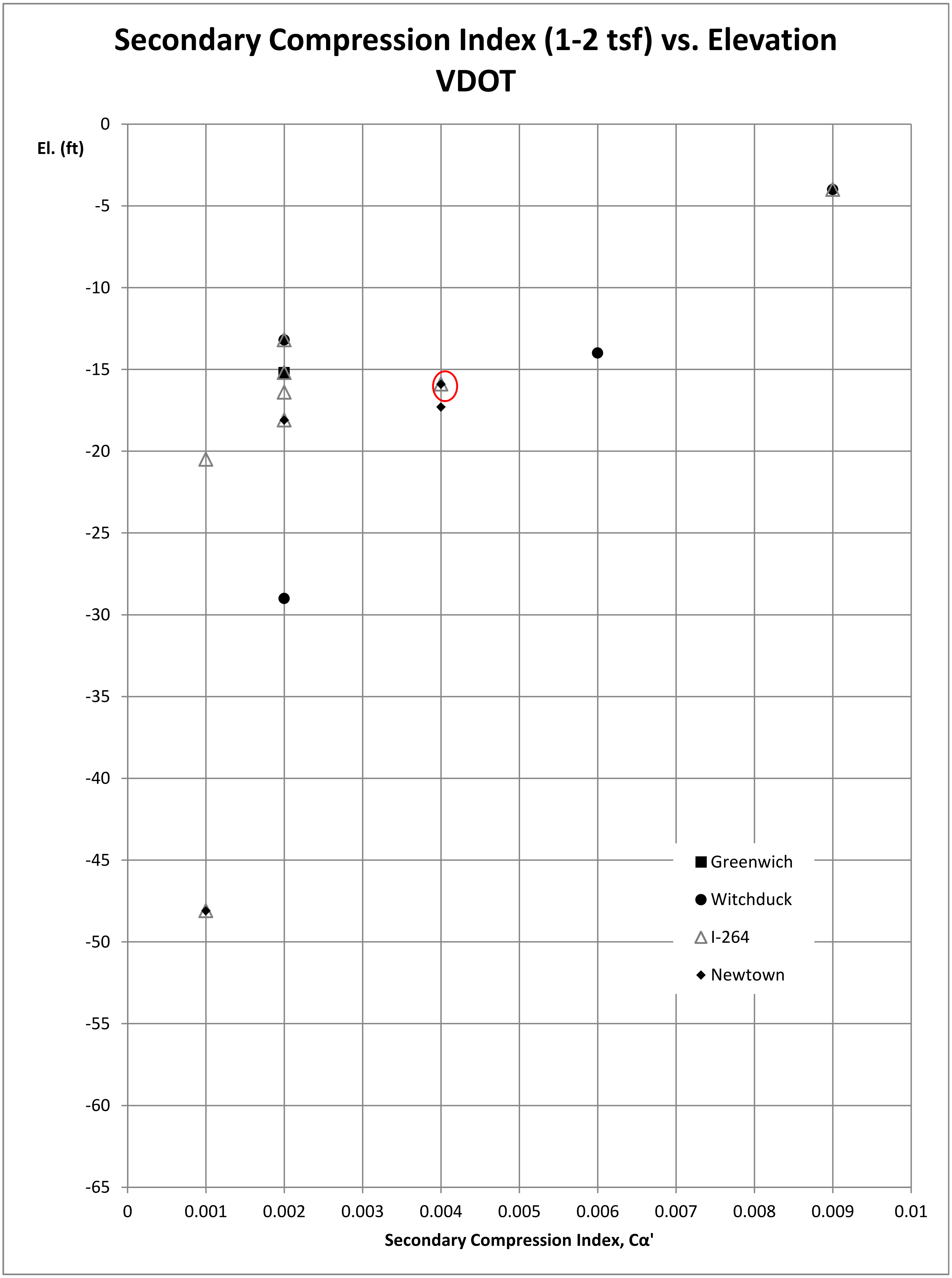

Secondary Compression Index (1-2 tsf) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
Secondary Compression Index, Cα'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

Table D-3

Typical Elastic Moduli

Soil	E_s, tsf
Clay	
Very soft clay	5 - 50
Soft clay	50 - 200
Medium clay	200 - 500
Stiff clay, silty clay	500 - 1000
Sandy clay	250 - 2000
Clay shale	1000 - 2000
Sand	
Loose sand	100 - 250
Dense sand	250 - 1000
Dense sand and gravel	1000 - 2000
Silty sand	250 - 2000

c. Laboratory Tests on Cohesive Soil. The elastic modulus is sensitive to soil disturbance which may increase pore water pressure and, therefore, decrease the effective stress in the specimen and reduce the stiffness and strength. Fissures, which may have little influence on field settlement, may reduce the measured modulus compared with the in situ modulus if confining pressures are not applied to the soil specimen.

(1) Initial hyperbolic tangent modulus. Triaxial unconsolidated undrained (Q or UU) compression tests may be performed on the best available undisturbed specimens at confining pressures equal to the total vertical overburden pressure σ_o for that specimen when in the field using the Q test procedure described in EM 1110-2-1906, Laboratory Soils Testing. An appropriate measure of E_s is the initial tangent modulus $E_{ti} = 1/a$ where a is the intercept of a plot of strain/deviator stress versus strain, Figure D-3 (item 14).

(2) Reload modulus. A triaxial consolidated undrained (R or CU) compression test may be performed on the best available undisturbed specimens. The specimen is initially fully consolidated to an isotropic confining pressure equal to the vertical overburden pressure σ_o for that specimen in the field. The R test procedure described in EM 1110-2-1906 may be used except as follows: stress is increased to the magnitude estimated for the field loading condition. The axial stress may then be reduced to zero and the cycle repeated until the reload curve shows no further increase in slope. The tangent modulus at 1/2 of the maximum applied stress is determined for each loading cycle and plotted versus the number of cycles, Figure D-4. An appropriate measure of E_s is the reload tangent modulus that approaches the asymptotic value at large cycles.

d. Field Tests. The elastic modulus may be estimated from empirical and semiempirical relationships based on results of field soil tests. Refer to

I-264 Witchduck STA 59+00

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PROJECT IDENTIFICATION

Title: I-264 Witchduck STA 59+00
Project Number: -
Client:
Designer: AW
Station Number:

Description:
STA 59+00, 29' max fill, no GI

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... ect\Calculations\Settlement\FOSSA\CD STA 59+00.2ST
Original date and time of creating this file: Mon Jan 09 09:23:23 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 7 layers

	Wet Unit Weight, γ [lb/ft³]	Poisson's Ratio μ	Description of Soil
1	125.00	0.30	Layer 1 Existing Fill
2	120.00	0.50	Layer 2 Upper Clay
3	115.00	0.30	Layer 3 Upper Sand
4	112.00	0.50	Layer 4 Upper Clay
5	125.00	0.30	Layer 5 Lower Sand
6	118.00	0.50	Layer 6 Lower Clay
7	125.00	0.30	Layer 7 Yorktown

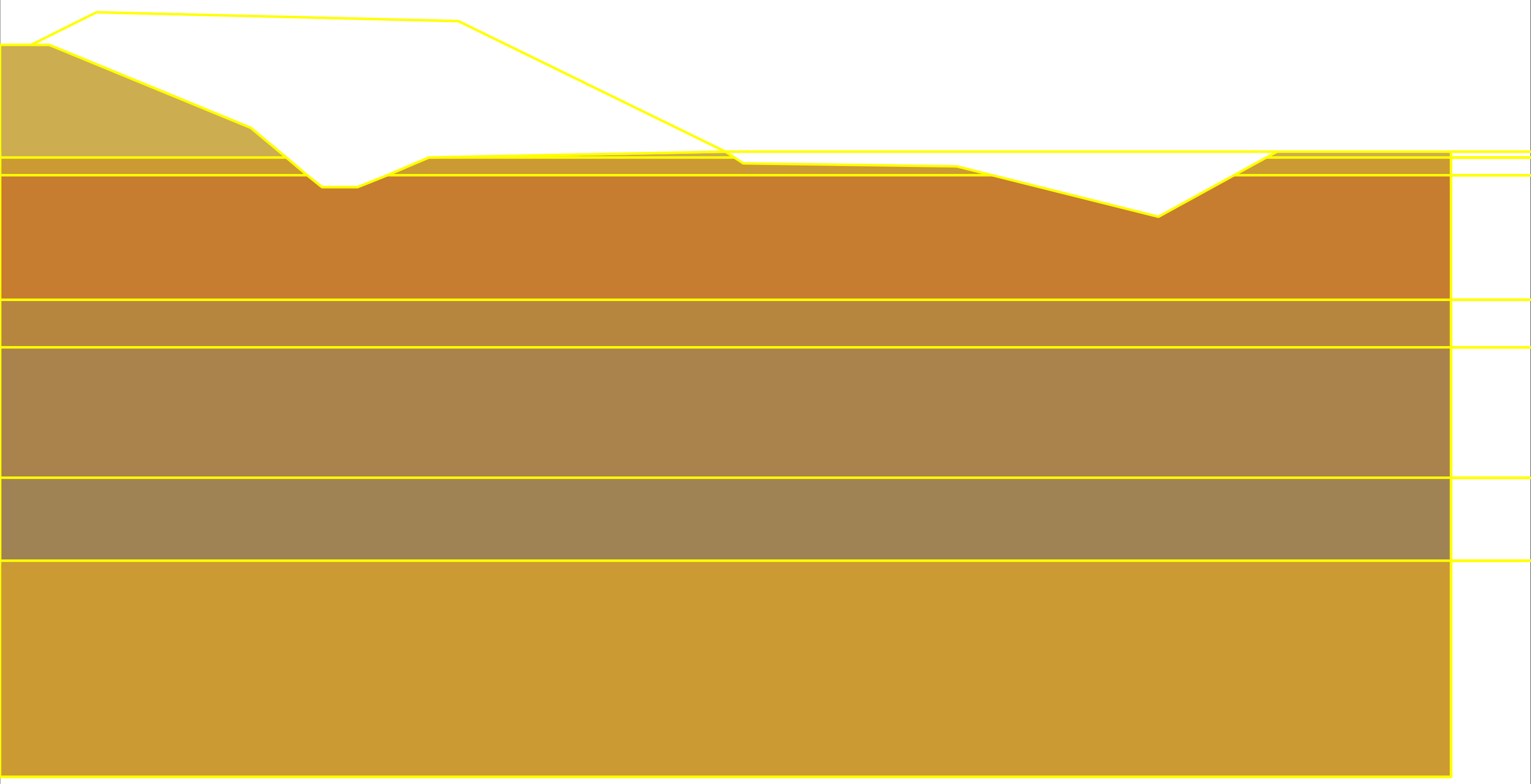
INPUT DATA – EMBANKMENT LAYERS -- 1 layers

	Wet Unit Weight, γ [lb/ft³]	Description of Soil
1	130.00	Proposed Fill

INPUT DATA OF WATER

Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]
1	0.00	10.00
2	1000.00	10.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :	CREEP Ca/Cc
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	0.0250
3	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	0.0176
5	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	0.0030
7	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Secondary Comprassion (Creep) : Settlement is calculated at t2/t1 = 10.0

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	-50.00	0.00	1	750000	0.3000	-0.0023	32.00	31.99	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0129			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
2	-44.90	0.00	1	750000	0.3000	-0.0024	32.00	31.98	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0022			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0165			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
3	-39.80	0.00	1	750000	0.3000	-0.0023	32.00	31.98	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0060			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0206			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
4	-34.69	0.00	1	750000	0.3000	-0.0013	32.00	31.96	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0111			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0252			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
5	-29.59	0.00	1	750000	0.3000	0.0031	31.83	31.78	0.05
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0177			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0303			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
6	-24.49	0.00	1	750000	0.3000	0.0094	29.73	29.66	0.07
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0256			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0357			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
7	-19.39	0.00	1	750000	0.3000	0.0136	27.63	27.54	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0343			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0414			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
8	-14.29	0.00	1	750000	0.3000	0.0155	25.53	25.42	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0433			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0471			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
9	-9.18	0.00	1	750000	0.3000	0.0157	23.43	23.31	0.12
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0524			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0527			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
10	-4.08	0.00	1	750000	0.3000	0.0153	21.33	21.19	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0614			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0581			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
11	1.02	0.00	1	750000	0.3000	0.0133	19.23	19.08	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0700			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0629			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
12	6.12	0.00	1	750000	0.3000	0.0082	16.23	16.08	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0778			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0670			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
13	11.22	0.00	1	750000	0.3000	0.0000	11.95	11.80	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0844			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0702			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
14	16.33	0.00	1	750000	0.3000	0.0000	8.00	7.85	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0790			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0724			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
15	21.43	0.00	1	750000	0.3000	0.0000	8.00	7.85	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0809			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0735			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
16	26.53	0.00	1	750000	0.3000	0.0000	9.81	9.65	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0893			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0735			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
17	31.63	0.00	1	750000	0.3000	0.0000	11.99	11.83	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0878			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0722			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
18	36.73	0.00	1	750000	0.3000	0.0000	13.05	12.90	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0830			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0699			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
19	41.84	0.00	1	750000	0.3000	0.0000	13.16	13.01	0.14
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0767			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0666			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
20	46.94	0.00	1	750000	0.3000	0.0000	13.26	13.13	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0692			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0625			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
21	52.04	0.00	1	750000	0.3000	0.0012	13.36	13.24	0.12
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0608			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0577			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
22	57.14	0.00	1	750000	0.3000	0.0010	13.46	13.36	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0518			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0524			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
23	62.24	0.00	1	750000	0.3000	0.0008	13.56	13.47	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0427			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0468			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
24	67.35	0.00	1	750000	0.3000	0.0009	13.67	13.59	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0337			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0411			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
25	72.45	0.00	1	750000	0.3000	0.0006	13.77	13.71	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0253			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0355			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
26	77.55	0.00	1	750000	0.3000	0.0003	13.87	13.82	0.05
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0177			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0302			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
27	82.65	0.00	1	750000	0.3000	0.0001	13.97	13.94	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0113			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0251			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
28	87.76	0.00	1	750000	0.3000	-0.0001	14.00	13.97	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0063			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0206			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
29	92.86	0.00	1	750000	0.3000	-0.0002	14.00	13.98	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0025			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0165			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
30	97.96	0.00	1	750000	0.3000	-0.0002	14.00	13.99	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0001			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0129			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
31	103.06	0.00	1	750000	0.3000	-0.0002	14.00	13.99	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0018			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0099			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
32	108.16	0.00	1	750000	0.3000	-0.0002	14.00	14.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0029			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0073			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
33	113.27	0.00	1	750000	0.3000	-0.0002	14.00	14.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0035			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0052			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
34	118.37	0.00	1	750000	0.3000	-0.0002	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0039			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0034			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
35	123.47	0.00	1	750000	0.3000	-0.0002	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0040			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0020			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
36	128.57	0.00	1	750000	0.3000	-0.0002	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0040			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0009			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
37	133.67	0.00	1	750000	0.3000	-0.0001	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0040			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0000			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
38	138.78	0.00	1	750000	0.3000	-0.0001	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0039			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0007			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
39	143.88	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0037			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0013			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
40	148.98	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0035			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0017			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
41	154.08	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0034			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0020			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
42	159.18	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0032			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0023			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ^{2}]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
43	164.29	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0031			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0025			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
44	169.39	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0029			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0026			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
45	174.49	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0028			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0027			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
46	179.59	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0026			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0027			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
47	184.69	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0024			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0027			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
48	189.80	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0023			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0027			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
49	194.90	0.00	1	750000	0.3000	-0.0001	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0022			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0027			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
50	200.00	0.00	1	750000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0021			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0027			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	32.00	0.00	12.14	0.61	11.53

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

SECONDARY SETTLEMENT (Creep), Ss -- Total Secondary Compression (Creep) = 0.035 ft.

Layer #	Underging Consolidation	Cc / (1+e0)	C-alpha/ (1+e0)	e-zero	H [ft.]	t1/t2	Settlement Ss [ft.]
1	No	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	0.1200	0.0030	N/A	2.14	10.0	0.006
3	No	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	0.1700	0.0030	N/A	8.00	10.0	0.024
5	No	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	0.1000	0.0003	N/A	14.00	10.0	0.004
7	No	N/A	N/A	N/A	N/A	N/A	N/A

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	-50.00	32.00	Layer 1 Existing Fill
	2	-33.00	32.00	
	3	-30.00	32.00	
	4	4.00	18.00	
	5	10.00	13.00	
	6	13.50	10.00	
	7	16.00	8.00	
	8	22.00	8.00	
	9	27.00	10.00	
	10	34.00	13.00	
	11	84.00	14.00	
	12	177.00	14.00	
2	1	-50.00	13.00	Layer 2 Upper Clay
	2	-33.00	13.00	
	3	-30.00	13.00	
	4	4.00	13.00	
	5	10.00	13.00	
	6	13.50	10.00	
	7	16.00	8.00	
	8	22.00	8.00	
	9	27.00	10.00	
	10	34.00	13.00	
	11	84.00	13.00	
	12	177.00	13.00	
3	1	-50.00	10.00	Layer 3 Upper Sand
	2	4.00	10.00	
	3	13.50	10.00	
	4	16.00	8.00	
	5	22.00	8.00	
	6	27.00	10.00	
	7	34.00	10.00	
	8	84.00	10.00	
4	1	0.00	-11.00	Layer 4 Upper Clay
	2	1000.00	-11.00	
5	1	0.00	-19.00	Layer 5 Lower Sand
	2	1000.00	-19.00	
6	1	0.00	-41.00	Layer 6 Lower Clay
	2	1000.00	-41.00	
7	1	0.00	-55.00	Layer 7 Yorktown
	2	1000.00	-55.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = -33.00 [ft]	1	-33.00	32.00	Surcharge
	X2 = 177.00 [ft]	2	-22.00	37.50	
		3	39.00	36.00	
		4	84.00	14.00	
		5	87.00	12.00	
		6	123.00	11.50	
		7	157.00	3.00	
		8	177.00	14.00	
		9	177.00	3.00	

I-264 Witchduck STA 59+00

PROJECT IDENTIFICATION

Title: I-264 Witchduck STA 59+00
Project Number: -
Client:
Designer: AW
Station Number:

Description:
STA 59+00, 29' max fill, 6' surcharge + PVD

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... ent\FOSSA\CD STA 59+00 with 6' surcharge + PVD.2ST
Original date and time of creating this file: Mon Jan 09 12:24:52 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 7 layers

	Wet Unit Weight, γ [lb/ft³]	**Poisson's Ratio μ**	**Description of Soil**
1	125.00	0.30	Layer 1 Existing Fill
2	120.00	0.50	Layer 2 Upper Clay
3	115.00	0.30	Layer 3 Upper Sand
4	112.00	0.50	Layer 4 Upper Clay
5	125.00	0.30	Layer 5 Lower Sand
6	118.00	0.50	Layer 6 Lower Clay
7	125.00	0.30	Layer 7 Yorktown

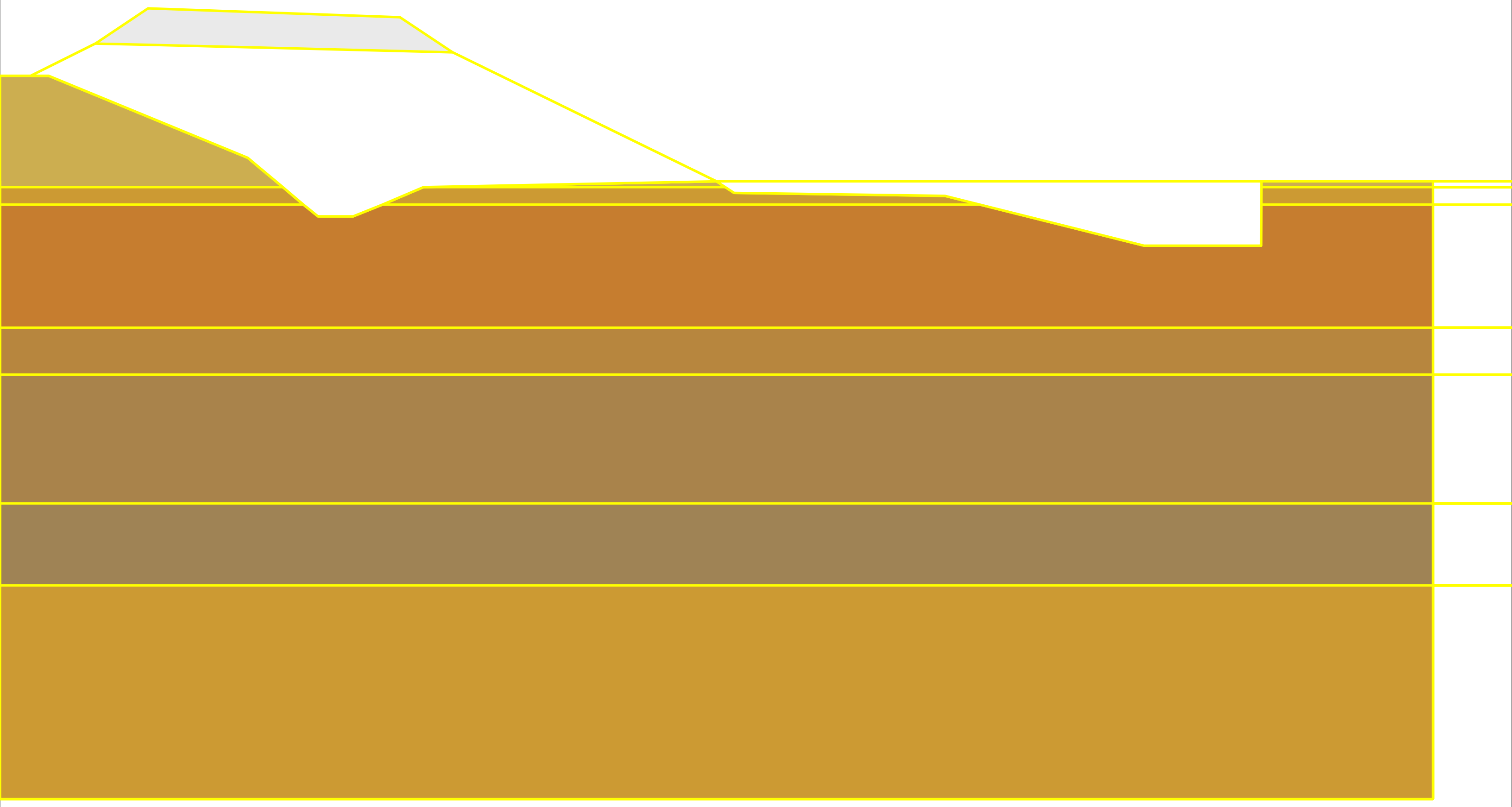
INPUT DATA – EMBANKMENT LAYERS -- 2 layers

	Wet Unit Weight, γ [lb/ft³]	**Description of Soil**
1	130.00	Proposed Fill
2	130.00	Surcharge

INPUT DATA OF WATER

Point #	**Coordinates (X, Z) : (X) [ft.]**	**(Z) [ft.]**
1	0.00	10.00
2	1000.00	10.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :	PVD through Layer No/Yes	Ch=Coeff. for horiz. drainage [ft ²/day]
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	Yes	0.2153
3	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	Yes	0.2153
5	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	No	0.2153
7	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

PVD : Triangle Pattern where D = 1.05 x 5.00 = 5.25 ft.
dw = 2 x (a + b) / 3.14 = 2.607 inch --> F(n) = 2.44. Fs for disturbance = 0.000
and Fr' = 0.050

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X	Y	Layer (k)	Young's Modulus, E	Poisson's Ratio, μ	Settlement of each layer, Si(k)	Initial Z	Final Z *	Total Settlement Sum of Si(k),
	[ft.]	[ft.]		[lb/ft ²]		[ft.]	[ft.]	[ft.]	[ft.]
1	-50.00	0.00	1	750000	0.3000	-0.0028	32.00	31.99	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0002			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0165			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
2	-44.90	0.00	1	750000	0.3000	-0.0031	32.00	31.98	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0030			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0210			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
3	-39.80	0.00	1	750000	0.3000	-0.0030	32.00	31.97	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0077			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0262			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
4	-34.69	0.00	1	750000	0.3000	-0.0020	32.00	31.96	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0143			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0320			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
5	-29.59	0.00	1	750000	0.3000	0.0027	31.83	31.77	0.06
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0229			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0383			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
6	-24.49	0.00	1	750000	0.3000	0.0100	29.73	29.64	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0334			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0451			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
7	-19.39	0.00	1	750000	0.3000	0.0171	27.63	27.52	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0450			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0521			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
8	-14.29	0.00	1	750000	0.3000	0.0218	25.53	25.39	0.14
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0572			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0591			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
9	-9.18	0.00	1	750000	0.3000	0.0224	23.43	23.27	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0691			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0658			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
10	-4.08	0.00	1	750000	0.3000	0.0213	21.33	21.15	0.17
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0801			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0720			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
11	1.02	0.00	1	750000	0.3000	0.0178	19.23	19.04	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0901			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0774			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
12	6.12	0.00	1	750000	0.3000	0.0106	16.23	16.04	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0985			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0818			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
13	11.22	0.00	1	750000	0.3000	0.0000	11.95	11.76	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.1049			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0850			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
14	16.33	0.00	1	750000	0.3000	0.0000	8.00	7.82	0.18
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0965			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0869			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
15	21.43	0.00	1	750000	0.3000	0.0000	8.00	7.82	0.18
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0969			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0873			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
16	26.53	0.00	1	750000	0.3000	0.0000	9.81	9.62	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.1050			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0863			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
17	31.63	0.00	1	750000	0.3000	0.0000	11.99	11.80	0.18
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.1009			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0839			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
18	36.73	0.00	1	750000	0.3000	0.0000	13.05	12.88	0.17
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0931			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0803			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
19	41.84	0.00	1	750000	0.3000	0.0000	13.16	13.00	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0839			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0757			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
20	46.94	0.00	1	750000	0.3000	0.0000	13.26	13.11	0.14
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0739			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0702			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
21	52.04	0.00	1	750000	0.3000	0.0012	13.36	13.23	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0637			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0642			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
22	57.14	0.00	1	750000	0.3000	0.0010	13.46	13.35	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0534			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0577			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
23	62.24	0.00	1	750000	0.3000	0.0008	13.56	13.47	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0434			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0511			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
24	67.35	0.00	1	750000	0.3000	0.0008	13.67	13.59	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0338			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0445			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
25	72.45	0.00	1	750000	0.3000	0.0005	13.77	13.71	0.06
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0250			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0382			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
26	77.55	0.00	1	750000	0.3000	0.0003	13.87	13.82	0.05
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0172			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0322			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
27	82.65	0.00	1	750000	0.3000	0.0001	13.97	13.94	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0106			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0266			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
28	87.76	0.00	1	750000	0.3000	-0.0001	14.00	13.97	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0055			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0216			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
29	92.86	0.00	1	750000	0.3000	-0.0002	14.00	13.98	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0017			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0172			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
30	97.96	0.00	1	750000	0.3000	-0.0002	14.00	13.99	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0009			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0134			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
31	103.06	0.00	1	750000	0.3000	-0.0003	14.00	13.99	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0026			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0101			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
32	108.16	0.00	1	750000	0.3000	-0.0002	14.00	14.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0037			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0074			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
33	113.27	0.00	1	750000	0.3000	-0.0002	14.00	14.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0043			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0051			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
34	118.37	0.00	1	750000	0.3000	-0.0002	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0046			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0032			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
35	123.47	0.00	1	750000	0.3000	-0.0002	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0047			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0017			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
36	128.57	0.00	1	750000	0.3000	-0.0002	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0047			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0005			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
37	133.67	0.00	1	750000	0.3000	-0.0002	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0046			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0004			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
38	138.78	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0045			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0012			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
39	143.88	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0043			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0017			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
40	148.98	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0041			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0022			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
41	154.08	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0039			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0025			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
42	159.18	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0037			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0028			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
43	164.29	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0035			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0030			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
44	169.39	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0034			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0031			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
45	174.49	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0032			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0031			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
46	179.59	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0030			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0032			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
47	184.69	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0028			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0032			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
48	189.80	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0027			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0032			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
49	194.90	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0025			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0032			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
50	200.00	0.00	1	750000	0.3000	-0.0001	14.00	14.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0024			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0031			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	-50.00	0.00	32.00	0.02	31.98
2	-44.90	0.00	32.00	0.02	31.98
3	-39.80	0.00	32.00	0.02	31.98
4	-34.69	0.00	32.00	0.03	31.97
5	-29.59	0.00	31.83	0.03	31.80
6	-24.49	0.00	29.73	0.04	29.70
7	-19.39	0.00	27.63	0.04	27.59
8	-14.29	0.00	25.53	0.08	25.45
9	-9.18	0.00	23.43	0.15	23.28
10	-4.08	0.00	21.33	0.23	21.09
11	1.02	0.00	19.23	0.33	18.90
12	6.12	0.00	16.23	0.47	15.76
13	11.22	0.00	11.95	0.68	11.27
14	16.33	0.00	8.00	0.51	7.49
15	21.43	0.00	8.00	0.51	7.49
16	26.53	0.00	9.81	0.47	9.34
17	31.63	0.00	11.99	0.67	11.31
18	36.73	0.00	13.05	0.69	12.37
19	41.84	0.00	13.16	0.64	12.52
20	46.94	0.00	13.26	0.58	12.68
21	52.04	0.00	13.36	0.52	12.84
22	57.14	0.00	13.46	0.45	13.01
23	62.24	0.00	13.56	0.38	13.18
24	67.35	0.00	13.67	0.31	13.36
25	72.45	0.00	13.77	0.23	13.54

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
26	77.55	0.00	13.87	0.15	13.73
27	82.65	0.00	13.97	0.08	13.89
28	87.76	0.00	14.00	0.04	13.96
29	92.86	0.00	14.00	0.03	13.97
30	97.96	0.00	14.00	0.03	13.97
31	103.06	0.00	14.00	0.02	13.98
32	108.16	0.00	14.00	0.02	13.98
33	113.27	0.00	14.00	0.02	13.98
34	118.37	0.00	14.00	0.01	13.99
35	123.47	0.00	14.00	0.01	13.99
36	128.57	0.00	14.00	0.01	13.99
37	133.67	0.00	14.00	0.01	13.99
38	138.78	0.00	14.00	0.01	13.99
39	143.88	0.00	14.00	0.01	13.99
40	148.98	0.00	14.00	0.01	13.99
41	154.08	0.00	14.00	0.01	13.99
42	159.18	0.00	14.00	0.00	14.00
43	164.29	0.00	14.00	0.00	14.00
44	169.39	0.00	14.00	0.00	14.00
45	174.49	0.00	14.00	0.00	14.00
46	179.59	0.00	14.00	0.00	14.00
47	184.69	0.00	14.00	0.00	14.00
48	189.80	0.00	14.00	0.00	14.00
49	194.90	0.00	14.00	0.00	14.00
50	200.00	0.00	14.00	0.00	14.00

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	-50.00	32.00	Layer 1 Existing Fill
	2	-33.00	32.00	
	3	-30.00	32.00	
	4	4.00	18.00	
	5	10.00	13.00	
	6	13.50	10.00	
	7	16.00	8.00	
	8	22.00	8.00	
	9	27.00	10.00	
	10	34.00	13.00	
	11	84.00	14.00	
	12	177.00	14.00	
2	1	-50.00	13.00	Layer 2 Upper Clay
	2	-33.00	13.00	
	3	-30.00	13.00	
	4	4.00	13.00	
	5	10.00	13.00	
	6	13.50	10.00	
	7	16.00	8.00	
	8	22.00	8.00	
	9	27.00	10.00	
	10	34.00	13.00	
	11	84.00	13.00	
	12	177.00	13.00	
3	1	-50.00	10.00	Layer 3 Upper Sand
	2	4.00	10.00	
	3	13.50	10.00	
	4	16.00	8.00	
	5	22.00	8.00	
	6	27.00	10.00	
	7	34.00	10.00	
	8	84.00	10.00	
4	1	0.00	-11.00	Layer 4 Upper Clay
	2	1000.00	-11.00	
5	1	0.00	-19.00	Layer 5 Lower Sand
	2	1000.00	-19.00	
6	1	0.00	-41.00	Layer 6 Lower Clay
	2	1000.00	-41.00	
7	1	0.00	-55.00	Layer 7 Yorktown
	2	1000.00	-55.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	D E S C R I P T I O N
1	X1 = -33.00 [ft]	1	-33.00	32.00	Proposed Fill
	X2 = 177.01 [ft]	2	-22.00	37.50	
		3	39.00	36.00	
		4	84.00	14.00	
		5	87.00	12.00	
		6	123.00	11.50	
		7	157.00	3.00	
		8	177.00	3.00	
		9	177.01	14.00	
2	X1 = -33.00 [ft]	1	-22.00	37.50	Surcharge
	X2 = 177.01 [ft]	2	-13.00	43.50	
		3	30.00	42.00	
		4	39.00	36.00	
		5	84.00	14.00	
		6	87.00	12.00	
		7	123.00	11.50	
		8	157.00	3.00	
		9	177.00	3.00	
		10	177.00	14.00	

```
                     STA 59+00 with 6' surcharge + PVD_90 days
    Results of Condolidation After 90.0 days.   (With PVD's)
  ======================================================================

------------------------------------------------------------------------------------
-
   Layer         PVD installed         Uv        Uh        Uave.   Sc-ult     Sc(t)
 Undergoing      Through Layer:
Consolidation
    NO / YES         NO / YES          [%]       [%]        [%]     [ft]      [ft]
------------------------------------------------------------------------------------
-
   1    NO             N/A              N/A       N/A       N/A       N/A       N/A
   2   YES             YES            100.00     88.91    100.00     0.347     0.347
   3    NO             N/A              N/A       N/A       N/A       N/A       N/A
   4   YES             YES             81.16     88.91     97.91     0.310     0.304
   5    NO             N/A              N/A       N/A       N/A       N/A       N/A
   6   YES              NO             57.27      0.00     57.27     0.029     0.017
   7    NO             N/A              N/A       N/A       N/A       N/A       N/A
```

```
                     STA 59+00 with 6' surcharge + PVD_120 days
    Results of Condolidation After 120.0 days.   (With PVD's)
  ======================================================================

------------------------------------------------------------------------------------
-
   Layer         PVD installed         Uv        Uh        Uave.   Sc-ult     Sc(t)
 Undergoing      Through Layer:
Consolidation
    NO / YES         NO / YES          [%]       [%]        [%]    [ft]      [ft]
------------------------------------------------------------------------------------
-
   1    NO             N/A              N/A       N/A       N/A       N/A       N/A
   2   YES             YES            100.00     94.67    100.00     0.347     0.347
   3    NO             N/A              N/A       N/A       N/A       N/A       N/A
   4   YES             YES             88.75     94.67     99.40     0.310     0.308
   5    NO             N/A              N/A       N/A       N/A       N/A       N/A
   6   YES              NO             65.51      0.00     65.51     0.029     0.019
   7    NO             N/A              N/A       N/A       N/A       N/A       N/A
```

Estimation of Secondary Settlement

Project Name:	**I-264 Witchduck CD STA 59+00**
Date:	1/9/2017
Calculated by:	AW
Checked by:	

Project Life = **20** **years**

CASE II: Surcharge

Height of surcharge = **6** **feet**

Surcharge unit weight = **130** **pcf** (if surcharge placed below water, enter bouyant unit weight)

S No.	**Clay Layer**	**Thickness (ft)**	**C_α' (NC, strain based)**	**t_{90}[3] (years)**	**Final Effective stress at layer midpoint[4] (psf)**	**Effective stress decrease due to surcharge removal (psf)**	**AAOS[5]**	**C_α' (surcharge)/ C_α' (NC) [6]**	**C_α' (surcharge)[6]**	**Secondary Settlement (ft)**
1	UC-1	3	0.003	0.25	3300	780	24%	0.36	0.0011	0.01
2	UC	8	0.003	0.25	4783	780	16%	0.53	0.0016	0.02
3	LC	14	0.0003	0.25	6747.8	780	12%	0.70	0.0002	0.01

TOTAL SECONDARY SETTLEMENT = **0.04 ft**

or

0.43 in

Notes

1 C_α' (NC, strain based) is the coefficient of secondary settlement without the effect of oversolidation or surcharge.

2 t_{90} is the time to complete 90% primary consolidation.

3 t_{90} with surcharge might be less due to the use of wick drains.

4 The "final effective stress at layer mid point" is the effective stress after the removal of the surcharge.

5 AAOS is the Adjusted Amount of Surcharge, which is the effective stress reduction caused by surcharge removal.
It is calculated as stress decrease due to surcharge removal divided by final effective stress at the depth of interest.

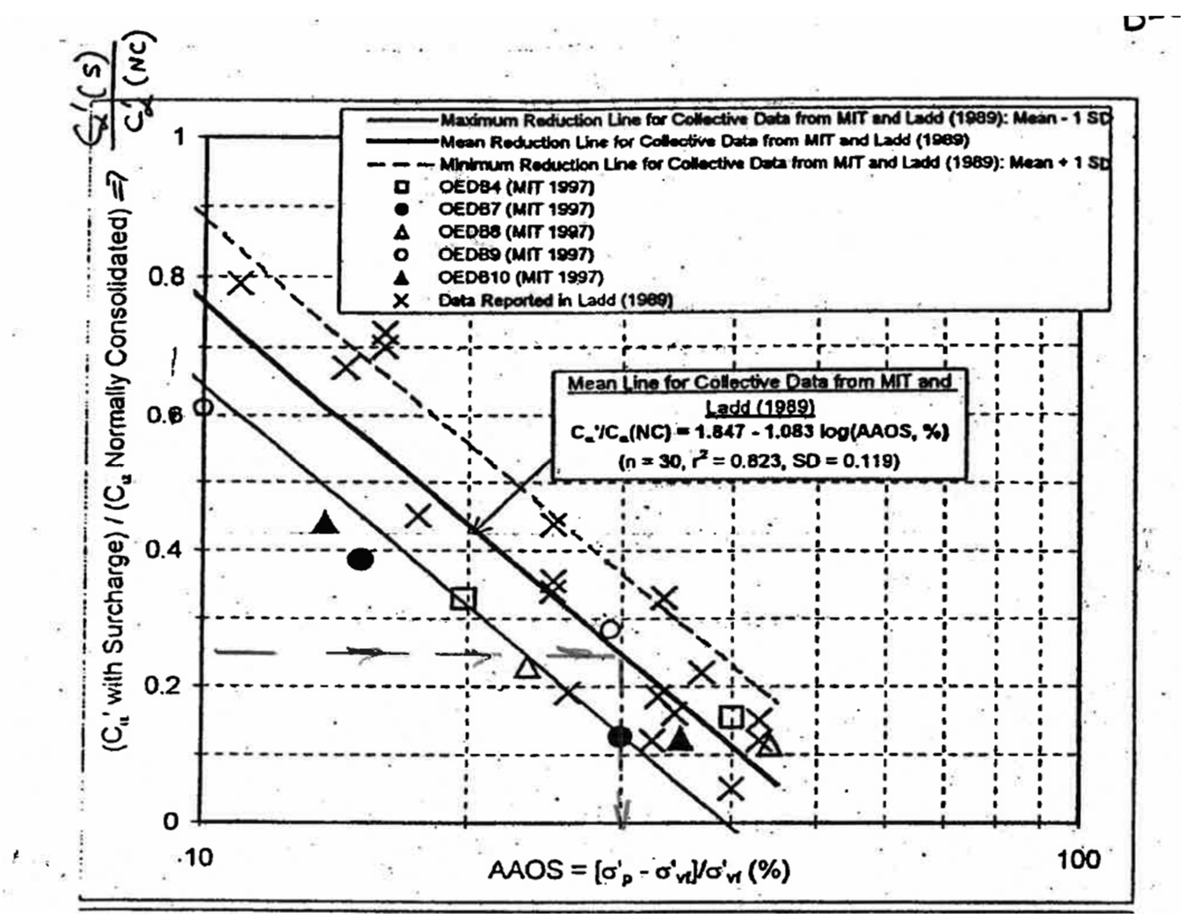
6 C_α' (surcharge) is the reduced coefficient of secondary settlement due to the application of surcharge.
This is estimated based on Ladd (1989) correlation shown in page 2.

7 Secondary settlement was calculated using the following equation:

$$S_{sec} = H.C'_{\propto}.\log(\frac{t_{project\ life}}{t_{90}})$$

8 It is assumed that surcharge, if placed, will be removed at 90% primary consolidation.

Ladd, 1989


Maximum Reduction Line for Collective Data from MIT and Ladd (1989): Mean - 1 SD
Mean Reduction Line for Collective Data from MIT and Ladd (1989)
Minimum Reduction Line for Collective Data from MIT and Ladd (1989): Mean + 1 SD
OEDB4 (MIT 1997)
OEDB7 (MIT 1997)
OEDB8 (MIT 1997)
OEDB9 (MIT 1997)
OEDB10 (MIT 1997)
Data Reported in Ladd (1989)
Mean Line for Collective Data from MIT and Ladd (1989)
$C_\alpha'/C_\alpha(NC) = 1.847 - 1.083 \log(AAOS, \%)$
(n = 30, r^2 = 0.823, SD = 0.119)
$(C_\alpha'$ with Surcharge) / (C_α Normally Consolidated) ⇒
$\frac{C_\alpha'(s)}{C_\alpha'(NC)}$
1
0.8
0.6
0.4
0.2
0
10
100
$AAOS = [\sigma'_p - \sigma'_{vf}]/\sigma'_{vf}$ (%)

Page ______ of ______

Job 1-64 WITCHDUCK

Project No. ______

Sheet ______ of ______

Description SOIL PROFILE STA 171+00

Computed by AS

Date 1/7/17

Checked by ______

Date ______

STA 171+00 & 170+00

Reference

+18

Upper Sand

$\gamma = 115$ pcf

Es' = 500,000 psf

+15

+11 ∇

Upper Clay-1

$\gamma = 120$ pcf

$C_c' = 0.12$

$C_r' = 0.012$

$C_\alpha' = 0.003$

OCR = 2

+13.5

Upper Sand

$\gamma = 115$ pcf

Es' = 500,000 psf

-12

Upper Clay-2

$\gamma = 112$ pcf

$C_c' = 0.17$

$C_r' = 0.014$

$C_\alpha' = 0.003$

OCR = 1.5

-41

Lower Sand

$\gamma = 125$ pcf

Es' = 500,000 psf

-62

Lower Clay

$\gamma = 118$ pcf

$C_c' = 0.1$

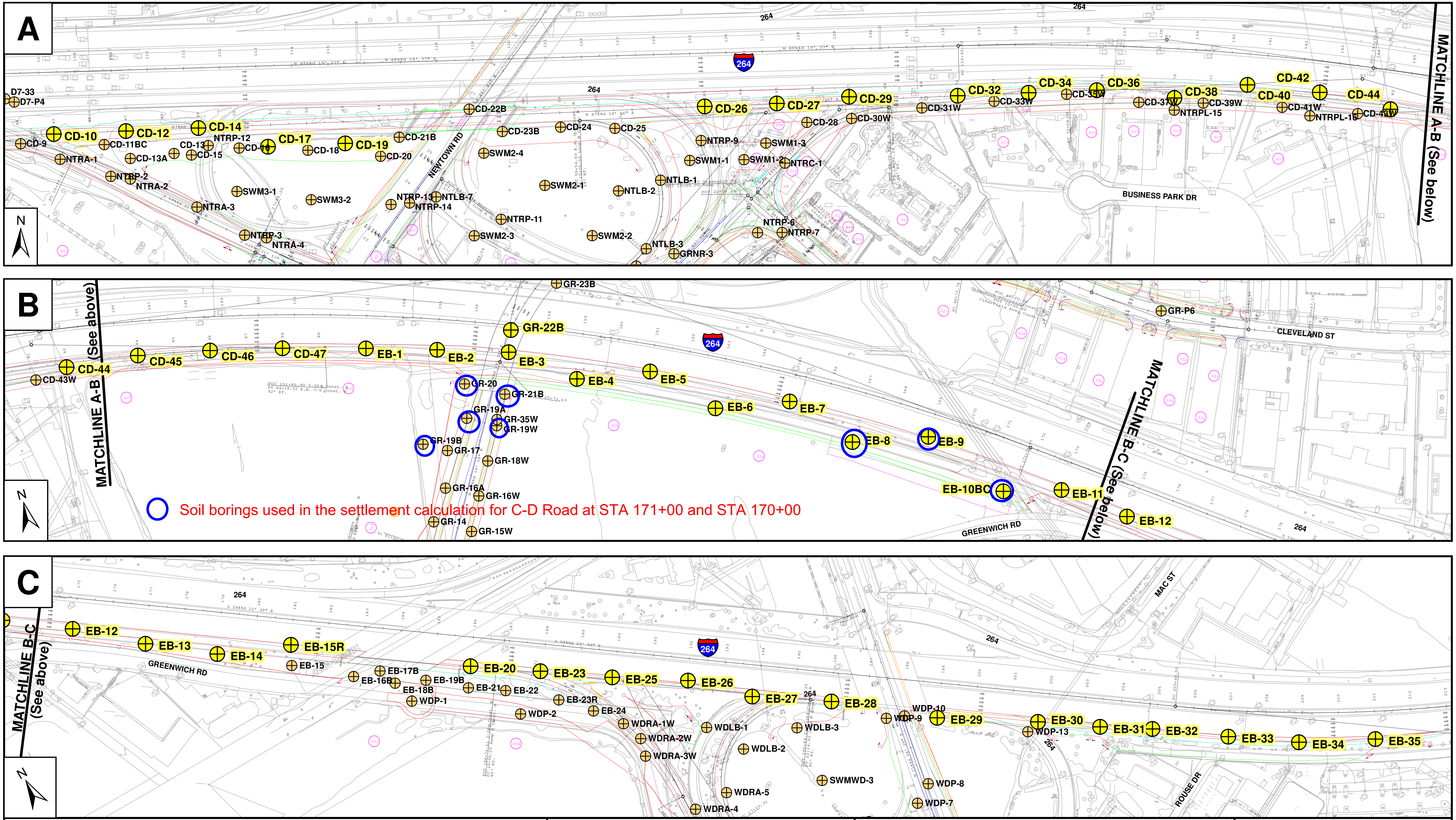
$C_r' = 0.012$

$C_\alpha' = 0.0003$

OCR = 2

-69

Yorktown



0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

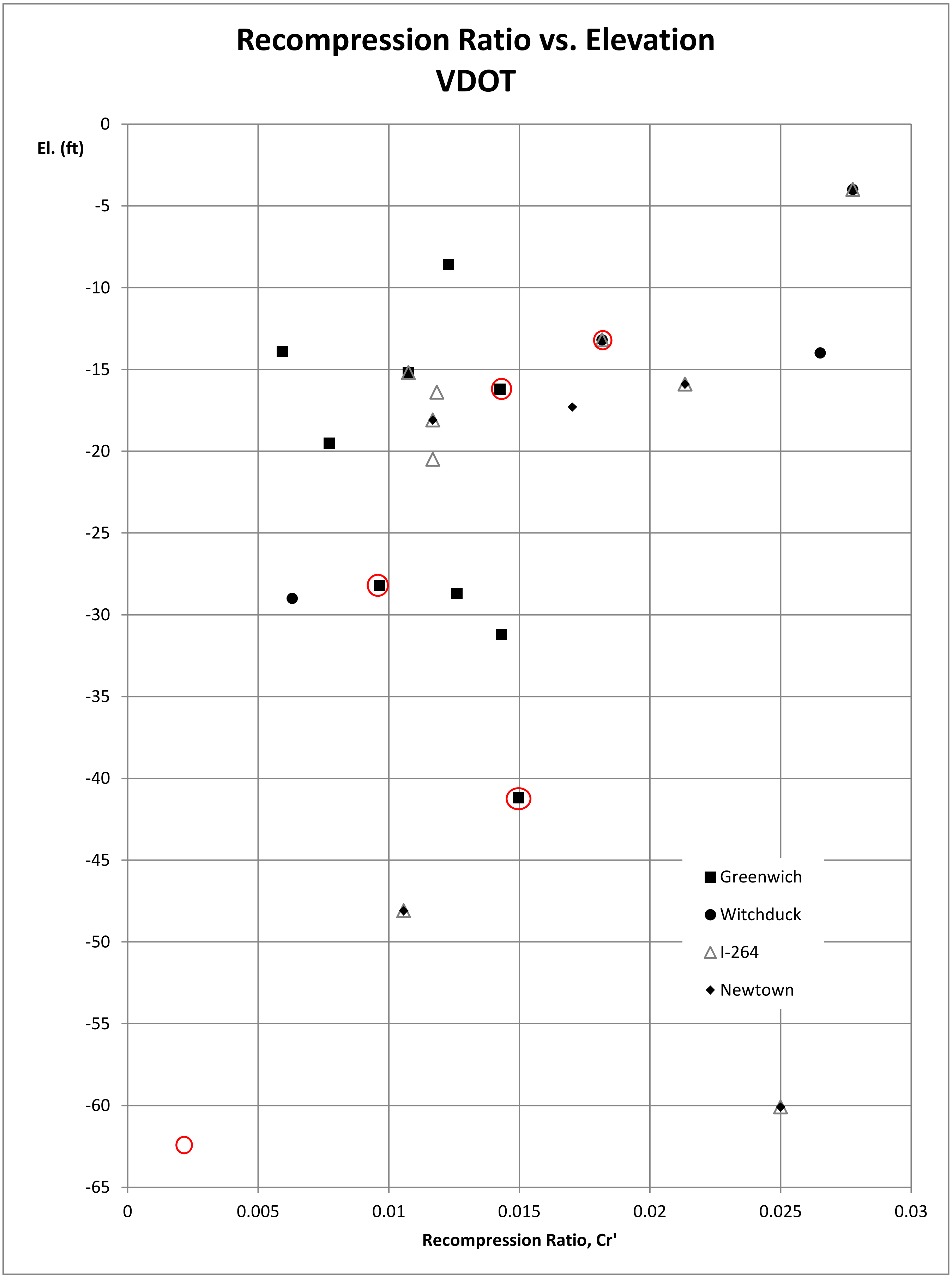
VDOT Virginia Department of Transportation

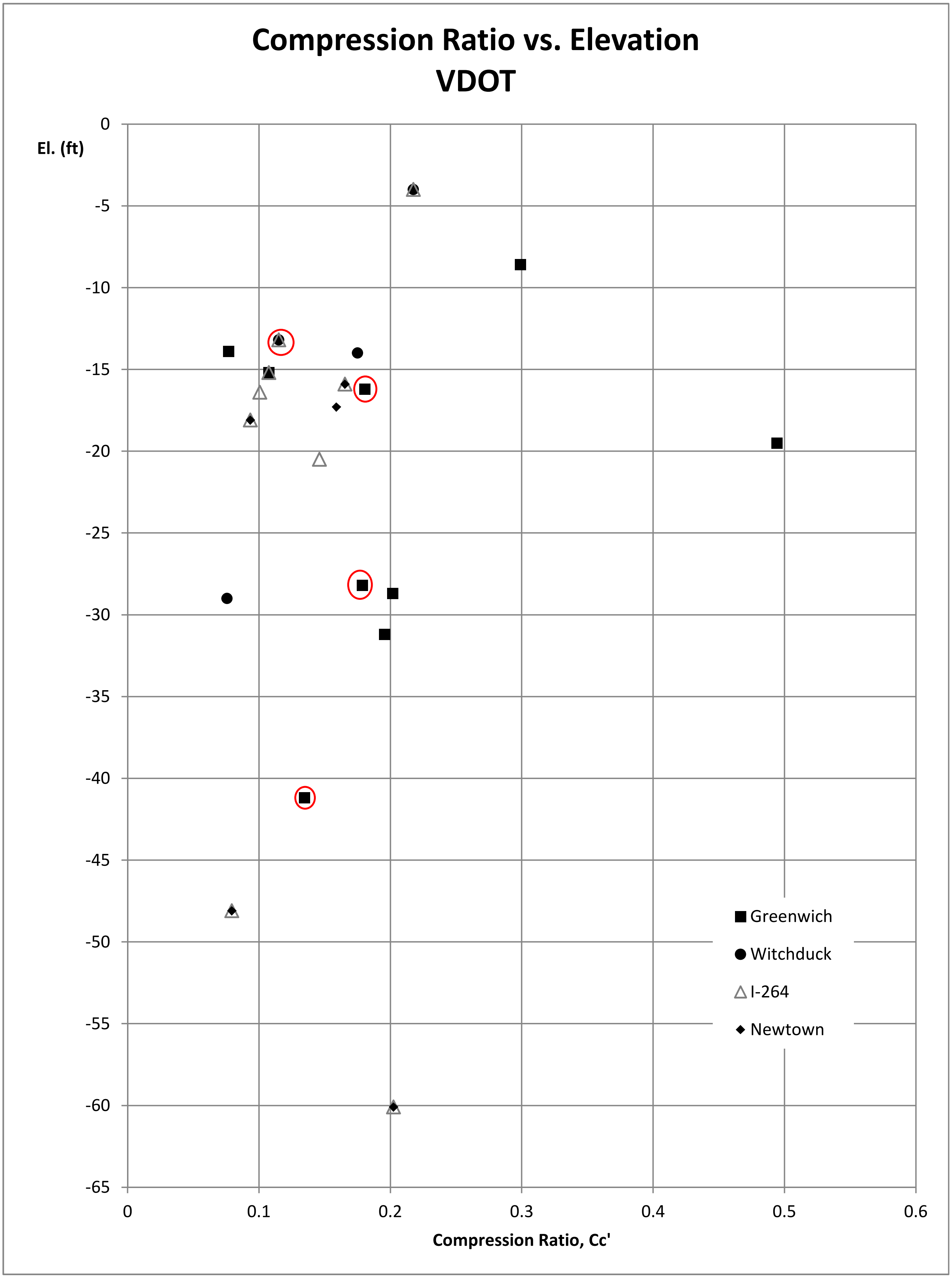
Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan


Recompression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.005
0.01
0.015
0.02
0.025
0.03
Recompression Ratio, Cr'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown


Compression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.1
0.2
0.3
0.4
0.5
0.6
Compression Ratio, Cc'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

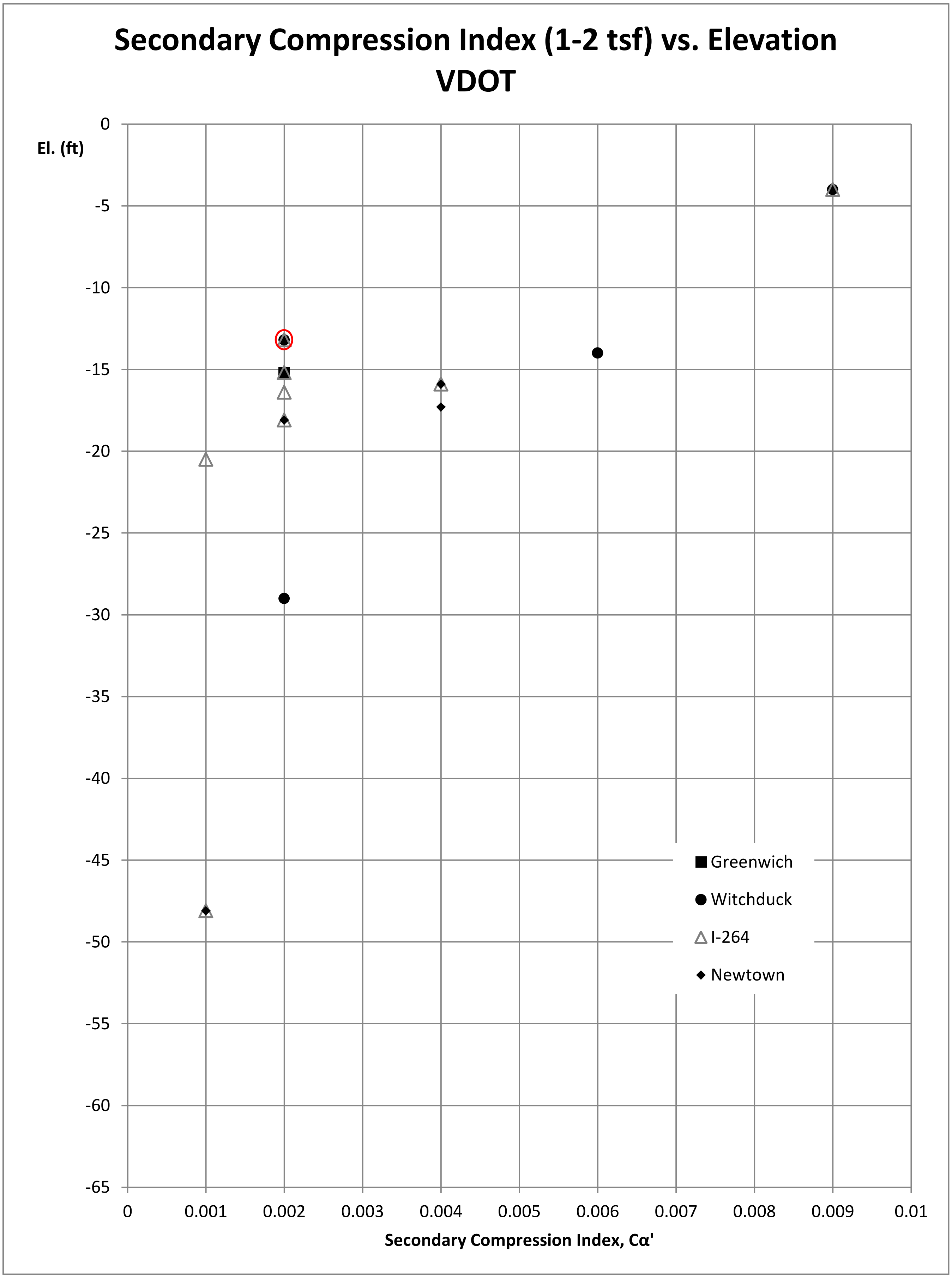

Secondary Compression Index (1-2 tsf) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
Secondary Compression Index, Cα'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

Table D-3

Typical Elastic Moduli

Soil	E_s, tsf
Clay	
Very soft clay	5 - 50
Soft clay	50 - 200
Medium clay	200 - 500
Stiff clay, silty clay	500 - 1000
Sandy clay	250 - 2000
Clay shale	1000 - 2000
Sand	
Loose sand	100 - 250
Dense sand	250 - 1000
Dense sand and gravel	1000 - 2000
Silty sand	250 - 2000

c. Laboratory Tests on Cohesive Soil. The elastic modulus is sensitive to soil disturbance which may increase pore water pressure and, therefore, decrease the effective stress in the specimen and reduce the stiffness and strength. Fissures, which may have little influence on field settlement, may reduce the measured modulus compared with the in situ modulus if confining pressures are not applied to the soil specimen.

(1) Initial hyperbolic tangent modulus. Triaxial unconsolidated undrained (Q or UU) compression tests may be performed on the best available undisturbed specimens at confining pressures equal to the total vertical overburden pressure σ_o for that specimen when in the field using the Q test procedure described in EM 1110-2-1906, Laboratory Soils Testing. An appropriate measure of E_s is the initial tangent modulus $E_{ti} = 1/a$ where a is the intercept of a plot of strain/deviator stress versus strain, Figure D-3 (item 14).

(2) Reload modulus. A triaxial consolidated undrained (R or CU) compression test may be performed on the best available undisturbed specimens. The specimen is initially fully consolidated to an isotropic confining pressure equal to the vertical overburden pressure σ_o for that specimen in the field. The R test procedure described in EM 1110-2-1906 may be used except as follows: stress is increased to the magnitude estimated for the field loading condition. The axial stress may then be reduced to zero and the cycle repeated until the reload curve shows no further increase in slope. The tangent modulus at 1/2 of the maximum applied stress is determined for each loading cycle and plotted versus the number of cycles, Figure D-4. An appropriate measure of E_s is the reload tangent modulus that approaches the asymptotic value at large cycles.

d. Field Tests. The elastic modulus may be estimated from empirical and semiempirical relationships based on results of field soil tests. Refer to

I-264 STA 170+00

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PROJECT IDENTIFICATION

Title:	I-264 STA 170+00
Project Number:	-
Client:	
Designer:	AW
Station Number:	

Description:
STA 170+00, 9' max fill, Solite

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... \Settlement\FOSSA\I-264 STA 170+00 with Solite.2ST
Original date and time of creating this file: Wed Apr 20 10:53:47 2016

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 7 layers

	Wet Unit Weight, γ [lb/ft³]	**Poisson's Ratio μ**	**Description of Soil**
1	115.00	0.30	Layer 1 Upper Sand
2	120.00	0.50	Layer 2 Upper Clay 1
3	115.00	0.30	Layer 3 Upper Sand
4	112.00	0.50	Layer 4 Upper Clay 2
5	125.00	0.30	Layer 5 Lower Sand
6	118.00	0.50	Layer 6 Lower Clay
7	125.00	0.30	Layer 6 Yorktown

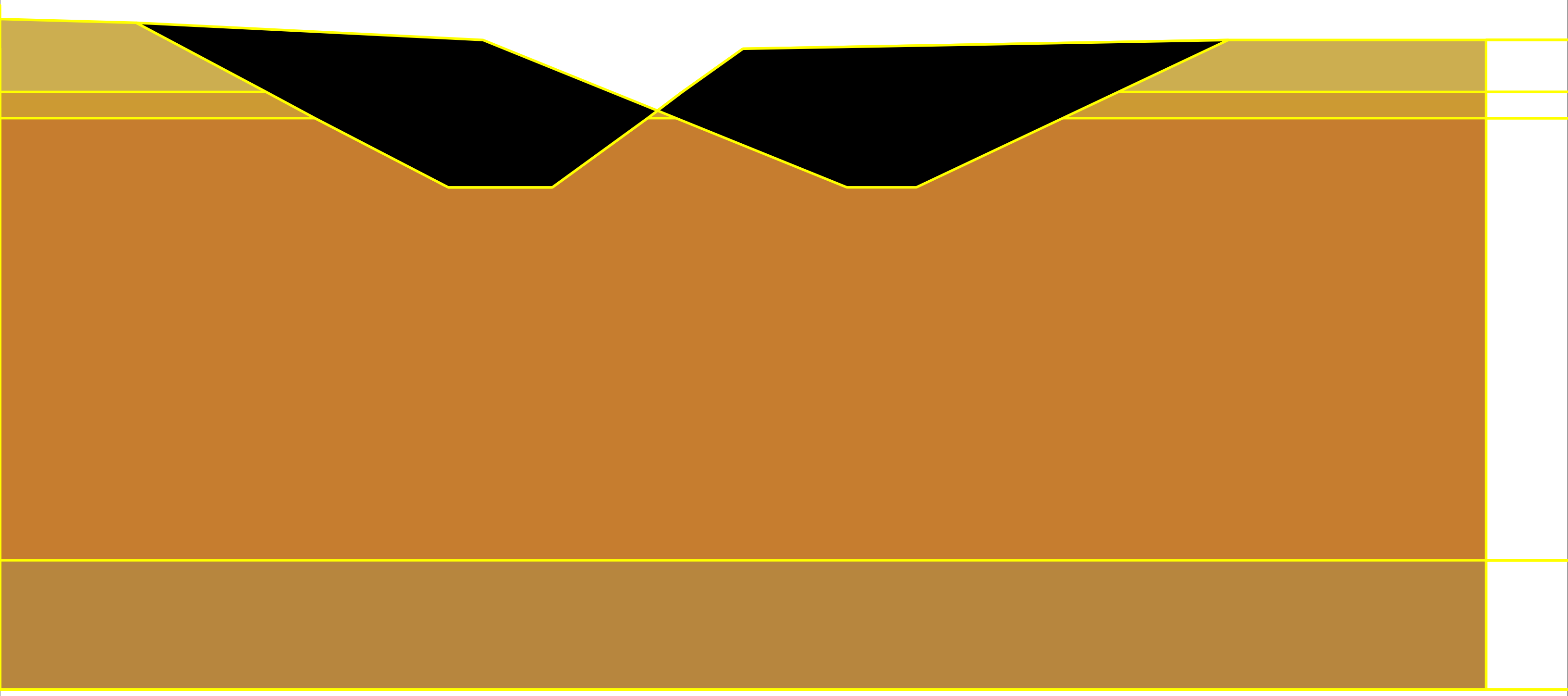
INPUT DATA – EMBANKMENT LAYERS -- 1 layers

	Wet Unit Weight, γ [lb/ft³]	**Description of Soil**
1	65.00	Solite

INPUT DATA OF WATER

Point #	**Coordinates (X, Z) : (X) [ft.]**	**(Z) [ft.]**
1	0.00	10.00
2	1000.00	10.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :	CREEP Ca/Cc
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	0.0250
3	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	0.0176
5	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	0.0030
7	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Secondary Comprassion (Creep) : Settlement is calculated at t2/t1 = 10.0

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	80.00	0.00	1	500000	0.3000	-0.0001	19.19	19.19	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0006			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0026			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
2	81.63	0.00	1	500000	0.3000	-0.0001	19.15	19.14	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0009			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0027			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
3	83.27	0.00	1	500000	0.3000	-0.0001	19.10	19.10	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0013			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0028			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
4	84.90	0.00	1	500000	0.3000	-0.0001	19.06	19.05	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0018			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0029			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
5	86.53	0.00	1	500000	0.3000	-0.0001	19.01	19.01	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0025			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0030			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
6	88.16	0.00	1	500000	0.3000	0.0001	18.38	18.37	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0034			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0031			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
7	89.80	0.00	1	500000	0.3000	0.0002	17.51	17.50	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0045			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0032			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ^{2}]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
8	91.43	0.00	1	500000	0.3000	0.0003	16.64	16.63	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0057			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0033			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
9	93.06	0.00	1	500000	0.3000	0.0002	15.77	15.76	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0070			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0033			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
10	94.69	0.00	1	500000	0.3000	0.0000	14.90	14.88	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0084			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0034			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
11	96.33	0.00	1	500000	0.3000	0.0000	14.02	14.01	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0097			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0034			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
12	97.96	0.00	1	500000	0.3000	0.0000	13.16	13.14	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0108			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0035			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
13	99.59	0.00	1	500000	0.3000	0.0000	12.31	12.29	0.02
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0116			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0035			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
14	101.22	0.00	1	500000	0.3000	0.0000	11.46	11.45	0.02
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0119			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0035			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
15	102.86	0.00	1	500000	0.3000	0.0000	10.61	10.60	0.02
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0119			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0035			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
16	104.49	0.00	1	500000	0.3000	0.0000	9.77	9.75	0.02
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0117			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0035			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
17	106.12	0.00	1	500000	0.3000	0.0000	9.50	9.49	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0114			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0035			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
18	107.76	0.00	1	500000	0.3000	0.0000	9.50	9.49	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0110			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0035			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
19	109.39	0.00	1	500000	0.3000	0.0000	9.50	9.49	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0103			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0035			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
20	111.02	0.00	1	500000	0.3000	0.0000	9.51	9.50	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0093			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0034			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
21	112.65	0.00	1	500000	0.3000	0.0000	10.70	10.69	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0086			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0034			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
22	114.29	0.00	1	500000	0.3000	0.0000	11.89	11.88	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0074			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0033			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
23	115.92	0.00	1	500000	0.3000	0.0000	13.08	13.07	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0059			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0033			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
24	117.55	0.00	1	500000	0.3000	0.0000	14.29	14.28	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0043			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0032			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
25	119.18	0.00	1	500000	0.3000	-0.0000	15.49	15.48	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0032			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0031			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
26	120.82	0.00	1	500000	0.3000	-0.0000	16.65	16.65	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0024			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0031			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
27	122.45	0.00	1	500000	0.3000	-0.0000	17.51	17.50	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0017			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0030			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
28	124.08	0.00	1	500000	0.3000	-0.0000	17.54	17.53	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0013			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0029			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
29	125.71	0.00	1	500000	0.3000	-0.0000	17.57	17.56	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0009			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0028			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
30	127.35	0.00	1	500000	0.3000	-0.0000	17.60	17.59	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0006			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0027			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
31	128.98	0.00	1	500000	0.3000	-0.0000	17.62	17.62	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0004			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0026			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
32	130.61	0.00	1	500000	0.3000	-0.0000	17.65	17.65	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0002			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0025			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
33	132.24	0.00	1	500000	0.3000	-0.0000	17.68	17.68	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0001			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0024			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
34	133.88	0.00	1	500000	0.3000	-0.0000	17.71	17.71	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0000			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0023			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
35	135.51	0.00	1	500000	0.3000	-0.0000	17.74	17.74	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0001			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0022			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
36	137.14	0.00	1	500000	0.3000	-0.0000	17.77	17.77	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0002			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0021			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
37	138.78	0.00	1	500000	0.3000	-0.0000	17.80	17.80	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0002			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0020			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
38	140.41	0.00	1	500000	0.3000	-0.0000	17.83	17.83	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0019			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
39	142.04	0.00	1	500000	0.3000	-0.0000	17.86	17.86	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0018			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
40	143.67	0.00	1	500000	0.3000	-0.0000	17.89	17.89	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0017			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
41	145.31	0.00	1	500000	0.3000	-0.0000	17.92	17.91	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0016			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
42	146.94	0.00	1	500000	0.3000	-0.0000	17.95	17.94	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0015			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
43	148.57	0.00	1	500000	0.3000	-0.0000	17.97	17.97	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0014			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
44	150.20	0.00	1	500000	0.3000	-0.0000	18.00	18.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0013			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
45	151.84	0.00	1	500000	0.3000	-0.0000	18.00	18.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0012			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
46	153.47	0.00	1	500000	0.3000	-0.0000	18.00	18.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0012			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
47	155.10	0.00	1	500000	0.3000	-0.0000	18.00	18.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0011			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
48	156.73	0.00	1	500000	0.3000	-0.0000	18.00	18.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0010			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
49	158.37	0.00	1	500000	0.3000	-0.0000	18.00	18.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0009			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
50	160.00	0.00	1	500000	0.3000	-0.0000	18.00	18.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0009			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	96.00	0.00	14.20	0.06	14.13

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

SECONDARY SETTLEMENT (Creep), Ss -- Total Secondary Compression (Creep) = 0.091 ft.

Layer #	Underging Consolidation	Cc / (1+e0)	C-alpha/ (1+e0)	e-zero	H [ft.]	t1/t2	Settlement Ss [ft.]
1	No	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	0.1200	0.0030	N/A	0.70	10.0	0.002
3	No	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	0.1700	0.0030	N/A	29.00	10.0	0.087
5	No	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	0.1000	0.0003	N/A	7.00	10.0	0.002
7	No	N/A	N/A	N/A	N/A	N/A	N/A

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	50.00	20.00	Layer 1 Upper Sand
	2	87.00	19.00	
	3	94.50	15.00	
	4	97.30	13.50	
	5	105.00	9.50	
	6	111.00	9.50	
	7	116.50	13.50	
	8	118.50	15.00	
	9	122.00	17.50	
	10	150.00	18.00	
	11	171.00	18.00	
2	1	50.00	15.00	Layer 2 Upper Clay 1
	2	87.00	15.00	
	3	94.50	15.00	
	4	97.30	13.50	
	5	105.00	9.50	
	6	111.00	9.50	
	7	116.50	13.50	
	8	118.50	15.00	
	9	122.00	15.00	
	10	150.00	15.00	
	11	171.00	15.00	
3	1	50.00	13.50	Layer 3 Upper Sand
	2	87.00	13.50	
	3	97.30	13.50	
	4	105.00	9.50	
	5	111.00	9.50	
	6	116.50	13.50	
	7	122.00	13.50	
	8	150.00	13.50	
	9	171.00	13.50	
4	1	0.00	-12.00	Layer 4 Upper Clay 2
	2	1000.00	-12.00	
5	1	0.00	-41.00	Layer 5 Lower Sand
	2	1000.00	-41.00	
6	1	0.00	-62.00	Layer 6 Lower Clay
	2	1000.00	-62.00	
7	1	0.00	-69.00	Layer 6 Yorktown
	2	1000.00	-69.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 87.00 [ft]	1	87.00	19.00	Solite
	X2 = 150.00 [ft]	2	107.00	18.00	
		3	128.00	9.50	
		4	132.00	9.50	
		5	150.00	18.00	

URS

Page ____ of ____

Job ____ Project No. ____ Sheet ____ of ____

Description IDEALIZED SOIL PROFILE & PARAMETERS

Computed by ____ Date ____

Checked by ____ Date ____

Reference

STA 182+50

El. +12

UPPER CLAY $\gamma_m = 120$ pcf $C_c' = 0.12$ $C_r' = 0.012$ $C_v = 0.1$ $C_\alpha' = .003$ OCR = 2.0 .025

El. +8

El. +3 ∇

UPPER SAND $\gamma_m = 115$ pcf

Es' = 500,000 psf

El. – 10

UPPER CLAY $\gamma_m = 112$ pcf $S_u =$ $C_c' = 0.17$ $C_r' = 0.014$ $C_v = 0.1$ $C_\alpha' = .003$ OCR = 1.5 .0176

El. – 14

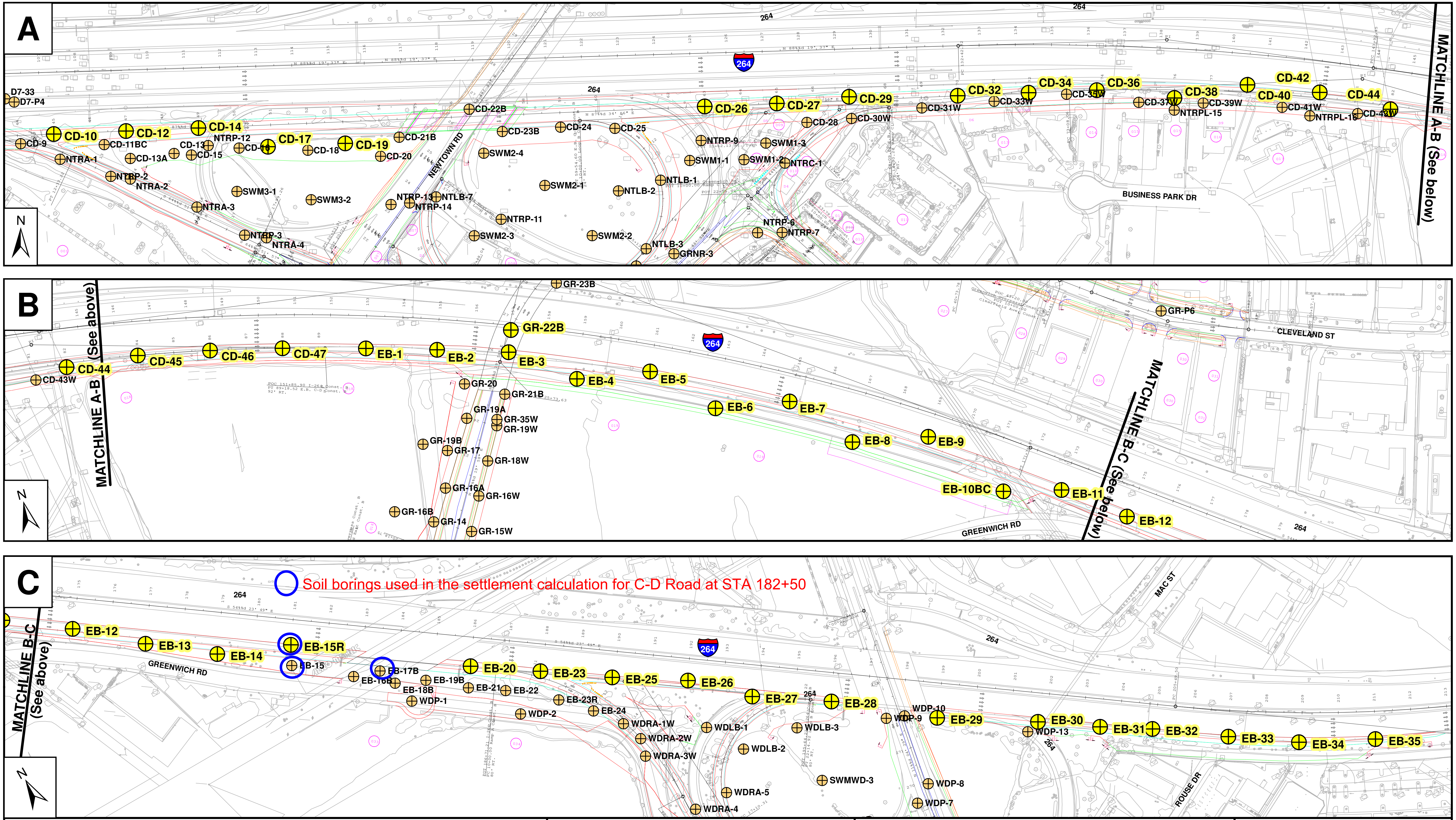
LOWER SAND $\gamma_m = 125$ pcf

Es' = 500,000 psf

El. – 62

LOWER CLAY $\gamma_m = 118$ pcf $C_c' = 0.10$ $C_r' = 0.012$ $C_v = 0.14$ $C_\alpha' = .0003$ OCR = 2.0 .0143

El. -72



Soil borings used in the settlement calculation for C-D Road at STA 182+50

0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

VDOT Virginia Department of Transportation

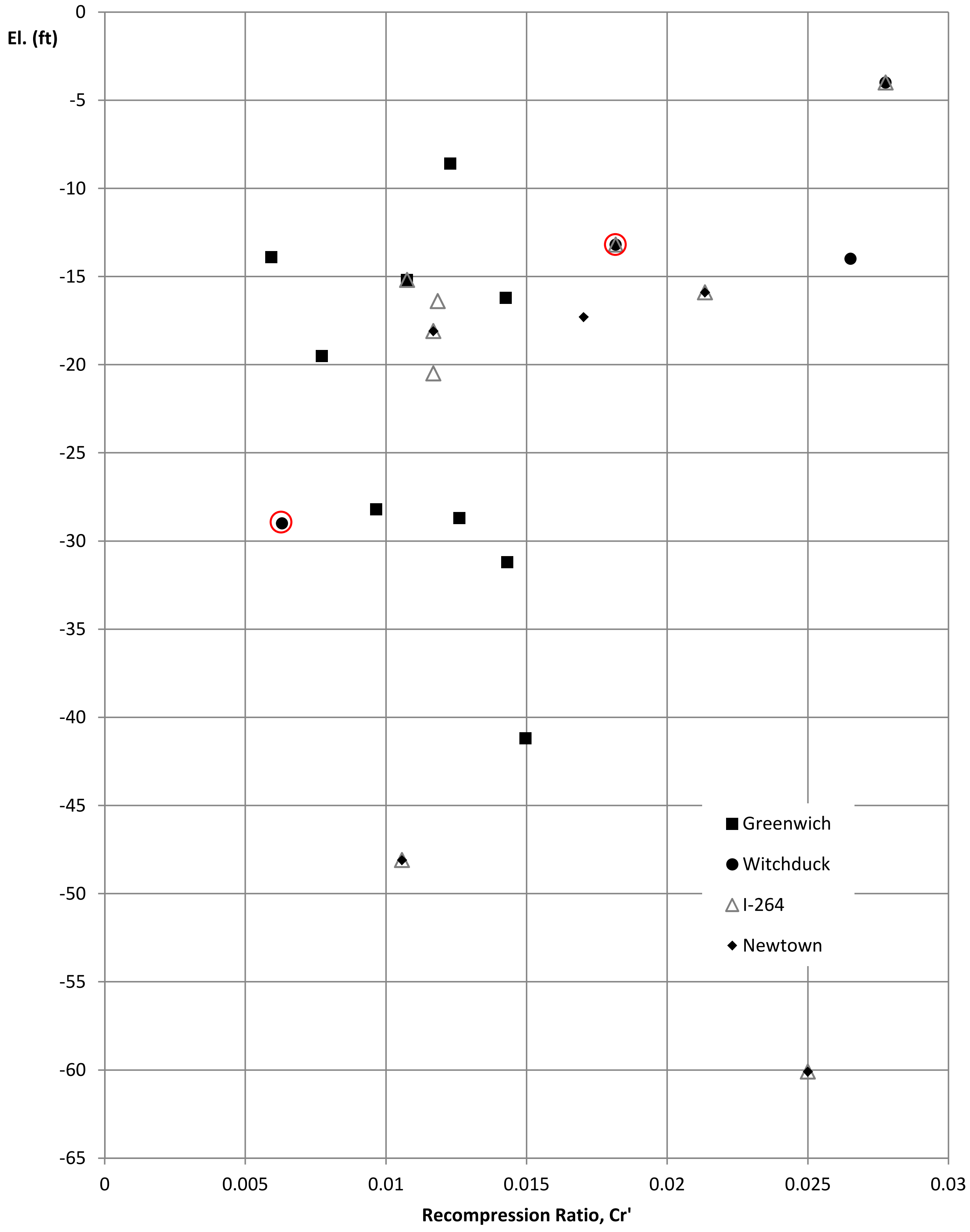
Project 0264-122-108
City of Norfolk

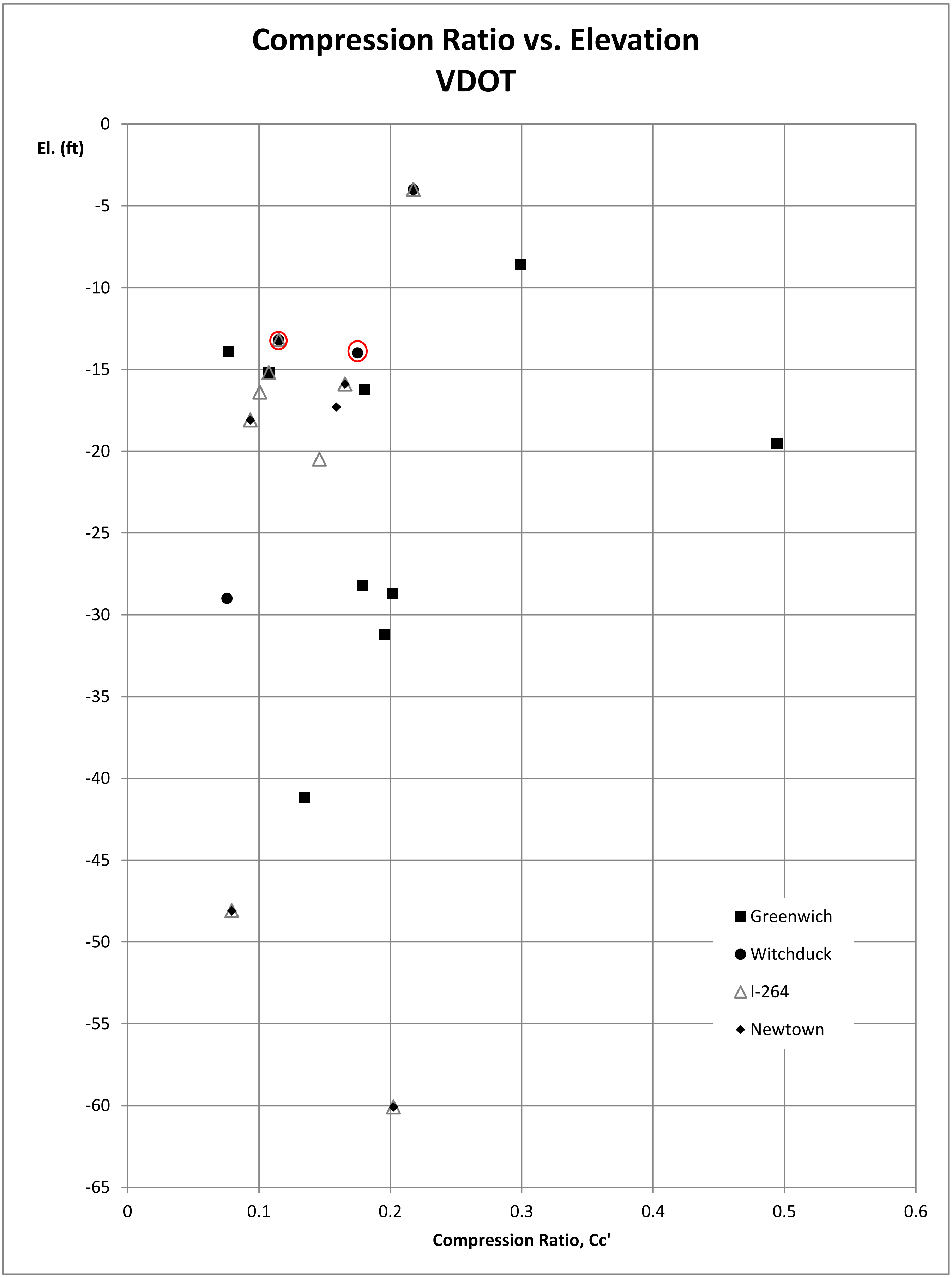
Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

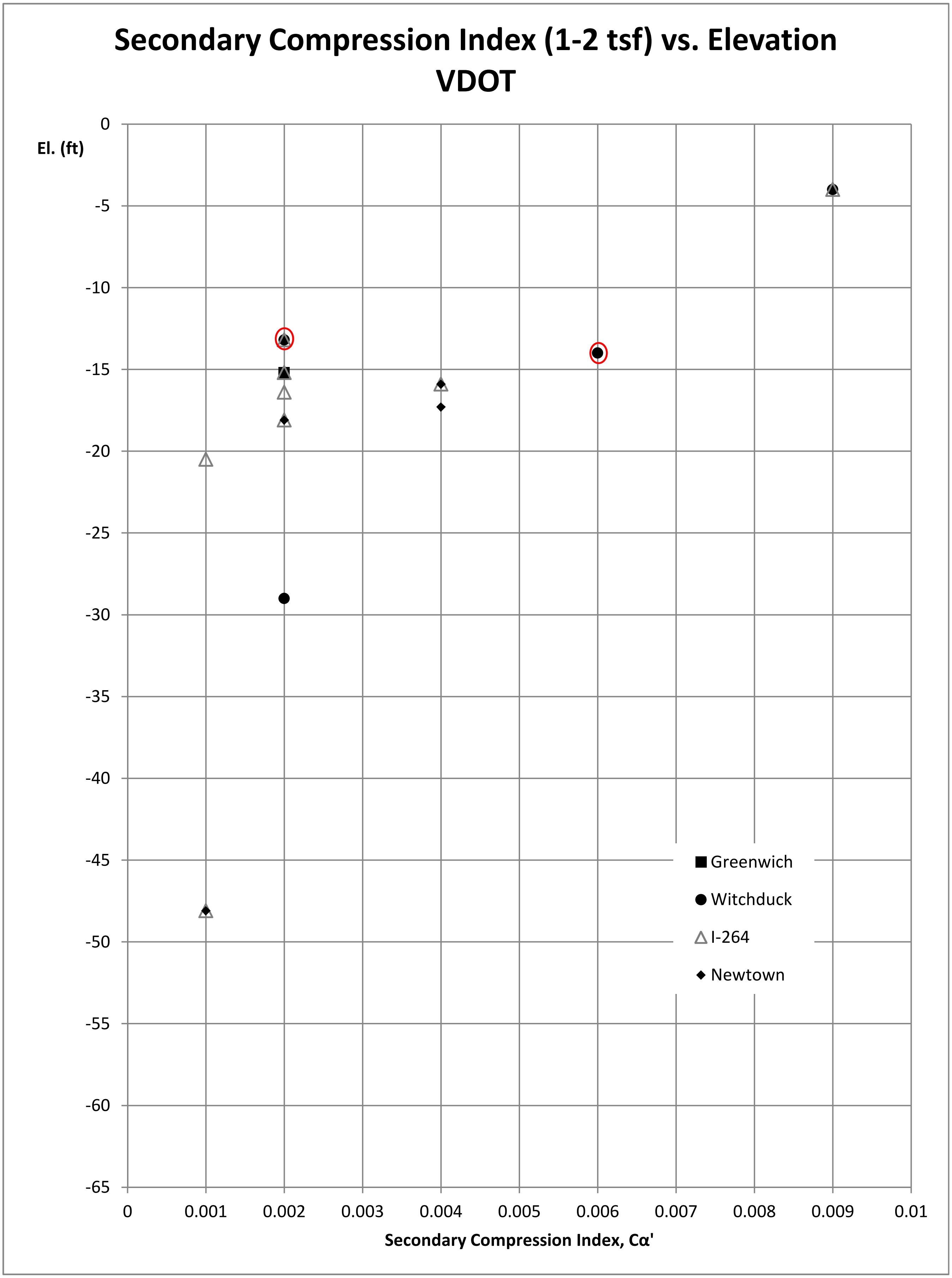
Drawing 2:
Exploration Location Plan

Recompression Ratio vs. Elevation
VDOT





Compression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.1
0.2
0.3
0.4
0.5
0.6
Compression Ratio, Cc'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown


Secondary Compression Index (1-2 tsf) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
Secondary Compression Index, Cα'
Greenwich
Witchduck
I-264
Newtown

I-264 Witchduck, STA 182+50

PROJECT IDENTIFICATION

Title:	I-264 Witchduck, STA 182+50
Project Number:	-
Client:	
Designer:	AW
Station Number:	

Description:

STA 182+50, 15' max fill, no GI

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... Calculations\Settlement\FOSSA\I-264 STA 182+50.2ST
Original date and time of creating this file: Fri Jan 06 15:18:44 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 7 layers

	Wet Unit Weight, γ [lb/ft³]	Poisson's Ratio μ	Description of Soil
1	125.00	0.30	Layer 1 Existing Fill
2	120.00	0.50	Layer 2 Upper Clay
3	115.00	0.30	Layer 3 Upper Sand
4	112.00	0.50	Layer 4 Upper Clay
5	125.00	0.30	Layer 5 Lower Sand
6	118.00	0.50	Layer 6 Lower Clay
7	125.00	0.30	Layer 7 Yorktown

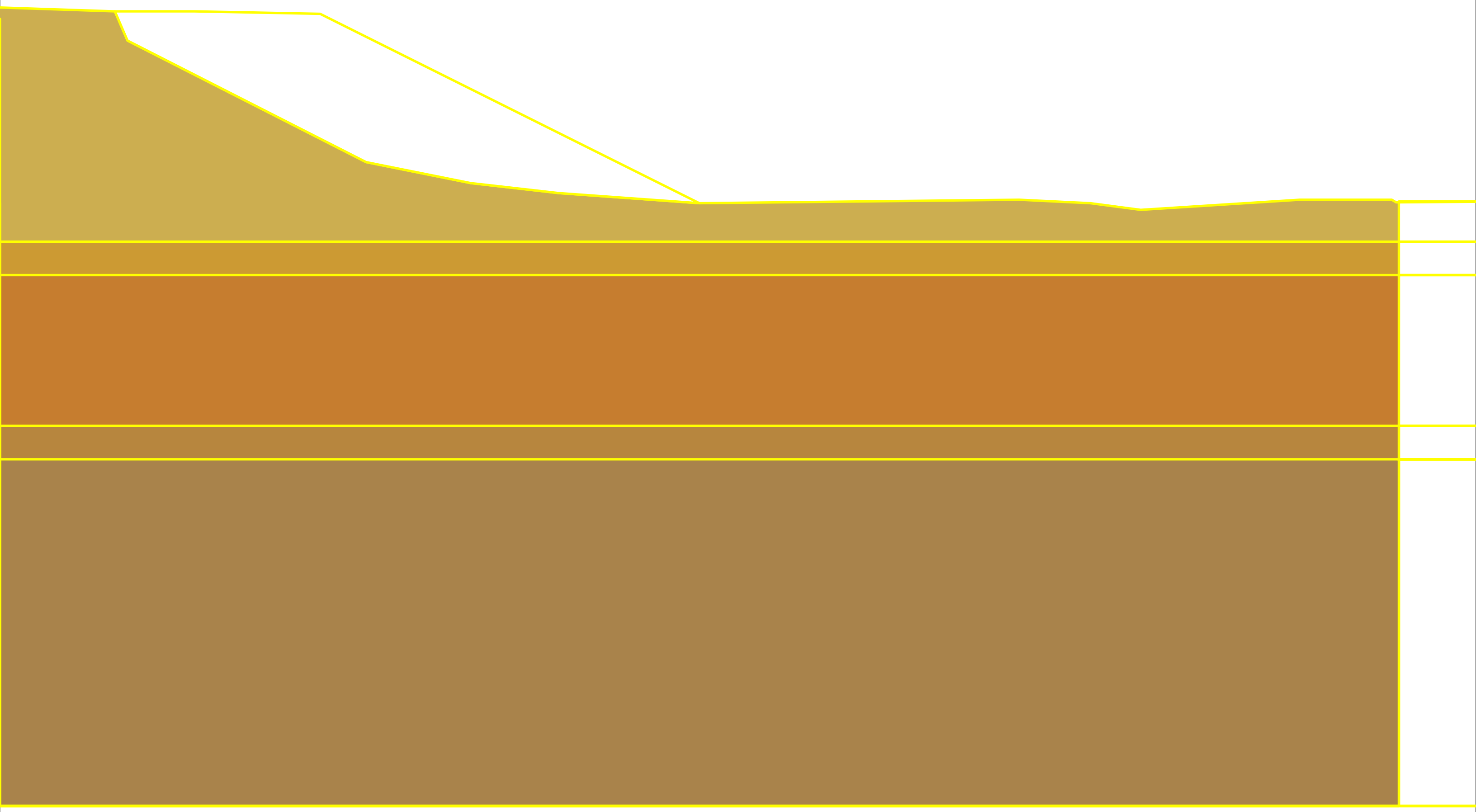
INPUT DATA – EMBANKMENT LAYERS -- 1 layers

	Wet Unit Weight, γ [lb/ft³]	Description of Soil
1	130.00	Proposed Fill

INPUT DATA OF WATER

Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]
1	0.00	3.00
2	1000.00	3.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ^{2}/day]	Drains at :	CREEP Ca/Cc
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	0.0250
3	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	0.0176
5	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	0.0030
7	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Secondary Comprassion (Creep) : Settlement is calculated at t2/t1 = 40.0

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	70.00	0.00	1	750000	0.3000	-0.0012	39.93	39.90	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0061			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0291			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
2	72.04	0.00	1	750000	0.3000	-0.0009	39.86	39.82	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0072			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0308			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
3	74.08	0.00	1	750000	0.3000	-0.0005	39.79	39.75	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0085			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0326			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
4	76.12	0.00	1	750000	0.3000	0.0001	39.72	39.68	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0098			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0344			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
5	78.16	0.00	1	750000	0.3000	0.0010	39.65	39.60	0.05
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0113			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0362			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
6	80.20	0.00	1	750000	0.3000	0.0023	39.58	39.53	0.05
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0128			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0380			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
7	82.24	0.00	1	750000	0.3000	0.0046	39.51	39.45	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0145			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0398			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
8	84.29	0.00	1	750000	0.3000	0.0083	35.85	35.79	0.07
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0162			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0416			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
9	86.33	0.00	1	750000	0.3000	0.0111	34.82	34.74	0.07
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0180			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0434			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
10	88.37	0.00	1	750000	0.3000	0.0135	33.78	33.70	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0198			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0451			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
11	90.41	0.00	1	750000	0.3000	0.0156	32.74	32.66	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0216			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0467			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
12	92.45	0.00	1	750000	0.3000	0.0175	31.70	31.61	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0234			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0483			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
13	94.49	0.00	1	750000	0.3000	0.0187	30.66	30.57	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0251			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0498			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
14	96.53	0.00	1	750000	0.3000	0.0199	29.62	29.53	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0267			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0511			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
15	98.57	0.00	1	750000	0.3000	0.0207	28.59	28.49	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0282			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0524			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
16	100.61	0.00	1	750000	0.3000	0.0212	27.55	27.44	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0296			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0535			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
17	102.65	0.00	1	750000	0.3000	0.0211	26.51	26.40	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0308			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0545			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
18	104.69	0.00	1	750000	0.3000	0.0207	25.47	25.36	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0319			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0554			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
19	106.73	0.00	1	750000	0.3000	0.0194	24.43	24.33	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0327			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0560			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
20	108.78	0.00	1	750000	0.3000	0.0182	23.39	23.29	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0333			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0565			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
21	110.82	0.00	1	750000	0.3000	0.0167	22.36	22.25	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0337			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0569			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
22	112.86	0.00	1	750000	0.3000	0.0151	21.43	21.32	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0338			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0570			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
23	114.90	0.00	1	750000	0.3000	0.0144	21.02	20.92	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0337			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0570			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
24	116.94	0.00	1	750000	0.3000	0.0136	20.61	20.51	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0334			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0568			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
25	118.98	0.00	1	750000	0.3000	0.0122	20.20	20.10	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0329			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0564			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
26	121.02	0.00	1	750000	0.3000	0.0113	19.80	19.70	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0321			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0559			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
27	123.06	0.00	1	750000	0.3000	0.0103	19.39	19.29	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0312			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0552			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
28	125.10	0.00	1	750000	0.3000	0.0093	18.99	18.89	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0301			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0543			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
29	127.14	0.00	1	750000	0.3000	0.0084	18.76	18.66	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0289			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0533			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
30	129.18	0.00	1	750000	0.3000	0.0074	18.52	18.43	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0275			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0522			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
31	131.22	0.00	1	750000	0.3000	0.0068	18.29	18.20	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0260			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0509			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
32	133.27	0.00	1	750000	0.3000	0.0059	18.06	17.98	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0245			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0495			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
33	135.31	0.00	1	750000	0.3000	0.0051	17.82	17.75	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0228			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0480			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
34	137.35	0.00	1	750000	0.3000	0.0045	17.67	17.60	0.07
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0212			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0465			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
35	139.39	0.00	1	750000	0.3000	0.0037	17.52	17.45	0.07
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0195			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0449			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
36	141.43	0.00	1	750000	0.3000	0.0032	17.38	17.31	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0178			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0432			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
37	143.47	0.00	1	750000	0.3000	0.0026	17.23	17.17	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0162			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0414			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
38	145.51	0.00	1	750000	0.3000	0.0021	17.08	17.03	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0145			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0397			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
39	147.55	0.00	1	750000	0.3000	0.0017	16.94	16.89	0.05
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0130			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0379			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
40	149.59	0.00	1	750000	0.3000	0.0013	16.79	16.74	0.05
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0115			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0361			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
41	151.63	0.00	1	750000	0.3000	0.0010	16.65	16.60	0.05
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0101			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0343			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
42	153.67	0.00	1	750000	0.3000	0.0007	16.61	16.57	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0088			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0325			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
43	155.71	0.00	1	750000	0.3000	0.0005	16.64	16.60	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0076			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0308			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
44	157.76	0.00	1	750000	0.3000	0.0003	16.66	16.62	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0065			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0291			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
45	159.80	0.00	1	750000	0.3000	0.0001	16.68	16.65	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0055			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0274			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
46	161.84	0.00	1	750000	0.3000	-0.0000	16.70	16.67	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0046			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0257			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
47	163.88	0.00	1	750000	0.3000	-0.0001	16.72	16.69	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0038			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0242			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
48	165.92	0.00	1	750000	0.3000	-0.0002	16.74	16.72	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0030			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0226			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
49	167.96	0.00	1	750000	0.3000	-0.0002	16.76	16.74	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0024			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0212			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ^{2}]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
50	170.00	0.00	1	750000	0.3000	-0.0003	16.79	16.76	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0019			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0197			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	125.00	0.00	19.00	0.03	18.97

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

SECONDARY SETTLEMENT (Creep), Ss -- Total Secondary Compression (Creep) = 0.043 ft.

Layer #	Underging Consolidation	Cc / (1+e0)	C-alpha/ (1+e0)	e-zero	H [ft.]	t1/t2	Settlement Ss [ft.]
1	No	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	0.1200	0.0030	N/A	4.00	40.0	0.019
3	No	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	0.1700	0.0030	N/A	4.00	40.0	0.019
5	No	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	0.1000	0.0003	N/A	10.00	40.0	0.005
7	No	N/A	N/A	N/A	N/A	N/A	N/A

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	 (Z) [ft.]	DESCRIPTION
1	1	0.00	38.60	Layer 1 Existing Fill
	2	1.00	39.80	
	3	11.50	40.30	
	4	20.00	40.50	
	5	40.00	40.50	
	6	68.00	40.00	
	7	82.50	39.50	
	8	84.00	36.00	
	9	112.50	21.50	
	10	125.00	19.00	
	11	135.50	17.80	
	12	152.30	16.60	
	13	190.50	17.00	
	14	199.00	16.60	
	15	205.00	15.80	
	16	224.00	17.00	
	17	235.00	17.00	
	18	235.50	16.70	
	19	250.00	16.80	
2	1	0.00	12.00	Layer 2 Upper Clay
	2	135.50	12.00	
	3	205.00	12.00	
	4	224.00	12.00	
	5	250.00	12.00	
3	1	0.00	8.00	Layer 3 Upper Sand
	2	1000.00	8.00	
4	1	0.00	-10.00	Layer 4 Upper Clay
	2	1000.00	-10.00	
5	1	0.00	-14.00	Layer 5 Lower Sand
	2	1000.00	-14.00	
6	1	0.00	-62.00	Layer 6 Lower Clay
	2	1000.00	-62.00	
7	1	0.00	-72.00	Layer 7 Yorktown
	2	1000.00	-72.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 82.50 [ft]	1	82.50	39.50	Proposed Fill
	X2 = 152.30 [ft]	2	92.00	39.50	
		3	107.00	39.20	
		4	152.30	16.60	

I-264 Witchduck, STA 182+50

PROJECT IDENTIFICATION

Title: I-264 Witchduck, STA 182+50
Project Number: -
Client:
Designer: AW
Station Number:

Description:

STA 182+50, 6' surcharge + PVD

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: Q:\Project ..... ment\FOSSA\I-264 STA 182+50 with existing fill.2ST
Original date and time of creating this file: Fri Jan 06 15:18:44 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 7 layers

	Wet Unit Weight, γ [lb/ft³]	Poisson's Ratio μ	Description of Soil
1	125.00	0.30	Layer 1 Existing Fill
2	120.00	0.50	Layer 2 Upper Clay
3	115.00	0.30	Layer 3 Upper Sand
4	112.00	0.50	Layer 4 Upper Clay
5	125.00	0.30	Layer 5 Lower Sand
6	118.00	0.50	Layer 6 Lower Clay
7	125.00	0.30	Layer 7 Yorktown

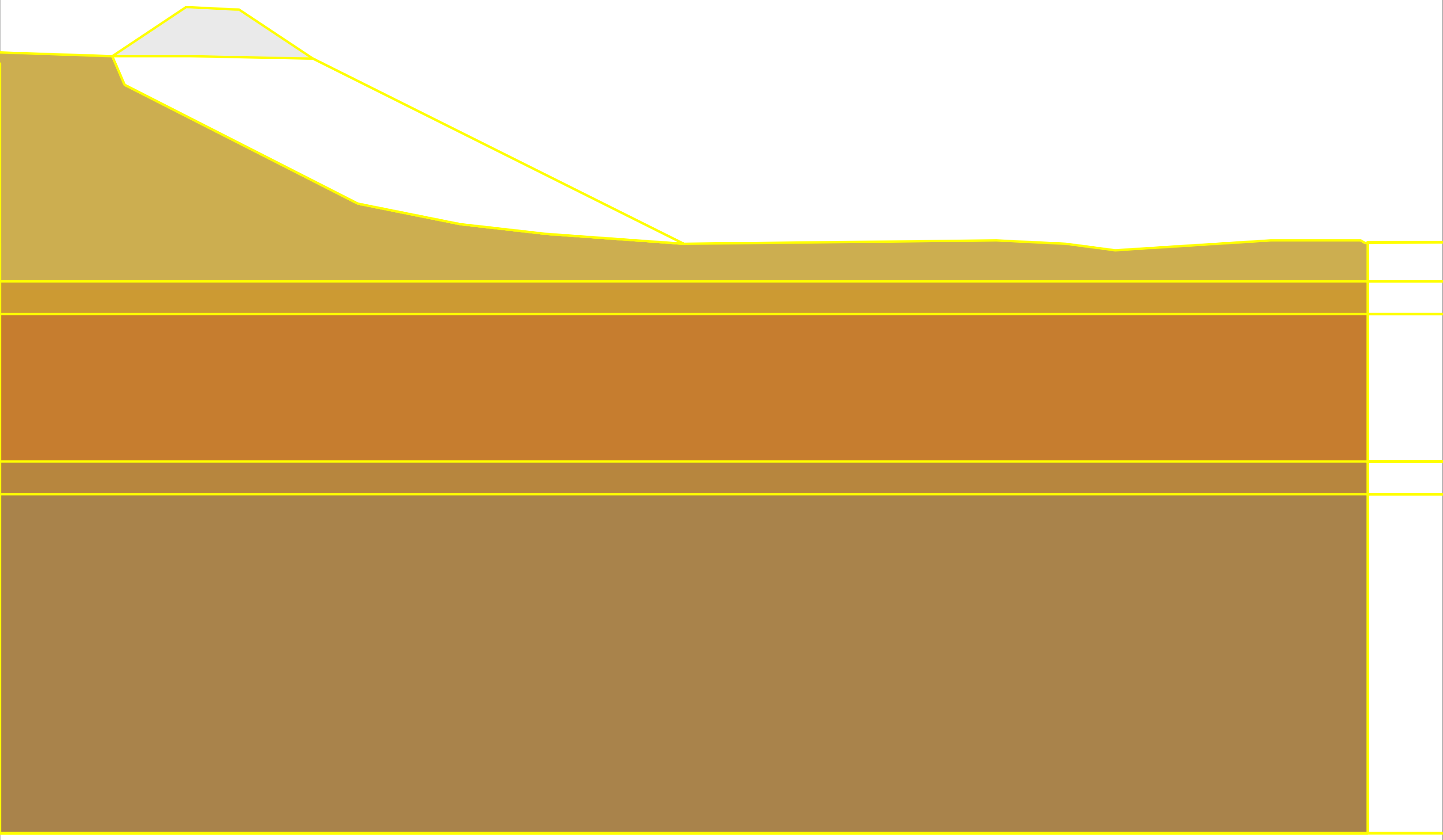
INPUT DATA – EMBANKMENT LAYERS -- 2 layers

	Wet Unit Weight, γ [lb/ft³]	Description of Soil
1	130.00	Proposed Fill
2	130.00	Surcharge

INPUT DATA OF WATER

Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]
1	0.00	3.00
2	1000.00	3.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :	PVD through Layer No/Yes	Ch=Coeff. for horiz. drainage [ft ²/day]
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	Yes	0.2153
3	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	Yes	0.2153
5	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	No	0.2153
7	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

PVD : Triangle Pattern where D = 1.05 x 5.00 = 5.25 ft.
dw = 2 x (a + b) / 3.14 = 2.607 inch --> F(n) = 2.44. Fs for disturbance = 0.000
and Fr' = 0.050

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	40.00	0.00	1	750000	0.3000	-0.0012	40.50	40.49	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0007			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0128			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
2	43.27	0.00	1	750000	0.3000	-0.0013	40.44	40.43	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0003			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0145			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
3	46.53	0.00	1	750000	0.3000	-0.0014	40.38	40.37	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0001			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0165			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
4	49.80	0.00	1	750000	0.3000	-0.0016	40.33	40.31	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0006			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0187			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
5	53.06	0.00	1	750000	0.3000	-0.0017	40.27	40.25	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0013			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0210			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
6	56.33	0.00	1	750000	0.3000	-0.0017	40.21	40.18	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0022			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0235			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
7	59.59	0.00	1	750000	0.3000	-0.0018	40.15	40.12	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0033			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0262			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
8	62.86	0.00	1	750000	0.3000	-0.0018	40.09	40.06	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0047			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0291			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
9	66.12	0.00	1	750000	0.3000	-0.0016	40.03	40.00	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0063			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0321			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
10	69.39	0.00	1	750000	0.3000	-0.0013	39.95	39.91	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0083			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0353			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
11	72.65	0.00	1	750000	0.3000	-0.0006	39.84	39.79	0.05
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0107			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0385			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
12	75.92	0.00	1	750000	0.3000	0.0007	39.73	39.67	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0134			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0419			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
13	79.18	0.00	1	750000	0.3000	0.0031	39.61	39.55	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0165			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0452			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
14	82.45	0.00	1	750000	0.3000	0.0082	39.50	39.43	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0198			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0485			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
15	85.71	0.00	1	750000	0.3000	0.0167	35.13	35.04	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0232			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0516			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
16	88.98	0.00	1	750000	0.3000	0.0232	33.47	33.36	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0265			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0545			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
17	92.24	0.00	1	750000	0.3000	0.0272	31.81	31.69	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0297			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0572			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
18	95.51	0.00	1	750000	0.3000	0.0287	30.14	30.02	0.12
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0324			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0596			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
19	98.78	0.00	1	750000	0.3000	0.0282	28.48	28.36	0.12
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0347			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0616			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
20	102.04	0.00	1	750000	0.3000	0.0264	26.82	26.70	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0365			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0631			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
21	105.31	0.00	1	750000	0.3000	0.0238	25.16	25.03	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0376			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0642			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
22	108.57	0.00	1	750000	0.3000	0.0207	23.50	23.38	0.12
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0380			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0648			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
23	111.84	0.00	1	750000	0.3000	0.0168	21.84	21.72	0.12
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0379			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0649			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
24	115.10	0.00	1	750000	0.3000	0.0151	20.98	20.86	0.12
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0371			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0645			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
25	118.37	0.00	1	750000	0.3000	0.0132	20.33	20.21	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0358			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0636			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
26	121.63	0.00	1	750000	0.3000	0.0113	19.67	19.57	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0341			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0622			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
27	124.90	0.00	1	750000	0.3000	0.0095	19.02	18.92	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0320			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0604			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
28	128.16	0.00	1	750000	0.3000	0.0081	18.64	18.54	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0296			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0582			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
29	131.43	0.00	1	750000	0.3000	0.0067	18.27	18.18	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0269			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0558			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
30	134.69	0.00	1	750000	0.3000	0.0052	17.89	17.81	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0241			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0530			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
31	137.96	0.00	1	750000	0.3000	0.0043	17.62	17.55	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0212			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0501			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
32	141.22	0.00	1	750000	0.3000	0.0032	17.39	17.32	0.07
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0183			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0470			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
33	144.49	0.00	1	750000	0.3000	0.0023	17.16	17.10	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0156			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0438			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
34	147.76	0.00	1	750000	0.3000	0.0015	16.92	16.87	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0130			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0406			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
35	151.02	0.00	1	750000	0.3000	0.0010	16.69	16.64	0.05
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0105			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0374			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
36	154.29	0.00	1	750000	0.3000	0.0006	16.62	16.58	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0084			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0342			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
37	157.55	0.00	1	750000	0.3000	0.0002	16.65	16.62	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0065			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0312			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
38	160.82	0.00	1	750000	0.3000	0.0000	16.69	16.66	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0049			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0283			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
39	164.08	0.00	1	750000	0.3000	-0.0002	16.72	16.69	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0035			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0255			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
40	167.35	0.00	1	750000	0.3000	-0.0003	16.76	16.73	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0024			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0229			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
41	170.61	0.00	1	750000	0.3000	-0.0003	16.79	16.77	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0015			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0204			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
42	173.88	0.00	1	750000	0.3000	-0.0004	16.83	16.81	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0008			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0182			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
43	177.14	0.00	1	750000	0.3000	-0.0004	16.86	16.84	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0002			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0161			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
44	180.41	0.00	1	750000	0.3000	-0.0004	16.89	16.88	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0002			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0142			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
45	183.67	0.00	1	750000	0.3000	-0.0004	16.93	16.92	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0006			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0124			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
46	186.94	0.00	1	750000	0.3000	-0.0004	16.96	16.95	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0008			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0108			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
47	190.20	0.00	1	750000	0.3000	-0.0004	17.00	16.99	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0010			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0094			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
48	193.47	0.00	1	750000	0.3000	-0.0003	16.86	16.85	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0012			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0081			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
49	196.73	0.00	1	750000	0.3000	-0.0003	16.71	16.70	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0013			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0069			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
50	200.00	0.00	1	750000	0.3000	-0.0003	16.47	16.46	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0014			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0058			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	40.00	0.00	40.50	0.00	40.50
2	43.27	0.00	40.44	0.00	40.44
3	46.53	0.00	40.38	0.00	40.38
4	49.80	0.00	40.33	0.00	40.32
5	53.06	0.00	40.27	0.00	40.26
6	56.33	0.00	40.21	0.00	40.20
7	59.59	0.00	40.15	0.00	40.15
8	62.86	0.00	40.09	0.00	40.09
9	66.12	0.00	40.03	0.01	40.03
10	69.39	0.00	39.95	0.01	39.95
11	72.65	0.00	39.84	0.01	39.83
12	75.92	0.00	39.73	0.01	39.72
13	79.18	0.00	39.61	0.01	39.61
14	82.45	0.00	39.50	0.01	39.49
15	85.71	0.00	35.13	0.01	35.12
16	88.98	0.00	33.47	0.01	33.45
17	92.24	0.00	31.81	0.02	31.79
18	95.51	0.00	30.14	0.02	30.13
19	98.78	0.00	28.48	0.02	28.46
20	102.04	0.00	26.82	0.02	26.80
21	105.31	0.00	25.16	0.02	25.14
22	108.57	0.00	23.50	0.02	23.47
23	111.84	0.00	21.84	0.03	21.81
24	115.10	0.00	20.98	0.03	20.95
25	118.37	0.00	20.33	0.03	20.29

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
26	121.63	0.00	19.67	0.04	19.64
27	124.90	0.00	19.02	0.04	18.98
28	128.16	0.00	18.64	0.03	18.61
29	131.43	0.00	18.27	0.03	18.24
30	134.69	0.00	17.89	0.02	17.87
31	137.96	0.00	17.62	0.02	17.60
32	141.22	0.00	17.39	0.02	17.37
33	144.49	0.00	17.16	0.02	17.14
34	147.76	0.00	16.92	0.02	16.91
35	151.02	0.00	16.69	0.02	16.67
36	154.29	0.00	16.62	0.01	16.61
37	157.55	0.00	16.65	0.01	16.64
38	160.82	0.00	16.69	0.01	16.68
39	164.08	0.00	16.72	0.01	16.71
40	167.35	0.00	16.76	0.01	16.75
41	170.61	0.00	16.79	0.01	16.78
42	173.88	0.00	16.83	0.01	16.82
43	177.14	0.00	16.86	0.01	16.85
44	180.41	0.00	16.89	0.01	16.89
45	183.67	0.00	16.93	0.00	16.92
46	186.94	0.00	16.96	0.00	16.96
47	190.20	0.00	17.00	0.00	16.99
48	193.47	0.00	16.86	0.00	16.86
49	196.73	0.00	16.71	0.00	16.70
50	200.00	0.00	16.47	0.00	16.46

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	 (Z) [ft.]	DESCRIPTION
1	1	0.00	38.60	Layer 1 Existing Fill
	2	1.00	39.80	
	3	11.50	40.30	
	4	20.00	40.50	
	5	40.00	40.50	
	6	68.00	40.00	
	7	82.50	39.50	
	8	84.00	36.00	
	9	112.50	21.50	
	10	125.00	19.00	
	11	135.50	17.80	
	12	152.30	16.60	
	13	190.50	17.00	
	14	199.00	16.60	
	15	205.00	15.80	
	16	224.00	17.00	
	17	235.00	17.00	
	18	235.50	16.70	
	19	250.00	16.80	
2	1	0.00	12.00	Layer 2 Upper Clay
	2	135.50	12.00	
	3	205.00	12.00	
	4	224.00	12.00	
	5	250.00	12.00	
3	1	0.00	8.00	Layer 3 Upper Sand
	2	1000.00	8.00	
4	1	0.00	-10.00	Layer 4 Upper Clay
	2	1000.00	-10.00	
5	1	0.00	-14.00	Layer 5 Lower Sand
	2	1000.00	-14.00	
6	1	0.00	-62.00	Layer 6 Lower Clay
	2	1000.00	-62.00	
7	1	0.00	-72.00	Layer 7 Yorktown
	2	1000.00	-72.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 82.50 [ft]	1	82.50	39.50	Proposed Fill
	X2 = 152.30 [ft]	2	92.00	39.50	
		3	107.00	39.20	
		4	152.30	16.60	
2	X1 = 82.50 [ft]	1	82.50	39.50	Surcharge
	X2 = 152.30 [ft]	2	91.50	45.50	
		3	98.00	45.20	
		4	107.00	39.20	
		5	152.30	16.60	

```
                    STA 182+50 with 6' surcharge + PVD_120 days
    Results of Condolidation After 120.0 days.   (With PVD's)
  ======================================================================

------------------------------------------------------------------------------------
-
   Layer         PVD installed         Uv        Uh        Uave.   Sc-ult     Sc(t)
 Undergoing      Through Layer:
Consolidation
    NO / YES         NO / YES          [%]       [%]        [%]     [ft]      [ft]
------------------------------------------------------------------------------------
-
   1    NO             N/A              N/A       N/A       N/A       N/A       N/A
   2   YES             YES             99.97     94.67    100.00     0.025     0.025
   3    NO             N/A              N/A       N/A       N/A       N/A       N/A
   4   YES             YES             99.97     94.67    100.00     0.007     0.007
   5    NO             N/A              N/A       N/A       N/A       N/A       N/A
   6   YES              NO             86.01      0.00     86.01     0.004     0.004
   7    NO             N/A              N/A       N/A       N/A       N/A       N/A
```

Estimation of Secondary Settlement

Project Name:	**Witchduck I-64/264 Interchange - STA 182+50 with 6' surcharge**
Date:	1/9/2017
Calculated by:	AW
Checked by:	

Project Life = **20** **years**

CASE II: Surcharge

Height of surcharge = **6** **feet**

Surcharge unit weight = **130** **pcf** (if surcharge placed below water, enter bouyant unit weight)

S No.	Clay Layer	Thickness (ft)	C_α' (NC, strain based)	t_{90} [3] (years)	Final Effective stress at layer midpoint[4] (psf)	Effective stress decrease due to surcharge removal (psf)	AAOS[5]	C_α' (surcharge)/ C_α' (NC) [6]	C_α' (surcharge)[6]	Secondary Settlement (ft)
1	UC-1	4	0.003	0.25	2545	780	31%	0.24	0.0007	0.01
2	UC	4	0.003	0.25	4143	780	19%	0.47	0.0014	0.01
3	LC	10	0.0003	0.25	7525	780	10%	0.75	0.0002	0.00

TOTAL SECONDARY SETTLEMENT = **0.02 ft**
or
0.24 in

Notes

1 C_α' (NC, strain based) is the coefficient of secondary settlement without the effect of oversolidation or surcharge.

2 t_{90} is the time to complete 90% primary consolidation.

3 t_{90} with surcharge might be less due to the use of wick drains.

4 The "final effective stress at layer mid point" is the effective stress after the removal of the surcharge.

5 AAOS is the Adjusted Amount of Surcharge, which is the effective stress reduction caused by surcharge removal.
It is calculated as stress decrease due to surcharge removal divided by final effective stress at the depth of interest.

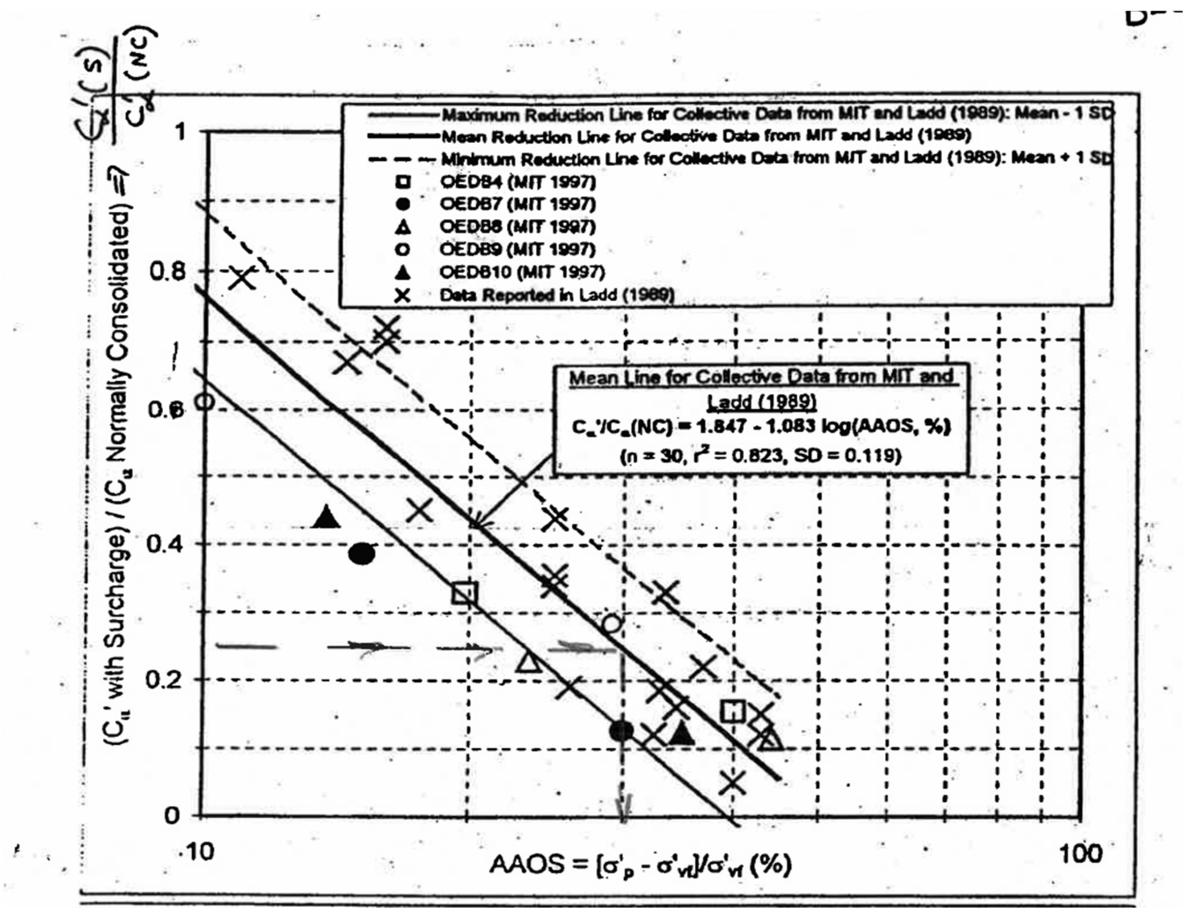
6 C_α' (surcharge) is the reduced coefficient of secondary settlement due to the application of surcharge.
This is estimated based on Ladd (1989) correlation shown in page 2.

7 Secondary settlement was calculated using the following equation:

$$S_{sec} = H.C'_{\propto}.\log(\frac{t_{project\ life}}{t_{90}})$$

8 It is assumed that surcharge, if placed, will be removed at 90% primary consolidation.

Ladd, 1989


$C_\alpha'(s)$ / $C_\alpha'(NC)$ ⇒
$(C_\alpha'$ with Surcharge) / $(C_\alpha$ Normally Consolidated)
1
0.8
0.6
0.4
0.2
0
10
100
AAOS = $[\sigma'_p - \sigma'_{vf}]/\sigma'_{vf}$ (%)
Maximum Reduction Line for Collective Data from MIT and Ladd (1989): Mean - 1 SD
Mean Reduction Line for Collective Data from MIT and Ladd (1989)
Minimum Reduction Line for Collective Data from MIT and Ladd (1989): Mean + 1 SD
□ OED84 (MIT 1997)
● OED87 (MIT 1997)
△ OED88 (MIT 1997)
○ OED89 (MIT 1997)
▲ OED810 (MIT 1997)
× Data Reported in Ladd (1989)
Mean Line for Collective Data from MIT and Ladd (1989)
$C_\alpha'/C_\alpha(NC) = 1.847 - 1.083 \log(AAOS, \%)$
$(n = 30, r^2 = 0.823, SD = 0.119)$

Page ____ of ____

Job 1-64 WITCHDUCK

Project No. ____

Sheet ____ of ____

Description SOIL PROFILE STA 179+00

Computed by AS

Date 1/7/17

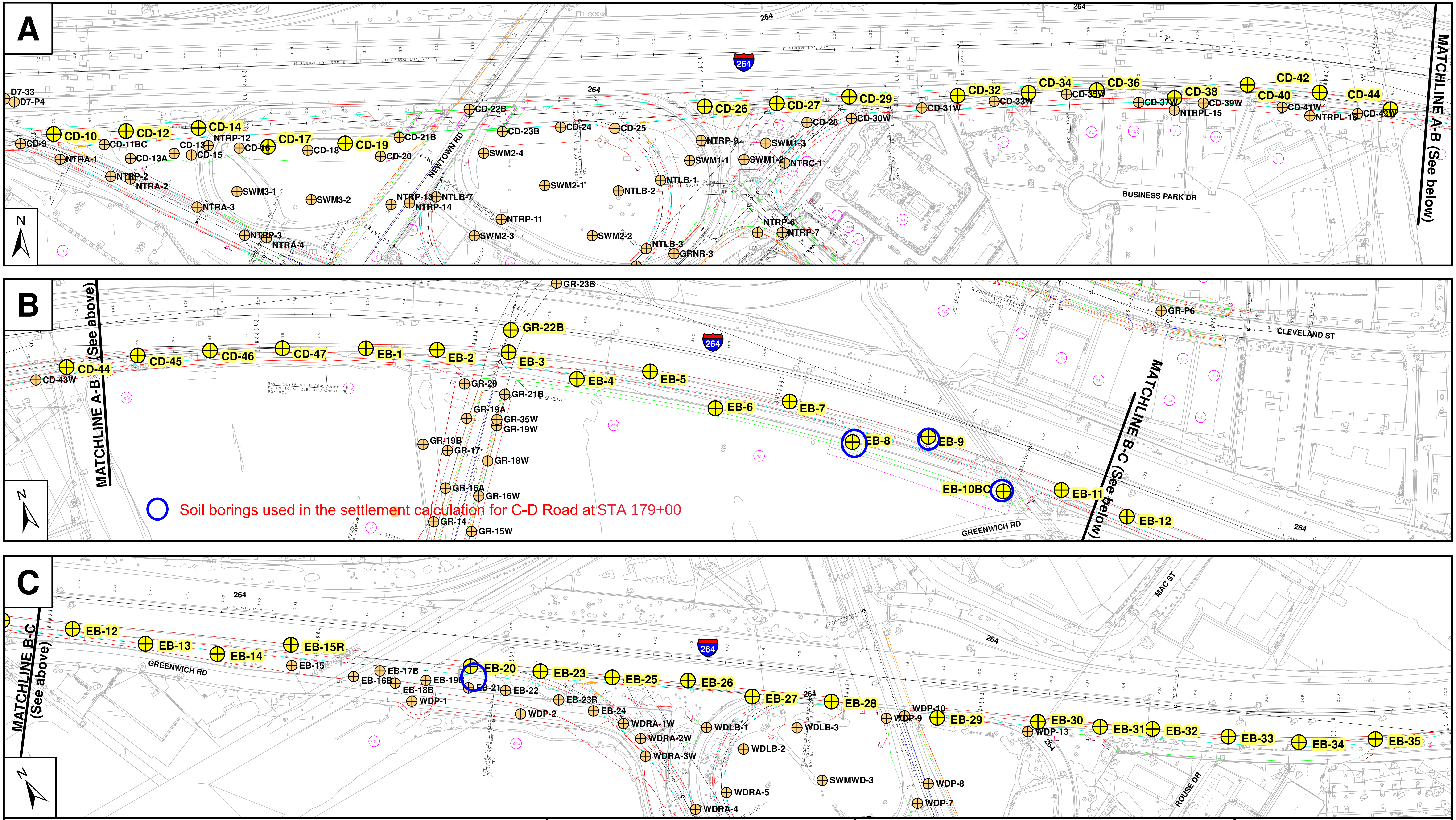
Checked by ____

Date ____

STA 179+00

Reference

+18	Upper Sand Es' = 500,000 psf	γ = 115pcf	
+17	Upper Clay-1	γ = 120pcf C_c' = 0.12 C_r' = 0.012	C_α' = 0.003 OCR = 2
+7 +3 ∇	Upper Sand Es' = 500,000 psf	γ = 115pcf	
-9	Upper Clay-2	γ = 112pcf C_c' = 0.17 C_r' = 0.014 C_α' = 0.003	OCR = 1.5
-18	Lower Sand Es' = 500,000 psf	γ = 125 pcf	
-59	Lower Clay	γ = 118 pcf C_c' = 0.1	C_r' = 0.012 C_α' = 0.0003 OCR = 2
-79	Yorktown		



Soil borings used in the settlement calculation for C-D Road at STA 179+00

0 125 250 Feet

⊕	SPT Exploration Locations
⊕	Borings in other PSAs

Prepared by: HDR

Date: November 2011

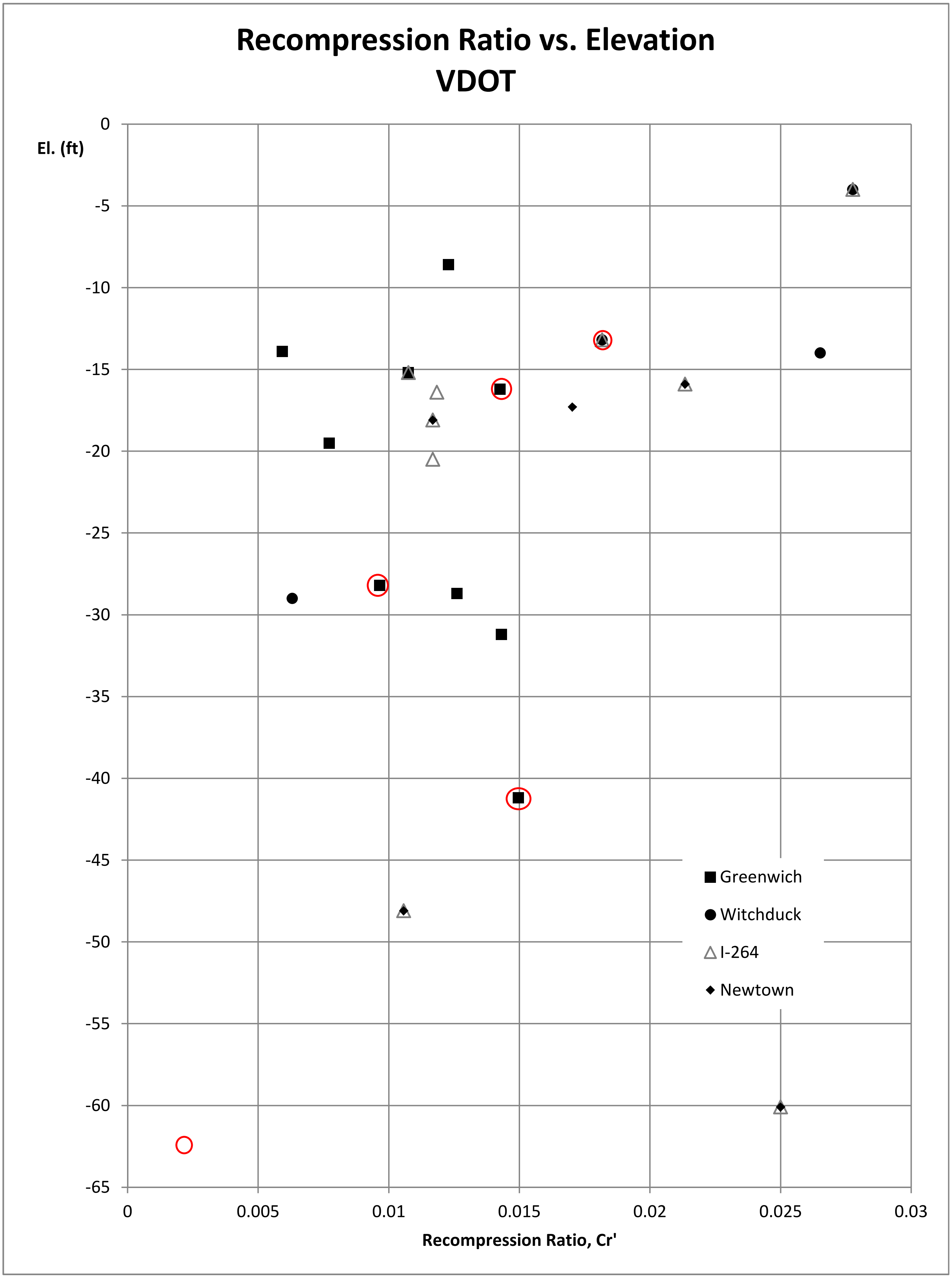
VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

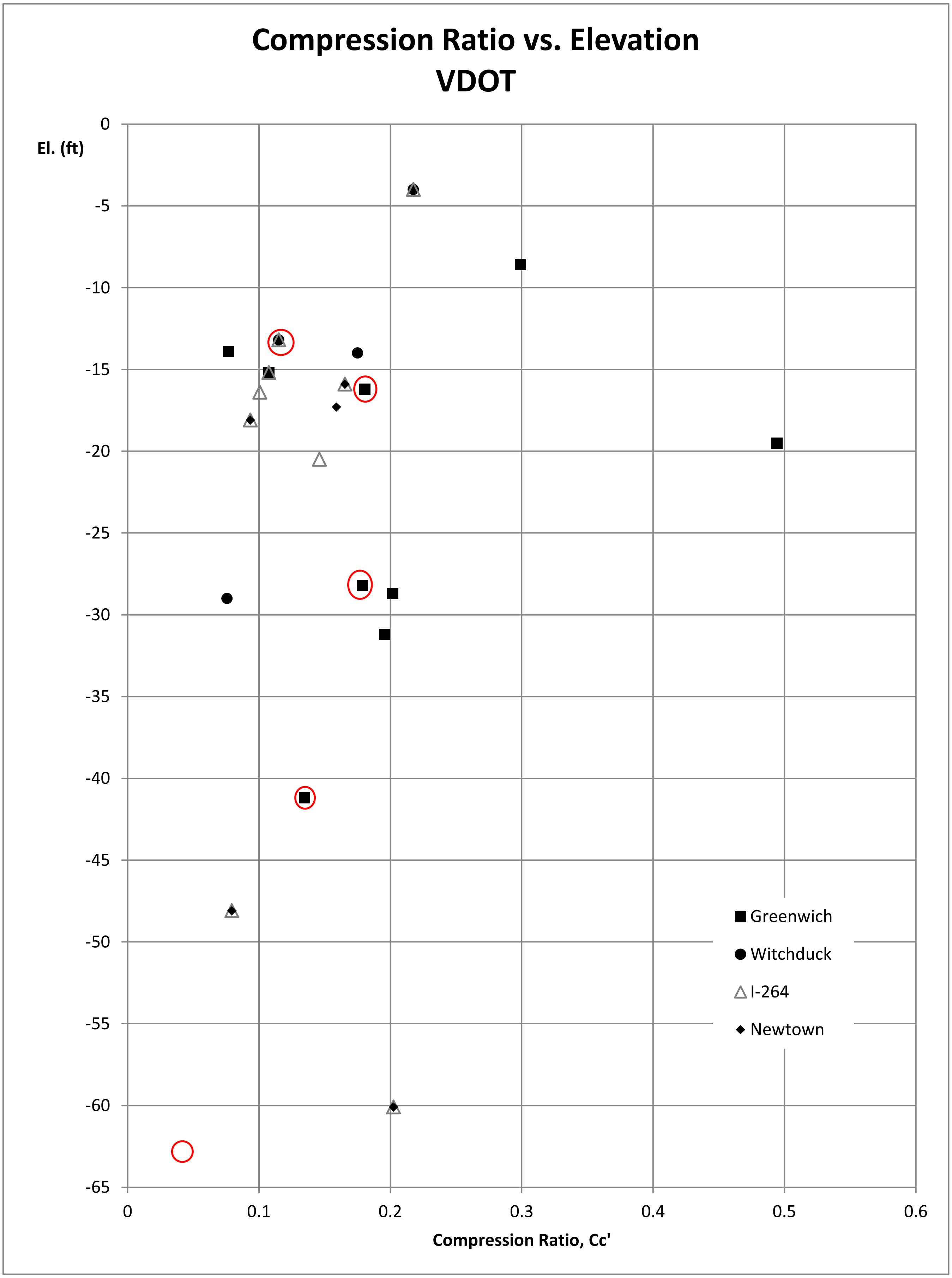
Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan



Recompression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.005
0.01
0.015
0.02
0.025
0.03
Recompression Ratio, Cr'
Greenwich
Witchduck
I-264
Newtown


Compression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.1
0.2
0.3
0.4
0.5
0.6
Compression Ratio, Cc'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

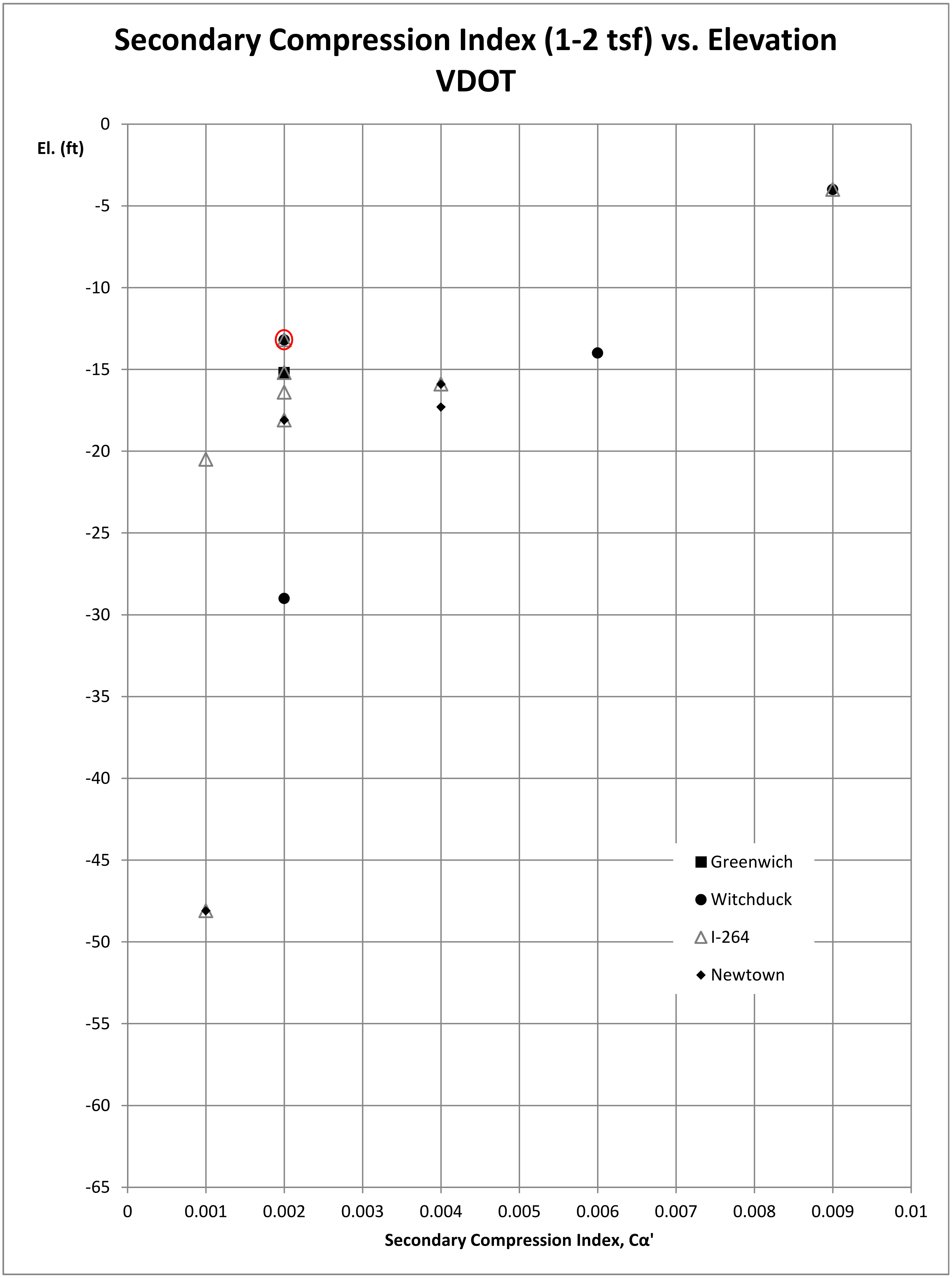

Secondary Compression Index (1-2 tsf) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
Secondary Compression Index, Cα'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

Table D-3

Typical Elastic Moduli

Soil	E_s, tsf
Clay	
Very soft clay	5 - 50
Soft clay	50 - 200
Medium clay	200 - 500
Stiff clay, silty clay	500 - 1000
Sandy clay	250 - 2000
Clay shale	1000 - 2000
Sand	
Loose sand	100 - 250
Dense sand	250 - 1000
Dense sand and gravel	1000 - 2000
Silty sand	250 - 2000

c. Laboratory Tests on Cohesive Soil. The elastic modulus is sensitive to soil disturbance which may increase pore water pressure and, therefore, decrease the effective stress in the specimen and reduce the stiffness and strength. Fissures, which may have little influence on field settlement, may reduce the measured modulus compared with the in situ modulus if confining pressures are not applied to the soil specimen.

(1) Initial hyperbolic tangent modulus. Triaxial unconsolidated undrained (Q or UU) compression tests may be performed on the best available undisturbed specimens at confining pressures equal to the total vertical overburden pressure σ_o for that specimen when in the field using the Q test procedure described in EM 1110-2-1906, Laboratory Soils Testing. An appropriate measure of E_s is the initial tangent modulus $E_{ti} = 1/a$ where a is the intercept of a plot of strain/deviator stress versus strain, Figure D-3 (item 14).

(2) Reload modulus. A triaxial consolidated undrained (R or CU) compression test may be performed on the best available undisturbed specimens. The specimen is initially fully consolidated to an isotropic confining pressure equal to the vertical overburden pressure σ_o for that specimen in the field. The R test procedure described in EM 1110-2-1906 may be used except as follows: stress is increased to the magnitude estimated for the field loading condition. The axial stress may then be reduced to zero and the cycle repeated until the reload curve shows no further increase in slope. The tangent modulus at 1/2 of the maximum applied stress is determined for each loading cycle and plotted versus the number of cycles, Figure D-4. An appropriate measure of E_s is the reload tangent modulus that approaches the asymptotic value at large cycles.

d. Field Tests. The elastic modulus may be estimated from empirical and semiempirical relationships based on results of field soil tests. Refer to

I 264 Witchduck

PROJECT IDENTIFICATION

Title: I 264 Witchduck
Project Number: -
Client:
Designer: AS
Station Number:

Description:
STA 179+00 no ground improvement

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... Calculations\Settlement\FOSSA\I-264 STA 179+00.2ST
Original date and time of creating this file: Tue Jan 10 10:26:23 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 6 layers

	Wet Unit Weight, γ [lb/ft³]	**Poisson's Ratio μ**	**Description of Soil**
1	120.00	0.50	Layer 1 Upper Clay
2	115.00	0.30	Layer 2 Upper Sand
3	112.00	0.50	Layer 3 Upper Clay
4	125.00	0.30	Layer 4 Lower Sand
5	118.00	0.50	Layer 5 Lower Clay
6	125.00	0.30	Layer 6 Yorktown

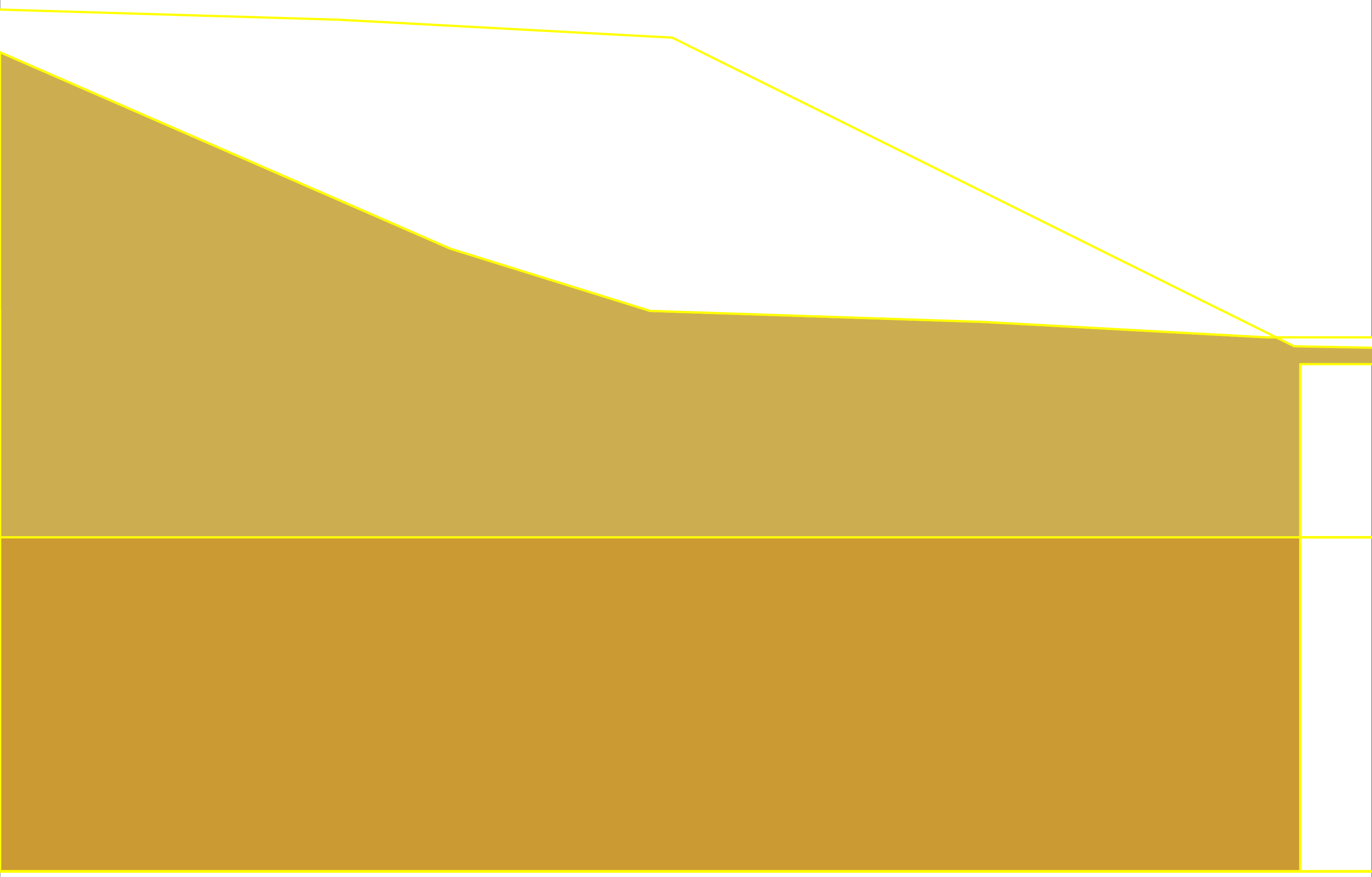
INPUT DATA – EMBANKMENT LAYERS -- 1 layers

	Wet Unit Weight, γ [lb/ft³]	**Description of Soil**
1	130.00	Proposed Fill

INPUT DATA OF WATER

Point #	**Coordinates (X, Z) :** (X) [ft.]	(Z) [ft.]
1	0.00	3.00
2	1000.00	3.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :	CREEP Ca/Cc
1	Yes	2.00	0.120	0.012	N/A	0.1500	Top & Bot.	0.0120
2	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	Yes	1.50	0.170	0.014	N/A	0.1500	Top & Bot.	0.0120
4	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	Yes	2.00	0.100	0.012	N/A	0.3000	Top & Bot.	0.0019
6	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Secondary Comprassion (Creep) : Settlement is calculated at t2/t1 = 20.0

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	103.00	0.00	1	9999999999	0.5000	0.0000	18.13	18.08	0.06
			2	500000	0.3000	0.0233			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0343			
			5	9999999999	0.5000	0.0000			
			6	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	103.00	0.00	18.13	0.34	17.79

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

SECONDARY SETTLEMENT (Creep), Ss -- Total Secondary Compression (Creep) = 0.050 ft.

Layer #	Underging Consolidation	Cc / (1+e0)	C-alpha/ (1+e0)	e-zero	H [ft.]	t1/t2	Settlement Ss [ft.]
1	Yes	0.1200	0.0014	N/A	11.13	20.0	0.021
2	No	N/A	N/A	N/A	N/A	N/A	N/A
3	Yes	0.1700	0.0020	N/A	9.00	20.0	0.024
4	No	N/A	N/A	N/A	N/A	N/A	N/A
5	Yes	0.1000	0.0002	N/A	20.00	20.0	0.005
6	No	N/A	N/A	N/A	N/A	N/A	N/A

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	0.00	29.50	Layer 1 Upper Clay
	2	1.00	30.50	
	3	10.00	31.00	
	4	26.50	31.20	
	5	38.00	31.20	
	6	68.00	30.90	
	7	72.00	30.90	
	8	97.00	20.00	
	9	106.00	17.20	
	10	121.00	16.70	
	11	133.80	16.00	
	12	147.00	16.00	
	13	153.00	13.00	
	14	159.00	15.00	
	15	161.50	15.30	
	16	196.50	14.80	
	17	199.00	15.00	
	18	212.00	15.80	
	19	226.50	15.00	
	20	239.00	14.80	
	21	250.00	14.80	
2	1	0.00	7.00	Layer 2 Upper Sand
	2	1000.00	7.00	
3	1	0.00	-9.00	Layer 3 Upper Clay
	2	1000.00	-9.00	
4	1	0.00	-18.00	Layer 4 Lower Sand
	2	1000.00	-18.00	
5	1	0.00	-59.00	Layer 5 Lower Clay
	2	1000.00	-59.00	
6	1	0.00	-79.00	Layer 6 Yorktown
	2	1000.00	-79.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 68.00 [ft]	1	68.00	30.90	Proposed Fill
	X2 = 161.50 [ft]	2	72.00	30.90	
		3	92.00	30.30	
		4	107.00	29.50	
		5	135.00	15.60	
		6	145.50	15.40	
		7	152.50	13.00	
		8	161.50	15.30	

I 264 Witchduck

PROJECT IDENTIFICATION

Title:	I 264 Witchduck
Project Number:	-
Client:	
Designer:	AS
Station Number:	

Description:
STA 179+00 PVD + 6 ft Surcharge

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... ettlement\FOSSA\I-264 STA 179+00 PVD Surcharge.2ST
Original date and time of creating this file: Tue Jan 10 10:26:23 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 6 layers

	Wet Unit Weight, γ [lb/ft³]	Poisson's Ratio μ	Description of Soil
1	120.00	0.50	Layer 1 Upper Clay
2	115.00	0.30	Layer 2 Upper Sand
3	112.00	0.50	Layer 3 Upper Clay
4	125.00	0.30	Layer 4 Lower Sand
5	118.00	0.50	Layer 5 Lower Clay
6	125.00	0.30	Layer 6 Yorktown

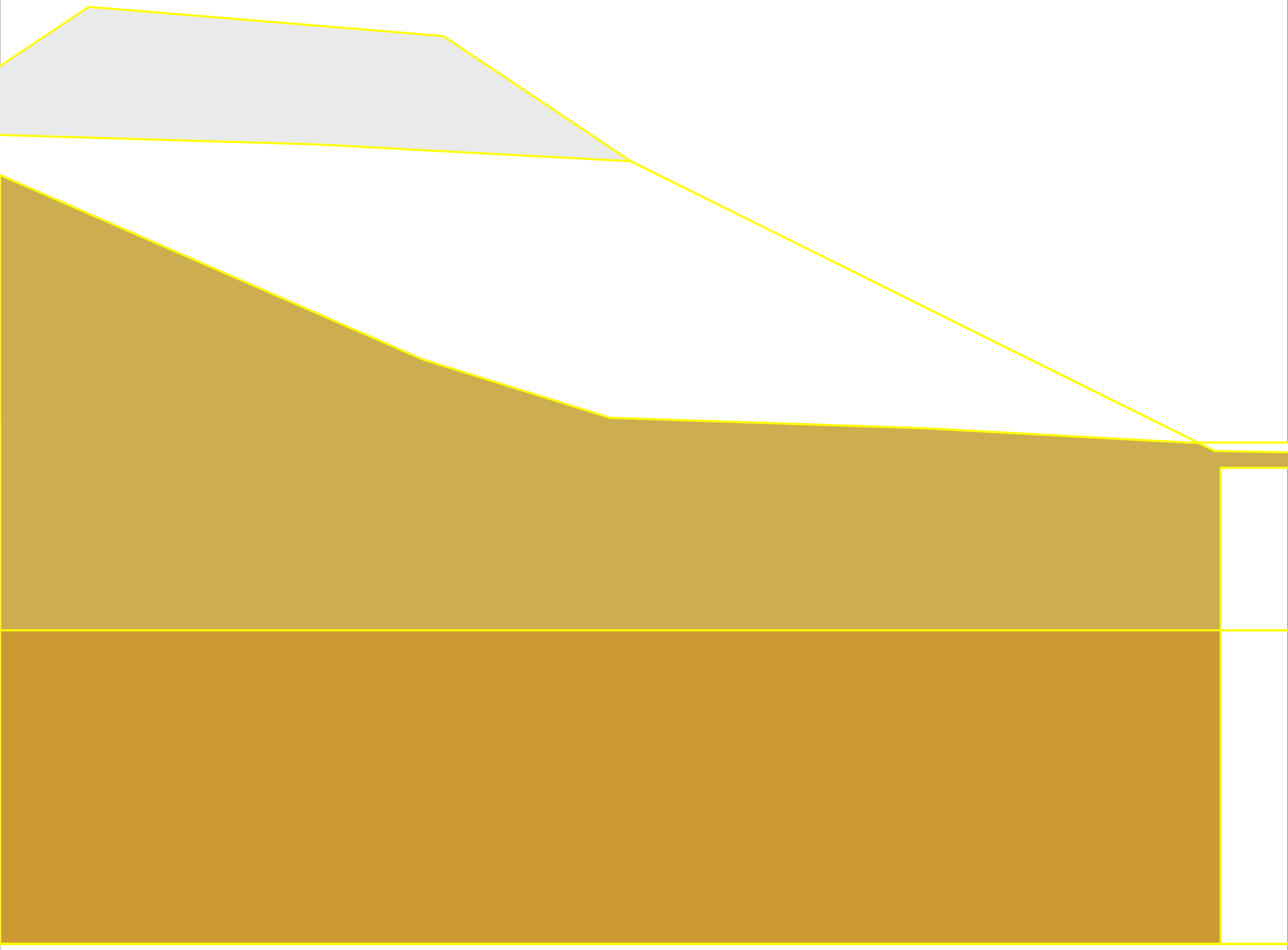
INPUT DATA – EMBANKMENT LAYERS -- 2 layers

	Wet Unit Weight, γ [lb/ft³]	Description of Soil
1	130.00	Proposed Fill
2	130.00	Surcharge

INPUT DATA OF WATER

Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]
1	0.00	3.00
2	1000.00	3.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :
1	Yes	2.00	0.120	0.012	N/A	0.1500	Top & Bot.
2	No	N/A	N/A	N/A	N/A	N/A	N/A
3	Yes	1.50	0.170	0.014	N/A	0.1500	Top & Bot.
4	No	N/A	N/A	N/A	N/A	N/A	N/A
5	Yes	2.00	0.100	0.012	N/A	0.3000	Top & Bot.
6	No	N/A	N/A	N/A	N/A	N/A	N/A

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	97.00	0.00	1	9999999999	0.5000	0.0000	20.00	19.91	0.09
			2	500000	0.3000	0.0371			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0539			
			5	9999999999	0.5000	0.0000			
			6	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	97.00	0.00	20.00	0.57	19.43

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	0.00	29.50	Layer 1 Upper Clay
	2	1.00	30.50	
	3	10.00	31.00	
	4	26.50	31.20	
	5	38.00	31.20	
	6	68.00	30.90	
	7	72.00	30.90	
	8	97.00	20.00	
	9	106.00	17.20	
	10	121.00	16.70	
	11	133.80	16.00	
	12	147.00	16.00	
	13	153.00	13.00	
	14	159.00	15.00	
	15	161.50	15.30	
	16	196.50	14.80	
	17	199.00	15.00	
	18	212.00	15.80	
	19	226.50	15.00	
	20	239.00	14.80	
	21	250.00	14.80	
2	1	0.00	7.00	Layer 2 Upper Sand
	2	1000.00	7.00	
3	1	0.00	-9.00	Layer 3 Upper Clay
	2	1000.00	-9.00	
4	1	0.00	-18.00	Layer 4 Lower Sand
	2	1000.00	-18.00	
5	1	0.00	-59.00	Layer 5 Lower Clay
	2	1000.00	-59.00	
6	1	0.00	-79.00	Layer 6 Yorktown
	2	1000.00	-79.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 72.00 [ft]	1	72.00	30.90	Proposed Fill
	X2 = 161.50 [ft]	2	92.00	30.30	
		3	107.00	29.50	
		4	135.00	15.60	
		5	145.50	15.40	
		6	152.50	13.00	
		7	161.50	15.30	
2	X1 = 72.00 [ft]	1	72.00	30.90	Surcharge
	X2 = 161.50 [ft]	2	81.00	36.90	
		3	98.00	35.50	
		4	107.00	29.50	
		5	135.00	15.60	
		6	145.50	15.72	
		7	152.50	13.00	
		8	161.50	15.30	

Estimation of Secondary Settlement

Project Name:	**I-264 Witchduck STA 179+00**
Date:	1/10/2017
Calculated by:	AW
Checked by:	

Project Life = **20** **years**

CASE II: Surcharge

Height of surcharge = **6** **feet**

Surcharge unit weight = **130** **pcf** (if surcharge placed below water, enter bouyant unit weight)

S No.	Clay Layer	Thickness (ft)	C_α' (NC, strain based)	t_{90}[3] (years)	Final Effective stress at layer midpoint[4] (psf)	Effective stress decrease due to surcharge removal (psf)	AAOS[5]	C_α' (surcharge)/ C_α' (NC)[6]	C_α' (surcharge)[6]	Secondary Settlement (ft)
1	UC-1	10	0.003	0.25	2160	780	36%	0.16	0.0005	0.01
2	UC	9	0.003	0.25	4600	780	17%	0.52	0.0015	0.03
3	LC	20	0.0003	0.25	7946	780	10%	0.77	0.0002	0.01

TOTAL SECONDARY SETTLEMENT = **0.04 ft**

or

0.53 in

Notes

1 C_α' (NC, strain based) is the coefficient of secondary settlement without the effect of oversolidation or surcharge.

2 t_{90} is the time to complete 90% primary consolidation.

3 t_{90} with surcharge might be less due to the use of wick drains.

4 The "final effective stress at layer mid point" is the effective stress after the removal of the surcharge.

5 AAOS is the Adjusted Amount of Surcharge, which is the effective stress reduction caused by surcharge removal.
It is calculated as stress decrease due to surcharge removal divided by final effective stress at the depth of interest.

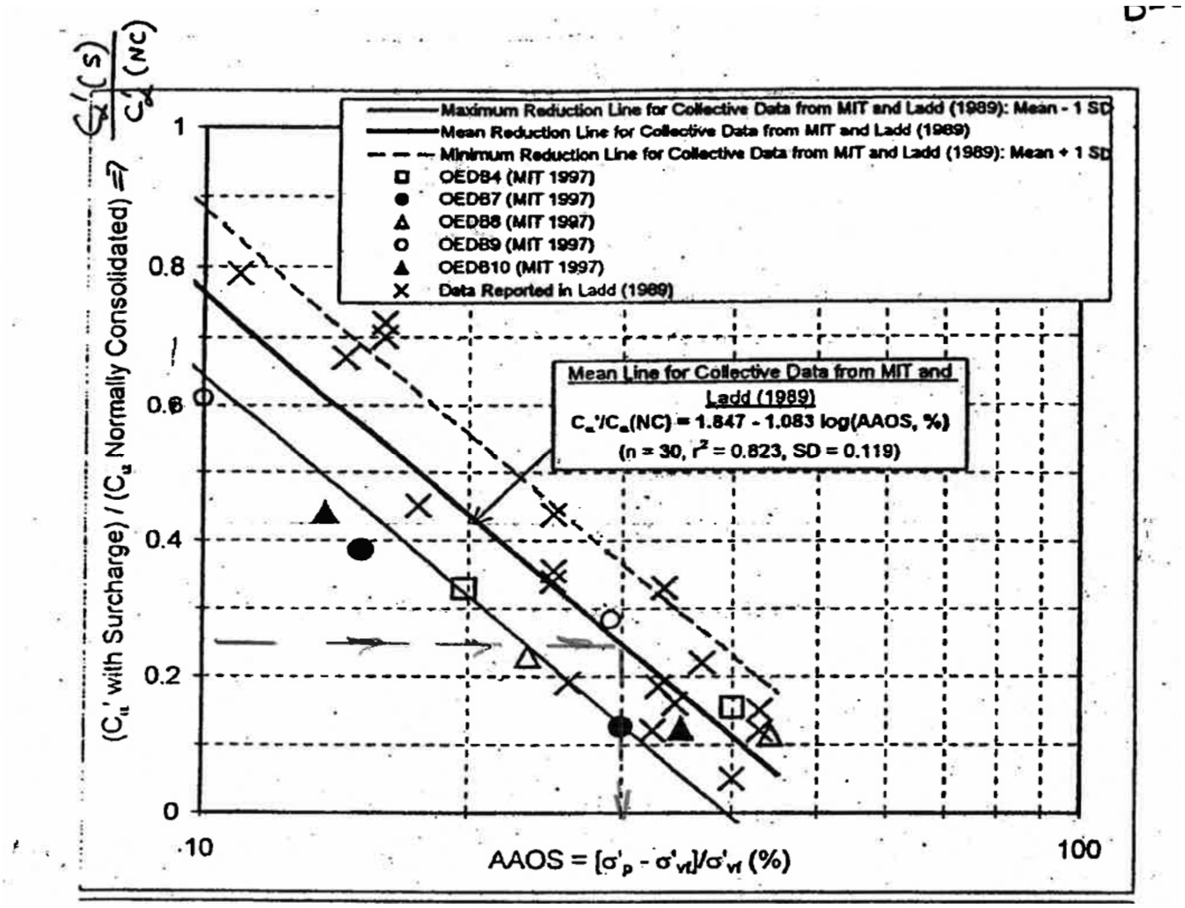
6 C_α' (surcharge) is the reduced coefficient of secondary settlement due to the application of surcharge.
This is estimated based on Ladd (1989) correlation shown in page 2.

7 Secondary settlement was calculated using the following equation:

$$S_{sec} = H.C'_{\propto}.\log(\frac{t_{project\ life}}{t_{90}})$$

8 It is assumed that surcharge, if placed, will be removed at 90% primary consolidation.

Ladd, 1989


Maximum Reduction Line for Collective Data from MIT and Ladd (1989): Mean - 1 SD
Mean Reduction Line for Collective Data from MIT and Ladd (1989)
Minimum Reduction Line for Collective Data from MIT and Ladd (1989): Mean + 1 SD
□ OEDB4 (MIT 1997)
● OEDB7 (MIT 1997)
△ OEDB8 (MIT 1997)
○ OEDB9 (MIT 1997)
▲ OEDB10 (MIT 1997)
× Data Reported in Ladd (1989)
Mean Line for Collective Data from MIT and Ladd (1989)
$C_\alpha'/C_\alpha(NC) = 1.847 - 1.083 \log(AAOS, \%)$
($n = 30$, $r^2 = 0.823$, $SD = 0.119$)
$\frac{C_\alpha'(s)}{C_\alpha'(NC)} \Rightarrow$
(C_α' with Surcharge) / (C_α Normally Consolidated)
1
0.8
0.6
0.4
0.2
0
10
100
AAOS = $[\sigma'_p - \sigma'_{vf}]/\sigma'_{vf}$ (%)

URS

Job 1-264 WITCHDUCK
Description IDEALIZED PROFILE
STA 189+50

Page ____ of ____
Sheet ____ of ____
Project No. ____
Computed by ____
Date ____
Checked by ____
Date ____
Reference

+12

UPPER CLAY-1
$\gamma = 120$ pcf $C_\alpha' = 0.003$
$C_c' = 0.12$ $C_v = 0.1$
$C_r' = 0.012$ OCR = 2.0

+7

+3 ∇

UPPER SAND $\gamma = 115$ pcf

Es' = 500,000 psf

-9

UPPER CLAY-2
$\gamma = 112$ pcf $C_\alpha' = 0.003$
$C_c' = 0.17$ $C_v = 0.1$
$C_r' = 0.014$ OCR = 1.5

-18

LOWER SAND $\gamma = 125$ pcf

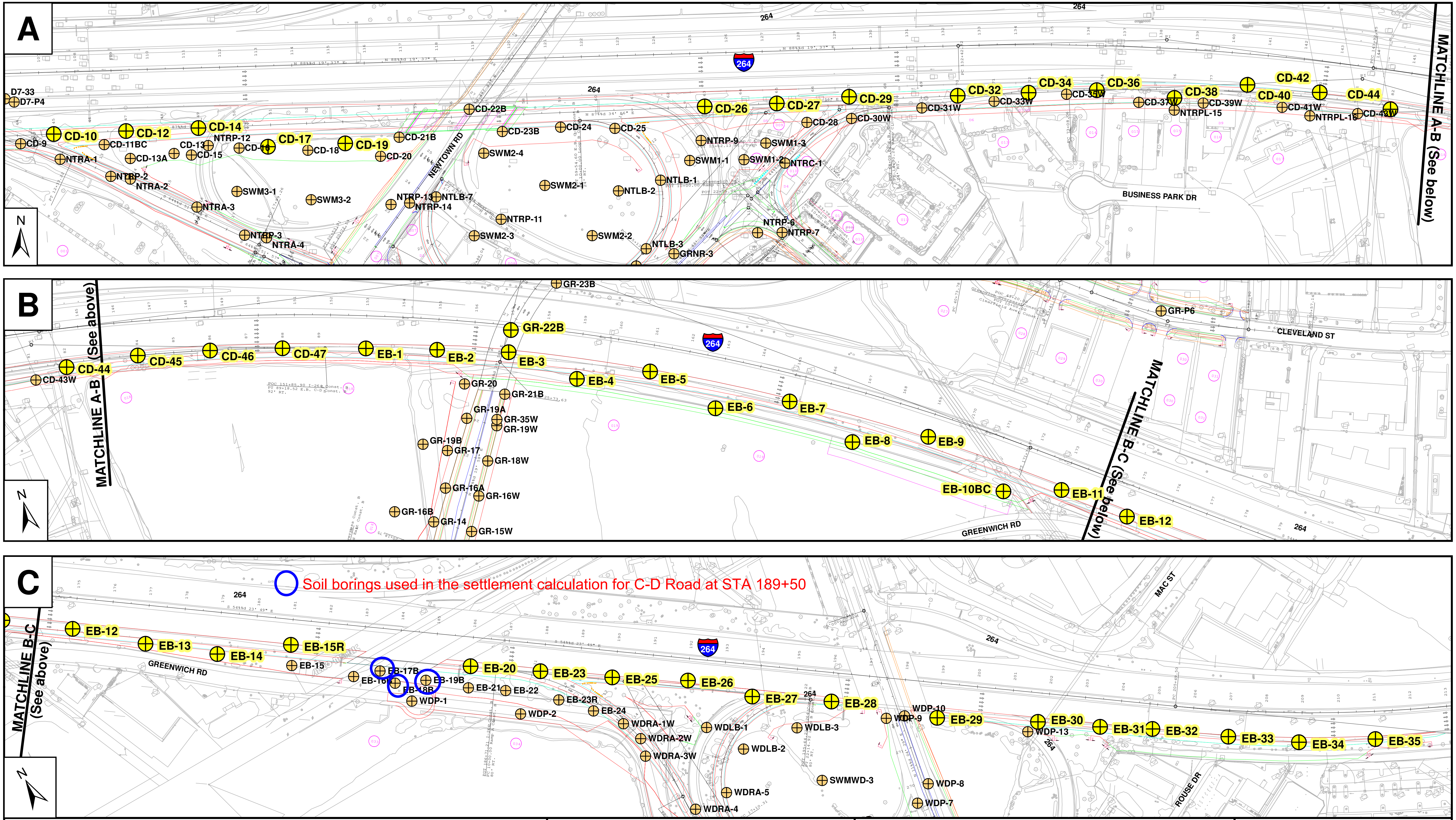
Es' = 500,000 psf

-59

LOWER CLAY
$\gamma = 118$ pcf $C_\alpha' = 0.0003$
$C_c' = 0.10$ $C_v = 0.14$
$C_R' = 0.012$ OCR = 2.0

-79

YORKTOWN



Soil borings used in the settlement calculation for C-D Road at STA 189+50

0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

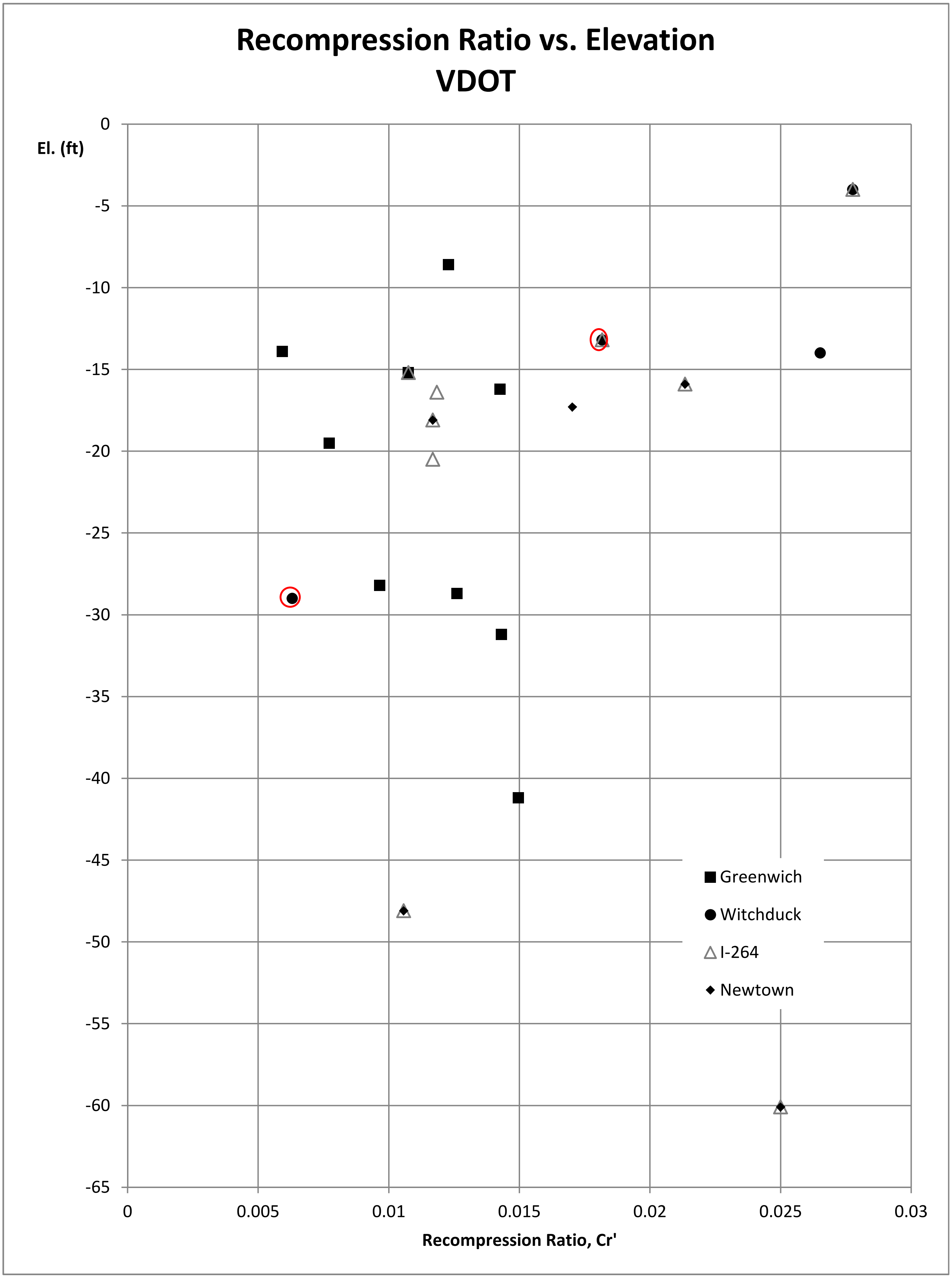
VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

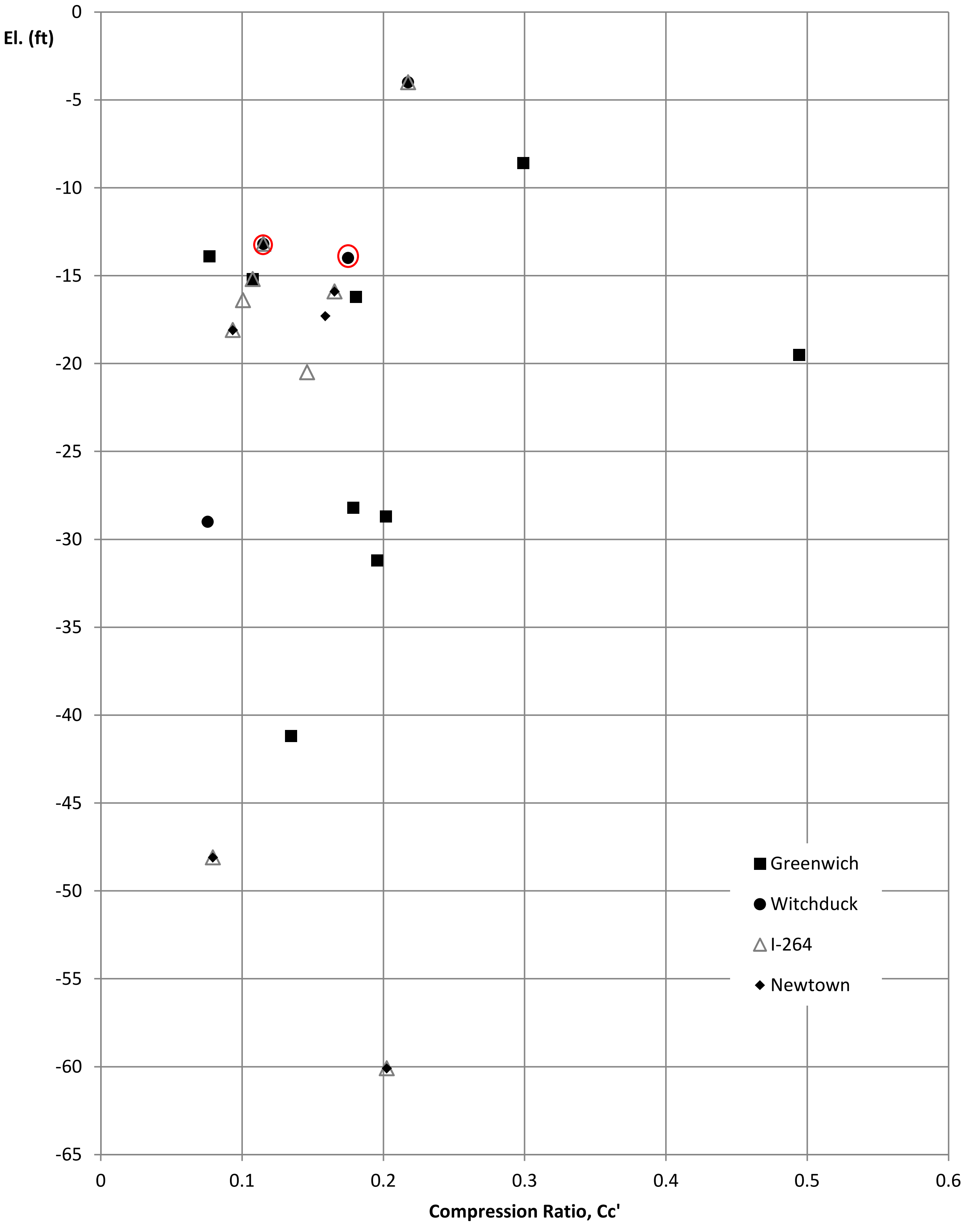
Project 0264-134-102
City of Virginia Beach

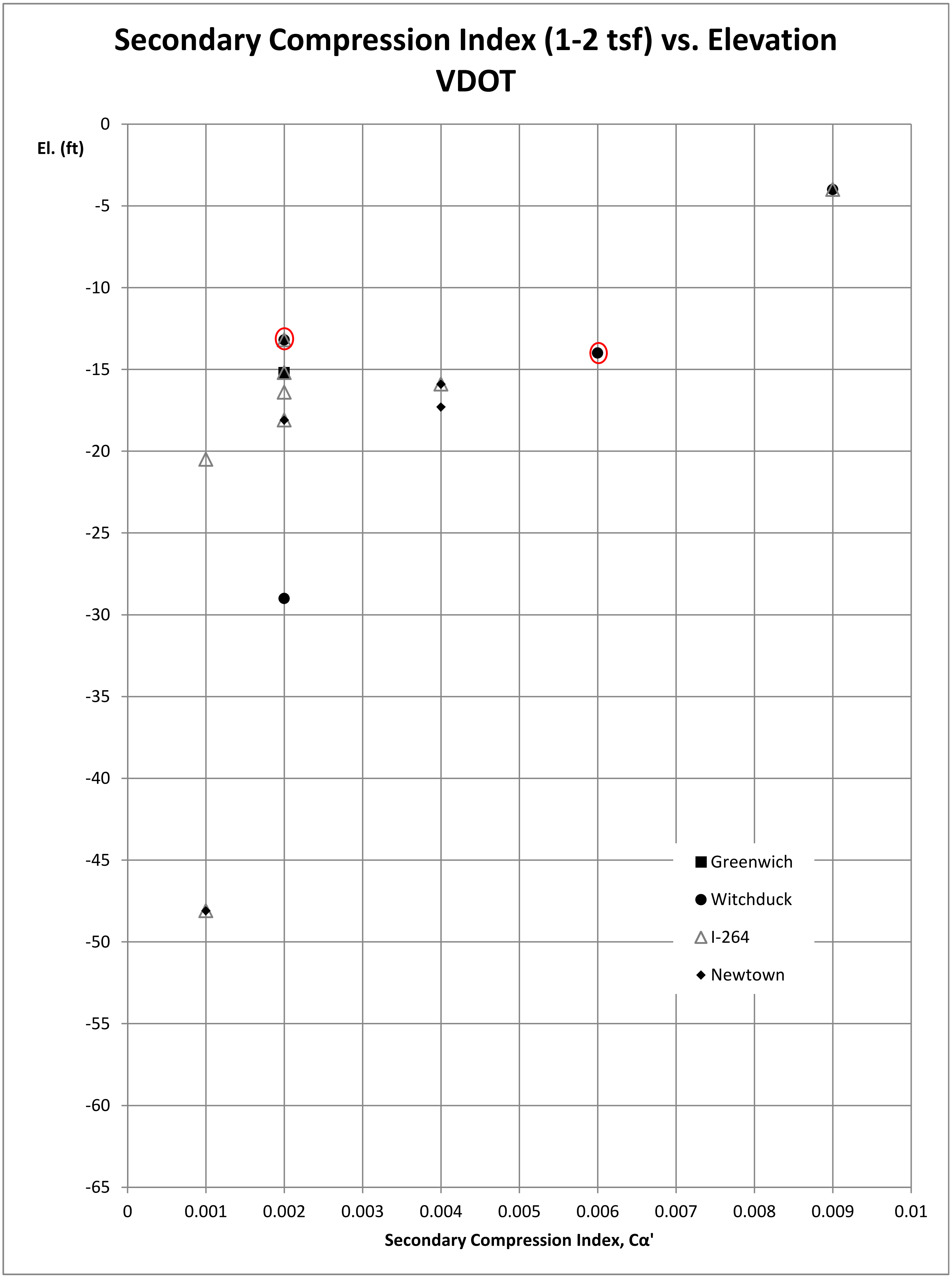
Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan


Recompression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.005
0.01
0.015
0.02
0.025
0.03
Recompression Ratio, Cr'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

Compression Ratio vs. Elevation
VDOT




Secondary Compression Index (1-2 tsf) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
Secondary Compression Index, Cα'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

REFERENCE: US ARMY CORPS OF ENGINEERS,
Engineering Manual 1110-1-1904 Settlement Analysis

Table D-3

Typical Elastic Moduli

Soil	E_s, tsf
Clay	
Very soft clay	5 - 50
Soft clay	50 - 200
Medium clay	200 - 500
Stiff clay, silty clay	500 - 1000
Sandy clay	250 - 2000
Clay shale	1000 - 2000
Sand	
Loose sand	100 - 250
Dense sand	250 - 1000
Dense sand and gravel	1000 - 2000
Silty sand	250 - 2000

c. Laboratory Tests on Cohesive Soil. The elastic modulus is sensitive to soil disturbance which may increase pore water pressure and, therefore, decrease the effective stress in the specimen and reduce the stiffness and strength. Fissures, which may have little influence on field settlement, may reduce the measured modulus compared with the in situ modulus if confining pressures are not applied to the soil specimen.

(1) Initial hyperbolic tangent modulus. Triaxial unconsolidated undrained (Q or UU) compression tests may be performed on the best available undisturbed specimens at confining pressures equal to the total vertical overburden pressure σ_o for that specimen when in the field using the Q test procedure described in EM 1110-2-1906, Laboratory Soils Testing. An appropriate measure of E_s is the initial tangent modulus $E_{ti} = 1/a$ where a is the intercept of a plot of strain/deviator stress versus strain, Figure D-3 (item 14).

(2) Reload modulus. A triaxial consolidated undrained (R or CU) compression test may be performed on the best available undisturbed specimens. The specimen is initially fully consolidated to an isotropic confining pressure equal to the vertical overburden pressure σ_o for that specimen in the field. The R test procedure described in EM 1110-2-1906 may be used except as follows: stress is increased to the magnitude estimated for the field loading condition. The axial stress may then be reduced to zero and the cycle repeated until the reload curve shows no further increase in slope. The tangent modulus at 1/2 of the maximum applied stress is determined for each loading cycle and plotted versus the number of cycles, Figure D-4. An appropriate measure of E_s is the reload tangent modulus that approaches the asymptotic value at large cycles.

d. Field Tests. The elastic modulus may be estimated from empirical and semiempirical relationships based on results of field soil tests. Refer to

I-264 Witchduck STA 189+50

PROJECT IDENTIFICATION

Title: I-264 Witchduck STA 189+50
Project Number: -
Client:
Designer: AW
Station Number:

Description:
STA 189+50, 25' max fill, no GI

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... SA\I-264 STA 189+50 new parameters_old profile.2ST
Original date and time of creating this file: Mon Jan 09 10:58:41 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 7 layers

	Wet Unit Weight, γ [lb/ft³]	Poisson's Ratio μ	Description of Soil
1	125.00	0.30	Layer 1 Existing Fill
2	120.00	0.50	Layer 2 Upper Clay
3	115.00	0.30	Layer 3 Upper Sand
4	112.00	0.50	Layer 4 Upper Clay
5	125.00	0.30	Layer 5 Lower Sand
6	118.00	0.50	Layer 6 Lower Clay
7	125.00	0.30	Layer 7 Yorktown

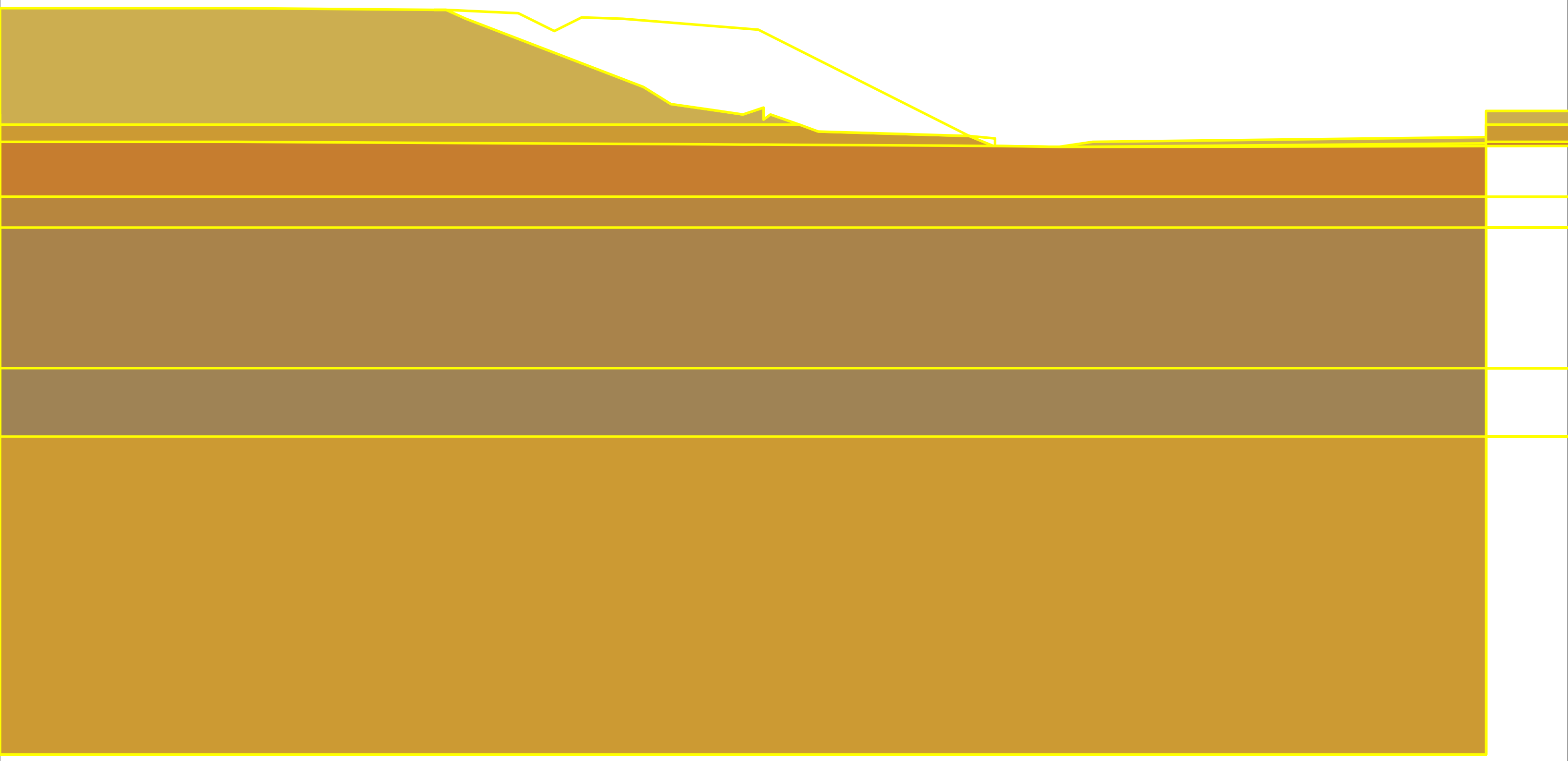
INPUT DATA – EMBANKMENT LAYERS -- 1 layers

	Wet Unit Weight, γ [lb/ft³]	Description of Soil
1	130.00	Proposed Fill

INPUT DATA OF WATER

Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]
1	0.00	3.00
2	1000.00	3.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :	CREEP Ca/Cc
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	0.0250
3	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	0.0176
5	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	0.0030
7	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Secondary Comprassion (Creep) : Settlement is calculated at t2/t1 = 12.0

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	30.00	0.00	1	750000	0.3000	-0.0033	45.74	45.73	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0016			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0123			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
2	34.49	0.00	1	750000	0.3000	-0.0034	45.70	45.69	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0011			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0150			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
3	38.98	0.00	1	750000	0.3000	-0.0036	45.66	45.65	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0004			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0180			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
4	43.47	0.00	1	750000	0.3000	-0.0036	45.63	45.61	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0006			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0213			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
5	47.96	0.00	1	750000	0.3000	-0.0036	45.59	45.56	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0017			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0250			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
6	52.45	0.00	1	750000	0.3000	-0.0030	45.55	45.52	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0031			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0293			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
7	56.94	0.00	1	750000	0.3000	-0.0020	45.51	45.47	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0048			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0335			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
8	61.43	0.00	1	750000	0.3000	0.0000	45.50	45.45	0.05
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0069			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0383			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
9	65.92	0.00	1	750000	0.3000	0.0035	43.49	43.44	0.06
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0093			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0434			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
10	70.41	0.00	1	750000	0.3000	0.0077	41.69	41.62	0.07
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0120			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0489			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
11	74.90	0.00	1	750000	0.3000	0.0114	39.96	39.88	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0149			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0546			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
12	79.39	0.00	1	750000	0.3000	0.0142	38.24	38.14	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0182			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0605			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
13	83.88	0.00	1	750000	0.3000	0.0164	36.51	36.40	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0216			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0667			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
14	88.37	0.00	1	750000	0.3000	0.0187	34.78	34.66	0.12
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0253			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0729			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
15	92.86	0.00	1	750000	0.3000	0.0213	33.05	32.93	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0292			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0792			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
16	97.35	0.00	1	750000	0.3000	0.0236	31.33	31.19	0.14
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0332			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0863			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
17	101.84	0.00	1	750000	0.3000	0.0259	29.60	29.45	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0373			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0914			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
18	106.33	0.00	1	750000	0.3000	0.0273	27.87	27.71	0.17
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0413			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0972			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
19	110.82	0.00	1	750000	0.3000	0.0278	26.15	25.97	0.17
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0443			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1026			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
20	115.31	0.00	1	750000	0.3000	0.0267	24.42	24.24	0.18
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0479			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1076			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
21	119.80	0.00	1	750000	0.3000	0.0245	22.50	22.31	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0511			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1121			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
22	124.29	0.00	1	750000	0.3000	0.0197	19.70	19.51	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0540			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1159			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
23	128.78	0.00	1	750000	0.3000	0.0155	17.75	17.56	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0563			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1190			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
24	133.27	0.00	1	750000	0.3000	0.0143	17.10	16.91	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0581			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1214			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
25	137.76	0.00	1	750000	0.3000	0.0128	16.46	16.27	0.20
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0592			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1244			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
26	142.24	0.00	1	750000	0.3000	0.0110	15.82	15.63	0.20
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0597			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1249			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
27	146.73	0.00	1	750000	0.3000	0.0092	15.18	14.99	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0596			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1233			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
28	151.22	0.00	1	750000	0.3000	0.0117	16.07	15.88	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0589			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1222			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
29	155.71	0.00	1	750000	0.3000	0.0079	14.78	14.60	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0575			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1203			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
30	160.20	0.00	1	750000	0.3000	0.0042	13.52	13.34	0.18
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0564			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1189			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
31	164.69	0.00	1	750000	0.3000	0.0000	11.94	11.77	0.17
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0540			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1139			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
32	169.18	0.00	1	750000	0.3000	0.0000	10.30	10.14	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0491			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1116			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
33	173.67	0.00	1	750000	0.3000	0.0000	9.89	9.74	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0467			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1048			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
34	178.16	0.00	1	750000	0.3000	0.0000	9.76	9.62	0.14
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0420			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0994			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
35	182.65	0.00	1	750000	0.3000	0.0000	9.63	9.49	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0381			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0936			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
36	187.14	0.00	1	750000	0.3000	0.0000	9.49	9.37	0.12
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0339			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0874			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
37	191.63	0.00	1	750000	0.3000	0.0000	9.36	9.25	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0298			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0811			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
38	196.12	0.00	1	750000	0.3000	0.0000	9.23	9.13	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0256			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0756			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
39	200.61	0.00	1	750000	0.3000	0.0000	9.10	9.01	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0216			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0681			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
40	205.10	0.00	1	750000	0.3000	0.0000	8.96	8.88	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0178			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0617			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
41	209.59	0.00	1	750000	0.3000	0.0000	8.83	8.76	0.07
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0143			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0555			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
42	214.08	0.00	1	750000	0.3000	0.0000	8.67	8.61	0.06
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0112			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0495			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
43	218.57	0.00	1	750000	0.3000	0.0000	6.81	6.75	0.05
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0085			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0438			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
44	223.06	0.00	1	750000	0.3000	0.0000	5.77	5.72	0.04
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0060			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0385			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
45	227.55	0.00	1	750000	0.3000	0.0000	5.70	5.66	0.04
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0041			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0336			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
46	232.04	0.00	1	750000	0.3000	0.0000	5.63	5.59	0.03
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0025			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0290			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
47	236.53	0.00	1	750000	0.3000	0.0000	5.55	5.53	0.03
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0012			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0256			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
48	241.02	0.00	1	750000	0.3000	0.0000	5.65	5.63	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0002			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0211			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
49	245.51	0.00	1	750000	0.3000	-0.0001	6.33	6.31	0.02
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	-0.0006			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0177			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
50	250.00	0.00	1	750000	0.3000	-0.0002	7.00	6.99	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	-0.0012			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0148			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	165.00	0.00	11.83	0.71	11.12

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

SECONDARY SETTLEMENT (Creep), Ss -- Total Secondary Compression (Creep) = 0.054 ft.

Layer #	Underging Consolidation	Cc / (1+e0)	C-alpha/ (1+e0)	e-zero	H [ft.]	t1/t2	Settlement Ss [ft.]
1	No	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	0.1200	0.0030	N/A	5.71	12.0	0.018
3	No	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	0.1700	0.0030	N/A	9.00	12.0	0.029
5	No	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	0.1000	0.0003	N/A	20.00	12.0	0.006
7	No	N/A	N/A	N/A	N/A	N/A	N/A

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	0.00	46.00	Layer 1 Existing Fill
	2	58.00	45.50	
	3	61.50	45.50	
	4	67.00	43.00	
	5	119.00	23.00	
	6	127.00	18.00	
	7	148.00	15.00	
	8	154.00	17.00	
	9	154.01	13.50	
	10	156.00	15.00	
	11	164.50	12.01	
	12	170.00	10.00	
	13	214.00	8.70	
	14	221.00	5.80	
	15	240.00	5.50	
	16	250.00	7.00	
	17	1000.00	16.00	
2	1	0.00	12.00	Layer 2 Upper Clay
	2	58.00	12.00	
	3	61.50	12.00	
	4	67.00	12.00	
	5	119.00	12.00	
	6	127.00	12.00	
	7	141.00	12.00	
	8	148.00	12.00	
	9	151.22	12.00	
	10	154.00	12.00	
	11	154.01	12.00	
	12	156.00	12.00	
	13	164.50	12.00	
	14	170.00	10.00	
	15	214.00	8.70	
	16	221.00	5.80	
	17	240.00	5.50	
	18	1000.00	12.00	
3	1	0.00	7.00	Layer 3 Upper Sand
	2	221.00	5.80	
	3	240.00	5.50	
	4	1000.00	7.00	
4	1	0.00	-9.00	Layer 4 Upper Clay
	2	1000.00	-9.00	
5	1	0.00	-18.00	Layer 5 Lower Sand
	2	1000.00	-18.00	
6	1	0.00	-59.00	Layer 6 Lower Clay
	2	1000.00	-59.00	
7	1	0.00	-79.00	Layer 7 Yorktown
	2	1000.00	-79.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 58.00 [ft]	1	58.00	45.50	Proposed Fill
	X2 = 221.50 [ft]	2	61.50	45.50	
		3	82.50	44.50	
		4	93.00	39.30	
		5	101.00	43.30	
		6	113.00	42.90	
		7	152.50	39.70	
		8	214.00	8.70	
		9	221.50	8.00	

I-264 Witchduck STA 189+50

PROJECT IDENTIFICATION

Title: I-264 Witchduck STA 189+50
Project Number: -
Client:
Designer: AW
Station Number:

Description:
STA 189+50, 25' max fill, PVD 5 FT SUR

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... STA 189+50 new parameters_old profile 5 FT sur.2ST
Original date and time of creating this file: Mon Jan 09 10:58:41 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 7 layers

	Wet Unit Weight, γ [lb/ft³]	**Poisson's Ratio μ**	**Description of Soil**
1	125.00	0.30	Layer 1 Existing Fill
2	120.00	0.50	Layer 2 Upper Clay
3	115.00	0.30	Layer 3 Upper Sand
4	112.00	0.50	Layer 4 Upper Clay
5	125.00	0.30	Layer 5 Lower Sand
6	118.00	0.50	Layer 6 Lower Clay
7	125.00	0.30	Layer 7 Yorktown

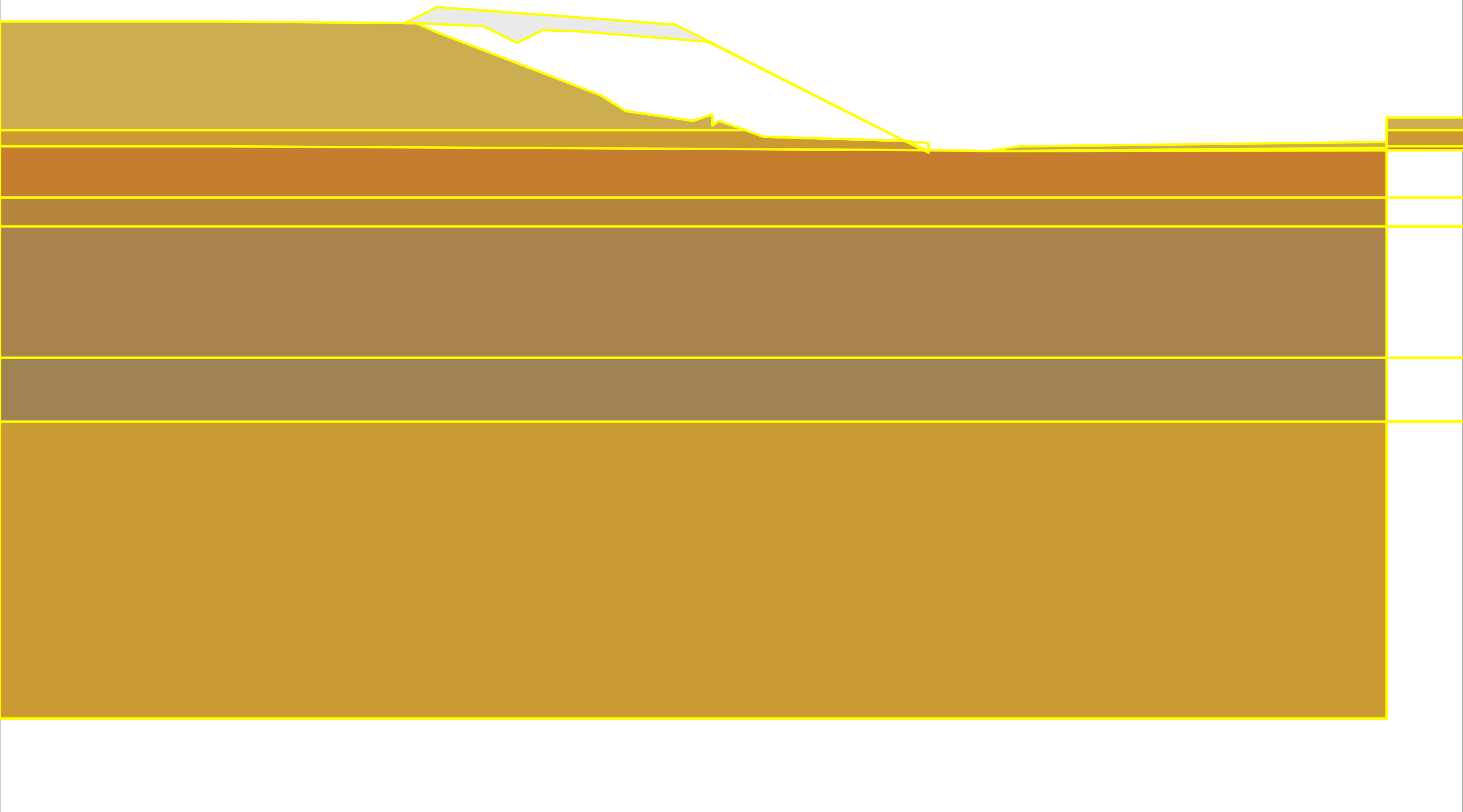
INPUT DATA – EMBANKMENT LAYERS -- 2 layers

	Wet Unit Weight, γ [lb/ft³]	**Description of Soil**
1	130.00	Proposed Fill
2	130.00	Surcharge

INPUT DATA OF WATER

Point #	**Coordinates (X, Z) : (X) [ft.]**	**(Z) [ft.]**
1	0.00	3.00
2	1000.00	3.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :	CREEP Ca/Cc
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	0.0250
3	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	0.0176
5	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	0.0030
7	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Secondary Comprassion (Creep) : Settlement is calculated at t2/t1 = 12.0

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	165.00	0.00	1	750000	0.3000	0.0000	11.83	11.65	0.18
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0560			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1259			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node # 	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	165.00	0.00	11.83	0.76	11.07

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	0.00	46.00	Layer 1 Existing Fill
	2	58.00	45.50	
	3	61.50	45.50	
	4	67.00	43.00	
	5	119.00	23.00	
	6	127.00	18.00	
	7	148.00	15.00	
	8	154.00	17.00	
	9	154.01	13.50	
	10	156.00	15.00	
	11	164.50	12.01	
	12	170.00	10.00	
	13	214.00	8.70	
	14	221.00	5.80	
	15	240.00	5.50	
	16	250.00	7.00	
	17	1000.00	16.00	
2	1	0.00	12.00	Layer 2 Upper Clay
	2	58.00	12.00	
	3	61.50	12.00	
	4	67.00	12.00	
	5	119.00	12.00	
	6	127.00	12.00	
	7	141.00	12.00	
	8	148.00	12.00	
	9	151.22	12.00	
	10	154.00	12.00	
	11	154.01	12.00	
	12	156.00	12.00	
	13	164.50	12.00	
	14	170.00	10.00	
	15	214.00	8.70	
	16	221.00	5.80	
	17	240.00	5.50	
	18	1000.00	12.00	
3	1	0.00	7.00	Layer 3 Upper Sand
	2	221.00	5.80	
	3	240.00	5.50	
	4	1000.00	7.00	
4	1	0.00	-9.00	Layer 4 Upper Clay
	2	1000.00	-9.00	
5	1	0.00	-18.00	Layer 5 Lower Sand
	2	1000.00	-18.00	
6	1	0.00	-59.00	Layer 6 Lower Clay
	2	1000.00	-59.00	
7	1	0.00	-79.00	Layer 7 Yorktown
	2	1000.00	-79.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 58.00 [ft]	1	58.00	45.50	Proposed Fill
	X2 = 221.50 [ft]	2	61.50	45.50	
		3	82.50	44.50	
		4	93.00	39.30	
		5	101.00	43.30	
		6	113.00	42.90	
		7	152.50	39.70	
		8	214.00	8.70	
		9	221.50	8.00	
2	X1 = 58.00 [ft]	1	58.00	45.50	Surcharge
	X2 = 221.50 [ft]	2	68.00	50.50	
		3	142.50	45.00	
		4	221.50	5.00	

Estimation of Secondary Settlement

Project Name:	**I-264 Witchduck STA 189+50**
Date:	1/13/2017
Calculated by:	AS
Checked by:	

Project Life = **20** **years**

CASE II: Surcharge

Height of surcharge = **5** **feet**

Surcharge unit weight = **130** **pcf** (if surcharge placed below water, enter bouyant unit weight)

S No.	Clay Layer	Thickness (ft)	C_α' (NC, strain based)	t_{90} [3] (years)	Final Effective stress at layer midpoint[4] (psf)	Effective stress decrease due to surcharge removal (psf)	AAOS[5]	C_α' (surcharge)/ C_α' (NC) [6]	C_α' (surcharge)[6]	Secondary Settlement (ft)
1	UC	3	0.003	0.33	3180	650	20%	0.43	0.0013	0.01
2	UC	9	0.003	0.33	4489	650	14%	0.59	0.0018	0.03

TOTAL SECONDARY SETTLEMENT = **0.04 ft** **or** **0.42 in**

Notes

1 C_α' (NC, strain based) is the coefficient of secondary settlement without the effect of oversolidation or surcharge.

2 t_{90} is the time to complete 90% primary consolidation.

3 t_{90} with surcharge might be less due to the use of wick drains.

4 The "final effective stress at layer mid point" is the effective stress after the removal of the surcharge.

5 AAOS is the Adjusted Amount of Surcharge, which is the effective stress reduction caused by surcharge removal.
It is calculated as stress decrease due to surcharge removal divided by final effective stress at the depth of interest.

6 C_α' (surcharge) is the reduced coefficient of secondary settlement due to the application of surcharge.
This is estimated based on Ladd (1989) correlation shown in page 2.

7 Secondary settlement was calculated using the following equation:

$$S_{sec} = H.C'_{\propto}.\log(\frac{t_{project\ life}}{t_{90}})$$

8 It is assumed that surcharge, if placed, will be removed at 90% primary consolidation.

URS

Job 1-264 WITCHDUCK
Description IDEALIZED PROFILE
Project No.
Computed by
Checked by
Page of
Sheet of
Date
Date
Reference

STA 59+00 ℄ NTLB

+13

UPPER CLAY-1 $\gamma_m = 120$ pcf $C_c' = 0.12$ $C_\alpha = 0.003$
$C_R' = 0.012$ OCR = 2.0
$C_v = 0.10$

+10 ∇

UPPER SAND $\gamma_m = 115$ pcf
Es' = 500,000 psf

-11

UPPER CLAY-2 $\gamma_m = 112$ pcf $C_c' = 0.17$ $C_\alpha = 0.003$
$C_R' = 0.014$ OCR = 1.5
$C_v = 0.10$

-19

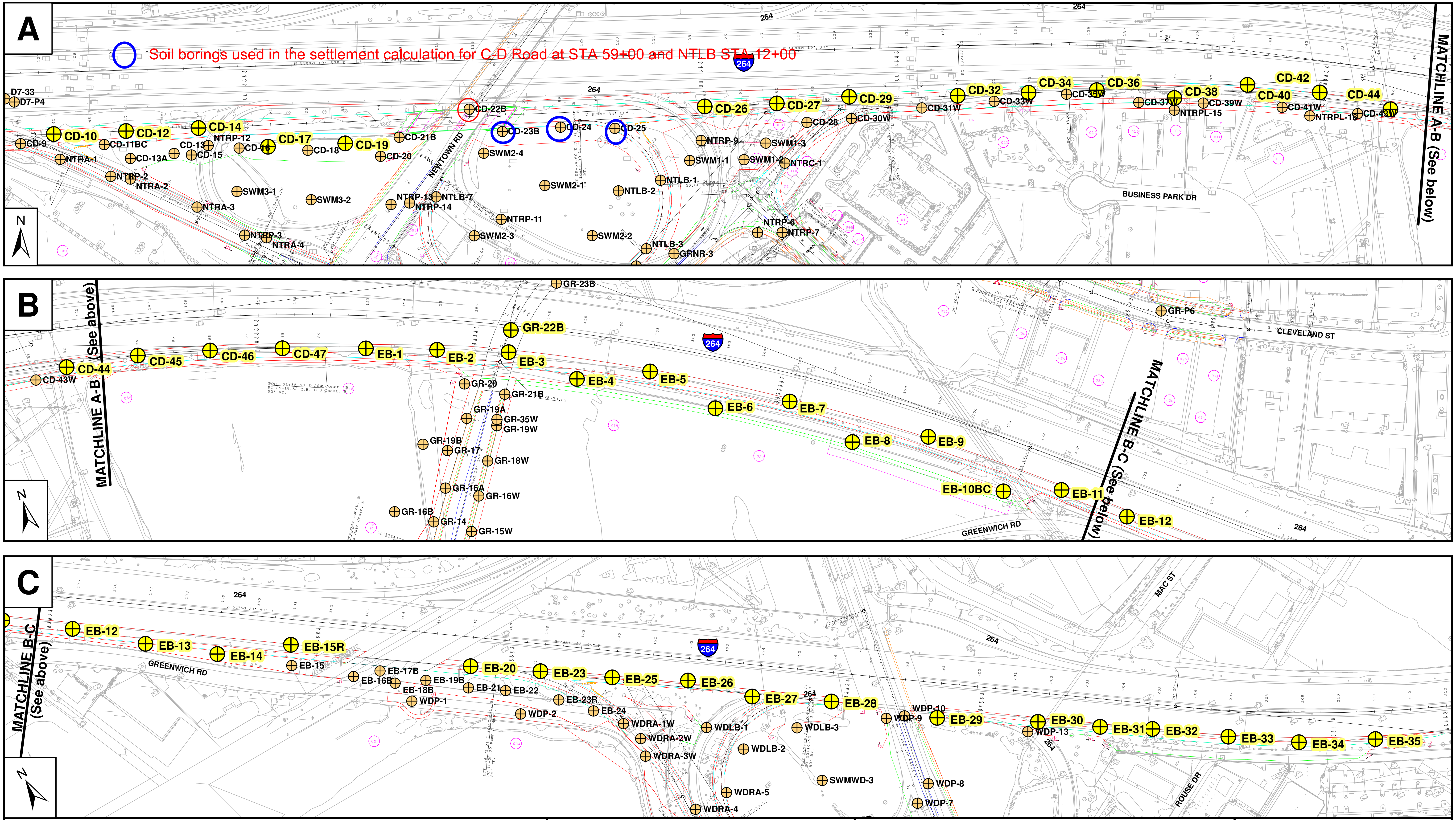
LOWER SAND $\gamma_m = 125$ pcf
Es' = 500,000 psf

-41

LOWER CLAY $\gamma_m = 118$ pcf $C_c' = 0.10$ $C_\alpha = 0.0003$
$C_R' = 0.012$ OCR = 2.0
$C_v = 0.14$

-55

YORKTOWN $\gamma = 125$ pcf



Soil borings used in the settlement calculation for C-D Road at STA 59+00 and NTLB STA 12+00

0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

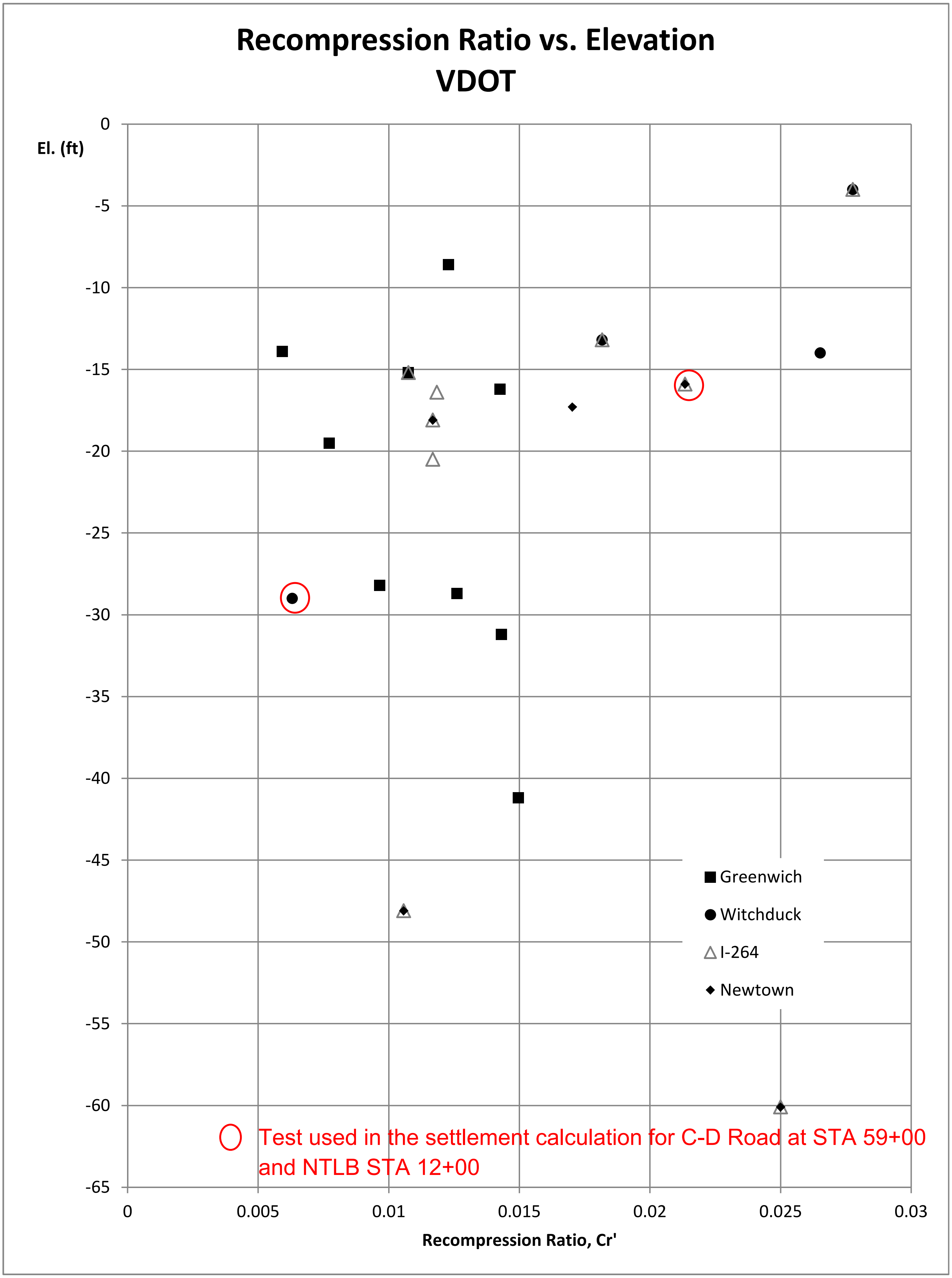
VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

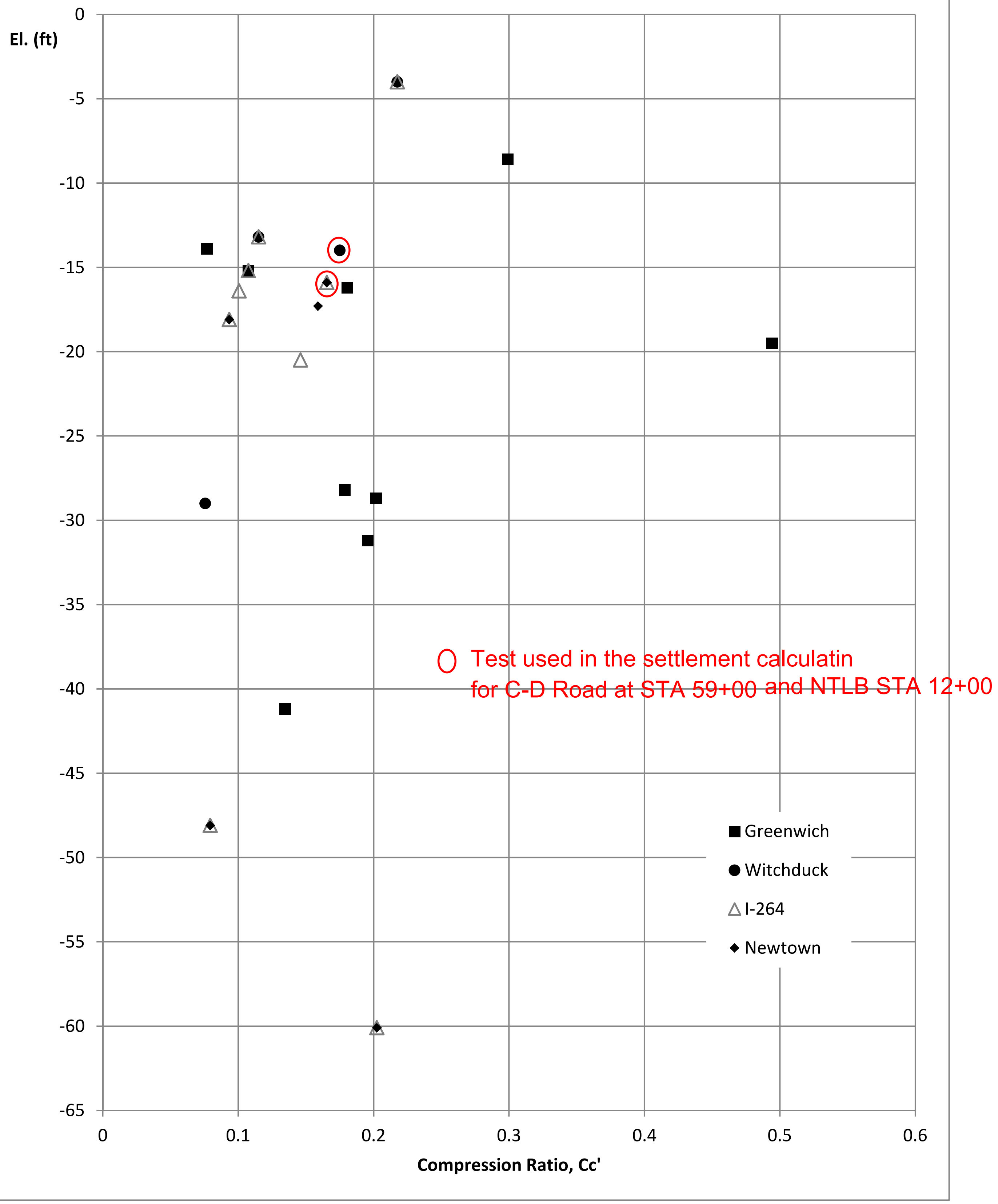
Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan


Recompression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.005
0.01
0.015
0.02
0.025
0.03
Recompression Ratio, Cr'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown
○ Test used in the settlement calculation for C-D Road at STA 59+00 and NTLB STA 12+00

Compression Ratio vs. Elevation
VDOT



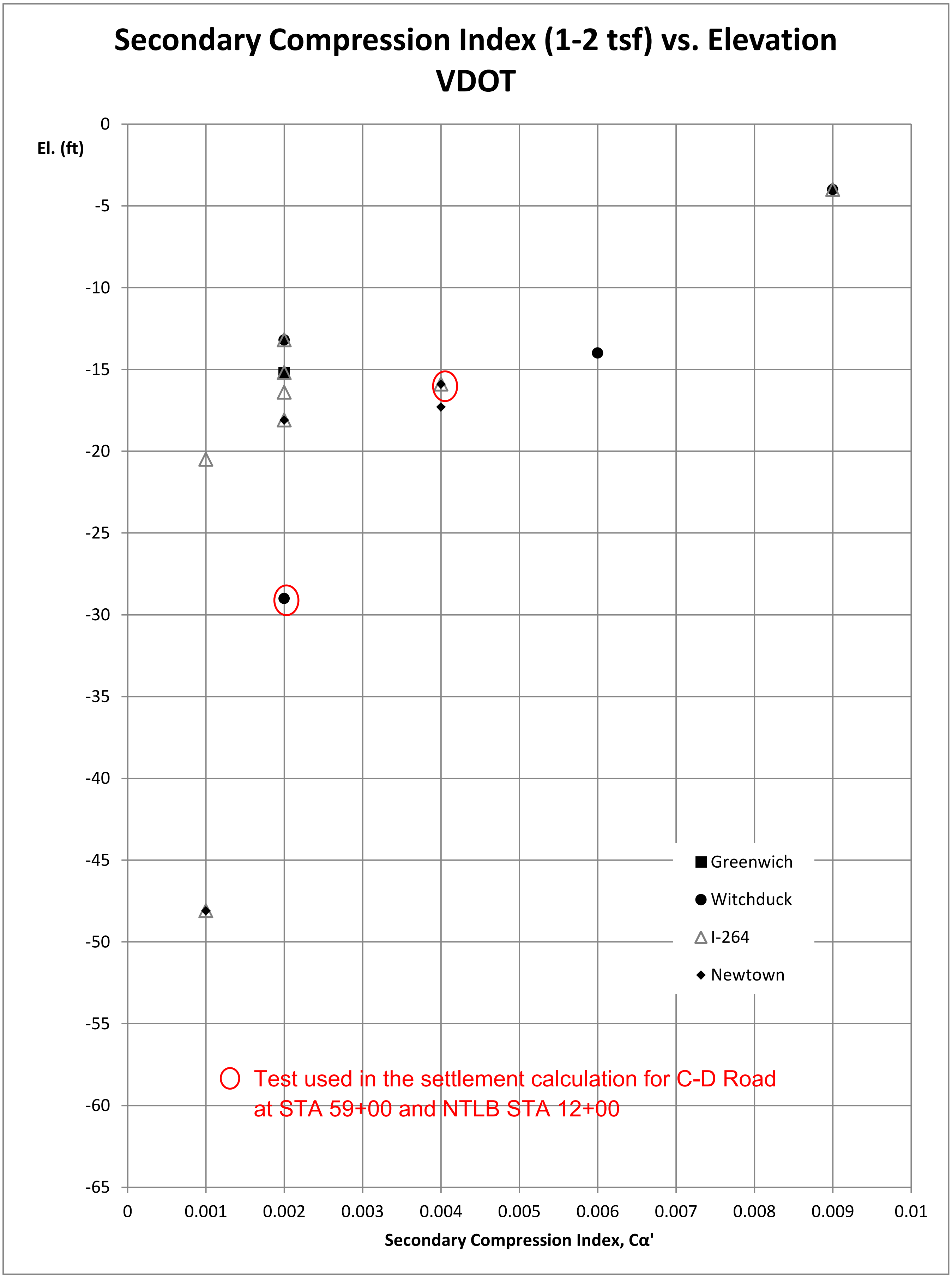

Secondary Compression Index (1-2 tsf) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
Secondary Compression Index, Cα'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown
○ Test used in the settlement calculation for C-D Road at STA 59+00 and NTLB STA 12+00

Table D-3

Typical Elastic Moduli

Soil	E_s, tsf
Clay	
Very soft clay	5 - 50
Soft clay	50 - 200
Medium clay	200 - 500
Stiff clay, silty clay	500 - 1000
Sandy clay	250 - 2000
Clay shale	1000 - 2000
Sand	
Loose sand	100 - 250
Dense sand	250 - 1000
Dense sand and gravel	1000 - 2000
Silty sand	250 - 2000

c. Laboratory Tests on Cohesive Soil. The elastic modulus is sensitive to soil disturbance which may increase pore water pressure and, therefore, decrease the effective stress in the specimen and reduce the stiffness and strength. Fissures, which may have little influence on field settlement, may reduce the measured modulus compared with the in situ modulus if confining pressures are not applied to the soil specimen.

(1) Initial hyperbolic tangent modulus. Triaxial unconsolidated undrained (Q or UU) compression tests may be performed on the best available undisturbed specimens at confining pressures equal to the total vertical overburden pressure σ_o for that specimen when in the field using the Q test procedure described in EM 1110-2-1906, Laboratory Soils Testing. An appropriate measure of E_s is the initial tangent modulus $E_{ti} = 1/a$ where a is the intercept of a plot of strain/deviator stress versus strain, Figure D-3 (item 14).

(2) Reload modulus. A triaxial consolidated undrained (R or CU) compression test may be performed on the best available undisturbed specimens. The specimen is initially fully consolidated to an isotropic confining pressure equal to the vertical overburden pressure σ_o for that specimen in the field. The R test procedure described in EM 1110-2-1906 may be used except as follows: stress is increased to the magnitude estimated for the field loading condition. The axial stress may then be reduced to zero and the cycle repeated until the reload curve shows no further increase in slope. The tangent modulus at 1/2 of the maximum applied stress is determined for each loading cycle and plotted versus the number of cycles, Figure D-4. An appropriate measure of E_s is the reload tangent modulus that approaches the asymptotic value at large cycles.

d. Field Tests. The elastic modulus may be estimated from empirical and semiempirical relationships based on results of field soil tests. Refer to

I-264 Witchduck NTLB STA 12+00

PROJECT IDENTIFICATION

Title: I-264 Witchduck NTLB STA 12+00
Project Number: -
Client:
Designer: AW
Station Number:

Description:
Newtown Loop B STA 12+00 with Solite and 6' surcharge + PVD

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... A 12+00.00_right side with 6ft surcharge + PVD.2ST
Original date and time of creating this file: Sat Jan 07 17:25:16 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 7 layers

	Wet Unit Weight, γ [lb/ft³]	**Poisson's Ratio μ**	**Description of Soil**
1	125.00	0.30	Layer 1 Existing Fill
2	120.00	0.50	Layer 2 Upper Clay
3	115.00	0.30	Layer 3 Upper Sand
4	112.00	0.50	Layer 4 Upper Clay
5	125.00	0.30	Layer 5 Lower Sand
6	118.00	0.50	Layer 6 Lower Clay
7	125.00	0.30	Layer 7 Yorktown

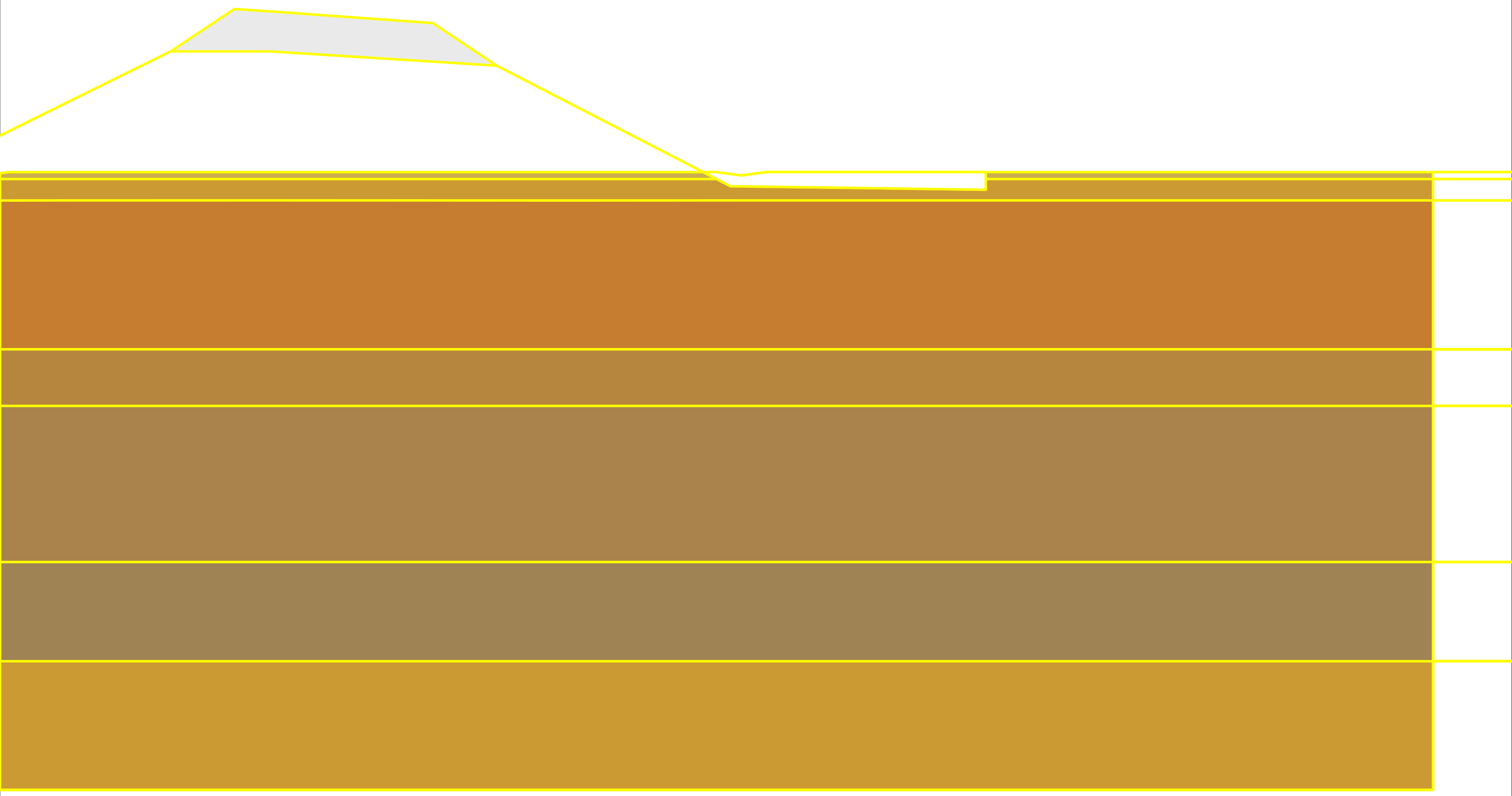
INPUT DATA – EMBANKMENT LAYERS -- 2 layers

	Wet Unit Weight, γ [lb/ft³]	**Description of Soil**
1	65.00	Solite
2	130.00	Surcharge

INPUT DATA OF WATER

Point #	**Coordinates (X, Z) : (X) [ft.]**	**(Z) [ft.]**
1	0.00	10.00
2	1000.00	10.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION -- $\alpha = 1/2$

Layer # Underging Consolidation [Yes/No]		OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :	PVD through Layer No/Yes	Ch=Coeff. for horiz. drainage [ft ²/day]
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	Yes	0.2153
3	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	Yes	0.2153
5	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	No	0.2153
7	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

PVD : Triangle Pattern where D = 1.05 x 5.00 = 5.25 ft.
dw = 2 x (a + b) / 3.14 = 2.607 inch --> F(n) = 2.44. Fs for disturbance = 0.000
and Fr' = 0.050

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	75.00	0.00	1	500000	0.3000	0.0000	9.50	9.48	0.02
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0055			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0100			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
2	78.37	0.00	1	500000	0.3000	0.0000	10.88	10.86	0.02
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0057			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0118			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
3	81.73	0.00	1	500000	0.3000	0.0000	12.85	12.83	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0059			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0137			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
4	85.10	0.00	1	500000	0.3000	0.0002	13.52	13.49	0.02
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0073			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0158			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
5	88.47	0.00	1	500000	0.3000	0.0005	14.00	13.97	0.03
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0093			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0181			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
6	91.84	0.00	1	500000	0.3000	0.0007	14.00	13.97	0.03
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0119			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0206			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
7	95.20	0.00	1	500000	0.3000	0.0008	14.00	13.96	0.04
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0148			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0232			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
8	98.57	0.00	1	500000	0.3000	0.0010	14.00	13.96	0.04
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0179			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0260			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
9	101.94	0.00	1	500000	0.3000	0.0012	14.00	13.95	0.05
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0212			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0288			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
10	105.31	0.00	1	500000	0.3000	0.0014	14.00	13.94	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0247			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0317			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
11	108.67	0.00	1	500000	0.3000	0.0015	14.00	13.94	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0287			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0346			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
12	112.04	0.00	1	500000	0.3000	0.0019	14.00	13.93	0.07
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0337			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0373			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
13	115.41	0.00	1	500000	0.3000	0.0024	14.00	13.92	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0399			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0398			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
14	118.78	0.00	1	500000	0.3000	0.0028	14.00	13.91	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0457			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0420			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
15	122.14	0.00	1	500000	0.3000	0.0030	14.00	13.90	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0488			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0437			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
16	125.51	0.00	1	500000	0.3000	0.0030	14.00	13.90	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0497			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0450			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
17	128.88	0.00	1	500000	0.3000	0.0029	14.00	13.90	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0499			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0458			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
18	132.24	0.00	1	500000	0.3000	0.0029	14.00	13.90	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0497			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0461			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
19	135.61	0.00	1	500000	0.3000	0.0028	14.00	13.90	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0492			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0457			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
20	138.98	0.00	1	500000	0.3000	0.0028	14.00	13.90	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0484			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0449			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
21	142.35	0.00	1	500000	0.3000	0.0028	14.00	13.91	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0473			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0435			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
22	145.71	0.00	1	500000	0.3000	0.0028	14.00	13.91	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0455			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0416			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
23	149.08	0.00	1	500000	0.3000	0.0026	14.00	13.92	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0419			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0393			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
24	152.45	0.00	1	500000	0.3000	0.0021	14.00	13.93	0.07
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0362			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0367			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
25	155.82	0.00	1	500000	0.3000	0.0017	14.00	13.93	0.07
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0300			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0338			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
26	159.18	0.00	1	500000	0.3000	0.0013	14.00	13.94	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0250			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0307			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
27	162.55	0.00	1	500000	0.3000	0.0012	14.00	13.95	0.05
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0209			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0275			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
28	165.92	0.00	1	500000	0.3000	0.0010	14.00	13.96	0.04
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0173			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0242			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
29	169.29	0.00	1	500000	0.3000	0.0008	14.00	13.96	0.04
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0138			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0211			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
30	172.65	0.00	1	500000	0.3000	0.0006	14.00	13.97	0.03
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0105			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0181			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
31	176.02	0.00	1	500000	0.3000	0.0004	14.00	13.98	0.02
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0074			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0152			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
32	179.39	0.00	1	500000	0.3000	0.0003	14.00	13.98	0.02
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0044			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0126			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
33	182.76	0.00	1	500000	0.3000	0.0001	14.00	13.99	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0016			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0102			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
34	186.12	0.00	1	500000	0.3000	-0.0001	14.00	13.99	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0006			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0080			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
35	189.49	0.00	1	500000	0.3000	-0.0001	13.79	13.78	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0015			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0062			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
36	192.86	0.00	1	500000	0.3000	-0.0001	13.69	13.69	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0018			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0046			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
37	196.22	0.00	1	500000	0.3000	-0.0001	14.00	14.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0019			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0032			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
38	199.59	0.00	1	500000	0.3000	-0.0000	14.00	14.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0019			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0021			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
39	202.96	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0018			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0012			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
40	206.33	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0017			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0004			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
41	209.69	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0016			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0001			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
42	213.06	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0014			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0006			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
43	216.43	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0013			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0010			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
44	219.80	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0012			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0012			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
45	223.16	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0011			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0015			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
46	226.53	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0010			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0016			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
47	229.90	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0009			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0017			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
48	233.27	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0009			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0018			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
49	236.63	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0008			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0018			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
50	240.00	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0007			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0019			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	75.00	0.00	9.50	0.02	9.48
2	78.37	0.00	10.88	0.08	10.80
3	81.73	0.00	12.85	0.06	12.78
4	85.10	0.00	13.52	0.05	13.46
5	88.47	0.00	14.00	0.05	13.95
6	91.84	0.00	14.00	0.08	13.92
7	95.20	0.00	14.00	0.10	13.90
8	98.57	0.00	14.00	0.12	13.88
9	101.94	0.00	14.00	0.14	13.86
10	105.31	0.00	14.00	0.17	13.83
11	108.67	0.00	14.00	0.21	13.79
12	112.04	0.00	14.00	0.25	13.75
13	115.41	0.00	14.00	0.29	13.71
14	118.78	0.00	14.00	0.33	13.67
15	122.14	0.00	14.00	0.35	13.65
16	125.51	0.00	14.00	0.36	13.64
17	128.88	0.00	14.00	0.36	13.64
18	132.24	0.00	14.00	0.36	13.64
19	135.61	0.00	14.00	0.36	13.64
20	138.98	0.00	14.00	0.35	13.65
21	142.35	0.00	14.00	0.34	13.66
22	145.71	0.00	14.00	0.33	13.67
23	149.08	0.00	14.00	0.30	13.70
24	152.45	0.00	14.00	0.26	13.74
25	155.82	0.00	14.00	0.21	13.79

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
26	159.18	0.00	14.00	0.17	13.83
27	162.55	0.00	14.00	0.14	13.86
28	165.92	0.00	14.00	0.11	13.89
29	169.29	0.00	14.00	0.09	13.91
30	172.65	0.00	14.00	0.07	13.93
31	176.02	0.00	14.00	0.04	13.96
32	179.39	0.00	14.00	0.03	13.97
33	182.76	0.00	14.00	0.02	13.98
34	186.12	0.00	14.00	0.02	13.98
35	189.49	0.00	13.79	0.01	13.77
36	192.86	0.00	13.69	0.01	13.68
37	196.22	0.00	14.00	0.01	13.99
38	199.59	0.00	14.00	0.01	13.99
39	202.96	0.00	14.00	0.01	13.99
40	206.33	0.00	14.00	0.01	13.99
41	209.69	0.00	14.00	0.01	13.99
42	213.06	0.00	14.00	0.00	14.00
43	216.43	0.00	14.00	0.00	14.00
44	219.80	0.00	14.00	0.00	14.00
45	223.16	0.00	14.00	0.00	14.00
46	226.53	0.00	14.00	0.00	14.00
47	229.90	0.00	14.00	0.00	14.00
48	233.27	0.00	14.00	0.00	14.00
49	236.63	0.00	14.00	0.00	14.00
50	240.00	0.00	14.00	0.00	14.00

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	65.00	9.50	Layer 1 Existing Fill
	2	76.00	9.50	
	3	82.00	13.00	
	4	88.00	14.00	
	5	188.00	14.00	
	6	191.50	13.50	
	7	195.00	14.00	
	8	1000.00	14.00	
2	1	65.00	9.50	Layer 2 Upper Clay
	2	76.00	9.50	
	3	82.00	13.00	
	4	88.00	13.00	
	5	188.00	13.00	
	6	191.50	13.00	
	7	195.00	13.00	
	8	1000.00	13.00	
3	1	65.00	9.50	Layer 3 Upper Sand
	2	76.00	9.50	
	3	82.50	10.00	
	4	122.00	10.00	
	5	1000.00	10.00	
4	1	0.00	-11.00	Layer 4 Upper Clay
	2	1000.00	-11.00	
5	1	0.00	-19.00	Layer 5 Lower Sand
	2	1000.00	-19.00	
6	1	0.00	-41.00	Layer 6 Lower Clay
	2	1000.00	-41.00	
7	1	0.00	-55.00	Layer 7 Yorktown
	2	1000.00	-55.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 65.00 [ft]	1	65.00	17.50	Proposed Fill
	X2 = 226.00 [ft]	2	74.50	13.00	
		3	111.00	31.00	
		4	125.00	31.00	
		5	157.00	29.00	
		6	190.00	12.00	
		7	226.00	11.50	
2	X1 = 65.00 [ft]	1	65.00	17.50	Surcharge
	X2 = 226.00 [ft]	2	74.50	13.00	
		3	111.00	31.00	
		4	120.00	37.00	
		5	148.00	35.00	
		6	157.00	29.00	
		7	190.00	12.00	
		8	226.00	11.50	

```
                  NTLB 12+00 with solite and 6' surcharge_90 days
    Results of Condolidation After 90.0 days.   (With PVD's)
  ======================================================================

------------------------------------------------------------------------------------
-
   Layer         PVD installed         Uv        Uh        Uave.   Sc-ult     Sc(t)
 Undergoing      Through Layer:
Consolidation
    NO / YES         NO / YES          [%]       [%]        [%]     [ft]      [ft]
------------------------------------------------------------------------------------
-
   1    NO             N/A              N/A       N/A       N/A       N/A       N/A
   2   YES             YES              0.00     88.91     88.91     0.000     0.000
   3    NO             N/A              N/A       N/A       N/A       N/A       N/A
   4   YES             YES             81.28     88.91     97.92     0.000     0.000
   5    NO             N/A              N/A       N/A       N/A       N/A       N/A
   6   YES              NO             57.24      0.00     57.24     0.002     0.001
   7    NO             N/A              N/A       N/A       N/A       N/A       N/A
```

```
                  NTLB 12+00 with solite and 6' surcharge_120 days
    Results of Condolidation After 120.0 days.   (With PVD's)
  ======================================================================

------------------------------------------------------------------------------------
-
   Layer         PVD installed        Uv        Uh        Uave.   Sc-ult     Sc(t)
 Undergoing      Through Layer:
Consolidation
    NO / YES         NO / YES         [%]       [%]        [%]     [ft]      [ft]
------------------------------------------------------------------------------------
-
   1    NO             N/A              N/A       N/A       N/A       N/A       N/A
   2   YES             YES              0.00     94.67     94.67     0.000     0.000
   3    NO             N/A              N/A       N/A       N/A       N/A       N/A
   4   YES             YES             88.82     94.67     99.40     0.000     0.000
   5    NO             N/A              N/A       N/A       N/A       N/A       N/A
   6   YES              NO             65.49      0.00     65.49     0.002     0.001
   7    NO             N/A              N/A       N/A       N/A       N/A       N/A
```

Estimation of Secondary Settlement

Project Name:	**I-264 Witchduck - Newtown Loop B STA 12+00 with Solite**
Date:	1/9/2017
Calculated by:	AW
Checked by:	

Project Life = **20** **years**

CASE II: Surcharge

Height of surcharge = **6** **feet**

Surcharge unit weight = **130** **pcf** (if surcharge placed below water, enter bouyant unit weight)

S No.	Clay Layer	Thickness (ft)	C_α' (NC, strain based)	t_{90} [3] (years)	Final Effective stress at layer midpoint[4] (psf)	Effective stress decrease due to surcharge removal (psf)	AAOS[5]	C_α' (surcharge)/ C_α' (NC) [6]	C_α' (surcharge)[6]	Secondary Settlement (ft)
1	UC-1	3	0.003	0.25	1410	780	55%	-0.04	0.0000	0.00
2	UC	8	0.003	0.25	2893	780	27%	0.30	0.0009	0.01
3	LC	14	0.0003	0.25	4857.8	780	16%	0.54	0.0002	0.00

TOTAL SECONDARY SETTLEMENT = **0.02 ft**
or
0.21 in

Notes

1 C_α' (NC, strain based) is the coefficient of secondary settlement without the effect of oversolidation or surcharge.

2 t_{90} is the time to complete 90% primary consolidation.

3 t_{90} with surcharge might be less due to the use of wick drains.

4 The "final effective stress at layer mid point" is the effective stress after the removal of the surcharge.

5 AAOS is the Adjusted Amount of Surcharge, which is the effective stress reduction caused by surcharge removal.
It is calculated as stress decrease due to surcharge removal divided by final effective stress at the depth of interest.

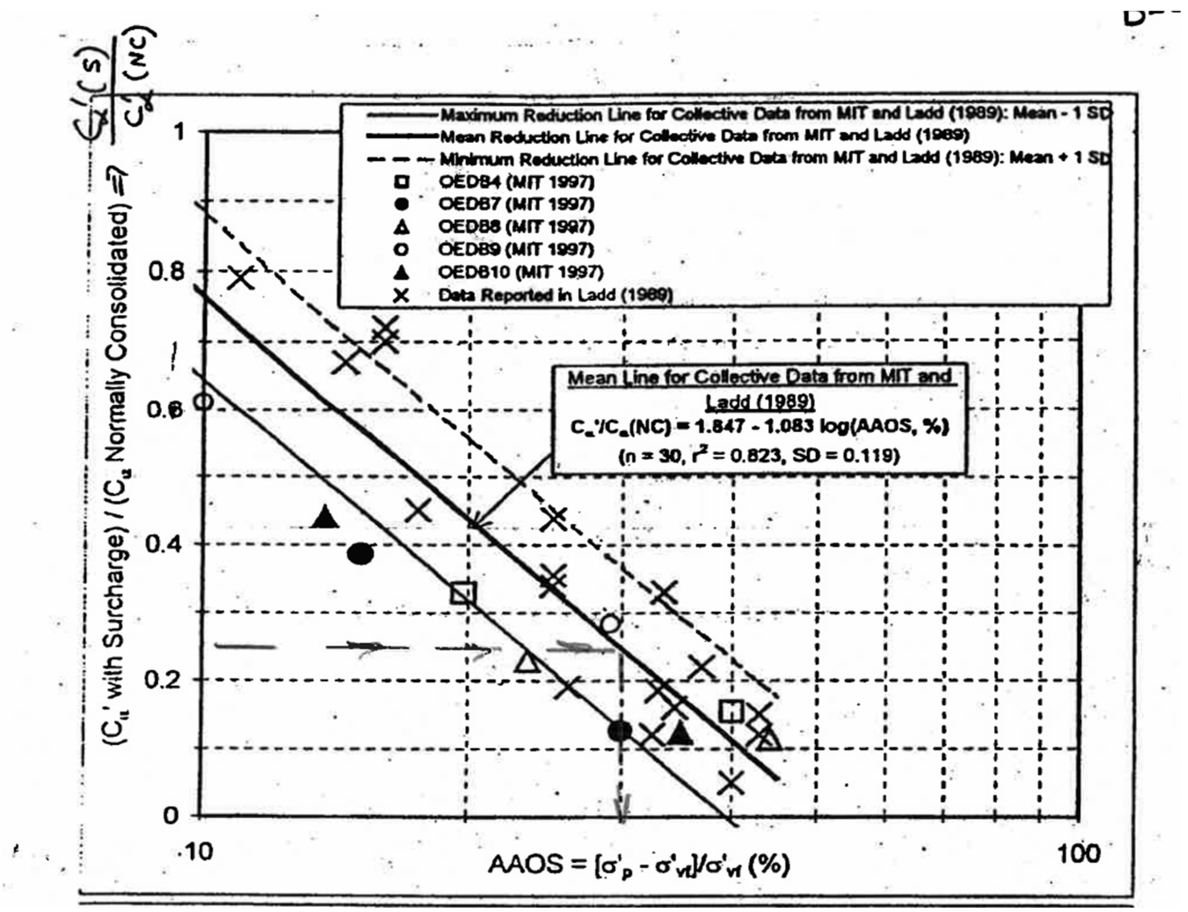
6 C_α' (surcharge) is the reduced coefficient of secondary settlement due to the application of surcharge.
This is estimated based on Ladd (1989) correlation shown in page 2.

7 Secondary settlement was calculated using the following equation:

$$S_{sec} = H.C'_{\propto}.\log(\frac{t_{project\ life}}{t_{90}})$$

8 It is assumed that surcharge, if placed, will be removed at 90% primary consolidation.

Ladd, 1989



Cα'(s) / Cα'(NC) ⇒
Maximum Reduction Line for Collective Data from MIT and Ladd (1989): Mean - 1 SD
Mean Reduction Line for Collective Data from MIT and Ladd (1989)
Minimum Reduction Line for Collective Data from MIT and Ladd (1989): Mean + 1 SD
□ OEDB4 (MIT 1997)
● OEDB7 (MIT 1997)
△ OEDB8 (MIT 1997)
○ OEDB9 (MIT 1997)
▲ OEDB10 (MIT 1997)
× Data Reported in Ladd (1989)
Mean Line for Collective Data from MIT and Ladd (1989)
$C_\alpha'/C_\alpha(NC) = 1.847 - 1.083 \log(AAOS, \%)$
($n = 30$, $r^2 = 0.823$, SD = 0.119)
$(C_\alpha'$ with Surcharge$) / (C_\alpha$ Normally Consolidated$)$
1
0.8
0.6
0.4
0.2
0
10
100
$AAOS = [\sigma'_p - \sigma'_{vf}]/\sigma'_{vf}$ (%)

I-264 Witchduck NTLB STA 12+00

PROJECT IDENTIFICATION

Title: I-264 Witchduck NTLB STA 12+00
Project Number: -
Client:
Designer: AW
Station Number:

Description:
Newtown Loop B STA 12+00 with 6' surcharge + PVD

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... A 12+00.00_right side with 6ft surcharge + PVD.2ST
Original date and time of creating this file: Sat Jan 07 17:25:16 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 7 layers

	Wet Unit Weight, γ [lb/ft³]	**Poisson's Ratio μ**	**Description of Soil**
1	125.00	0.30	Layer 1 Existing Fill
2	120.00	0.50	Layer 2 Upper Clay
3	115.00	0.30	Layer 3 Upper Sand
4	112.00	0.50	Layer 4 Upper Clay
5	125.00	0.30	Layer 5 Lower Sand
6	118.00	0.50	Layer 6 Lower Clay
7	125.00	0.30	Layer 7 Yorktown

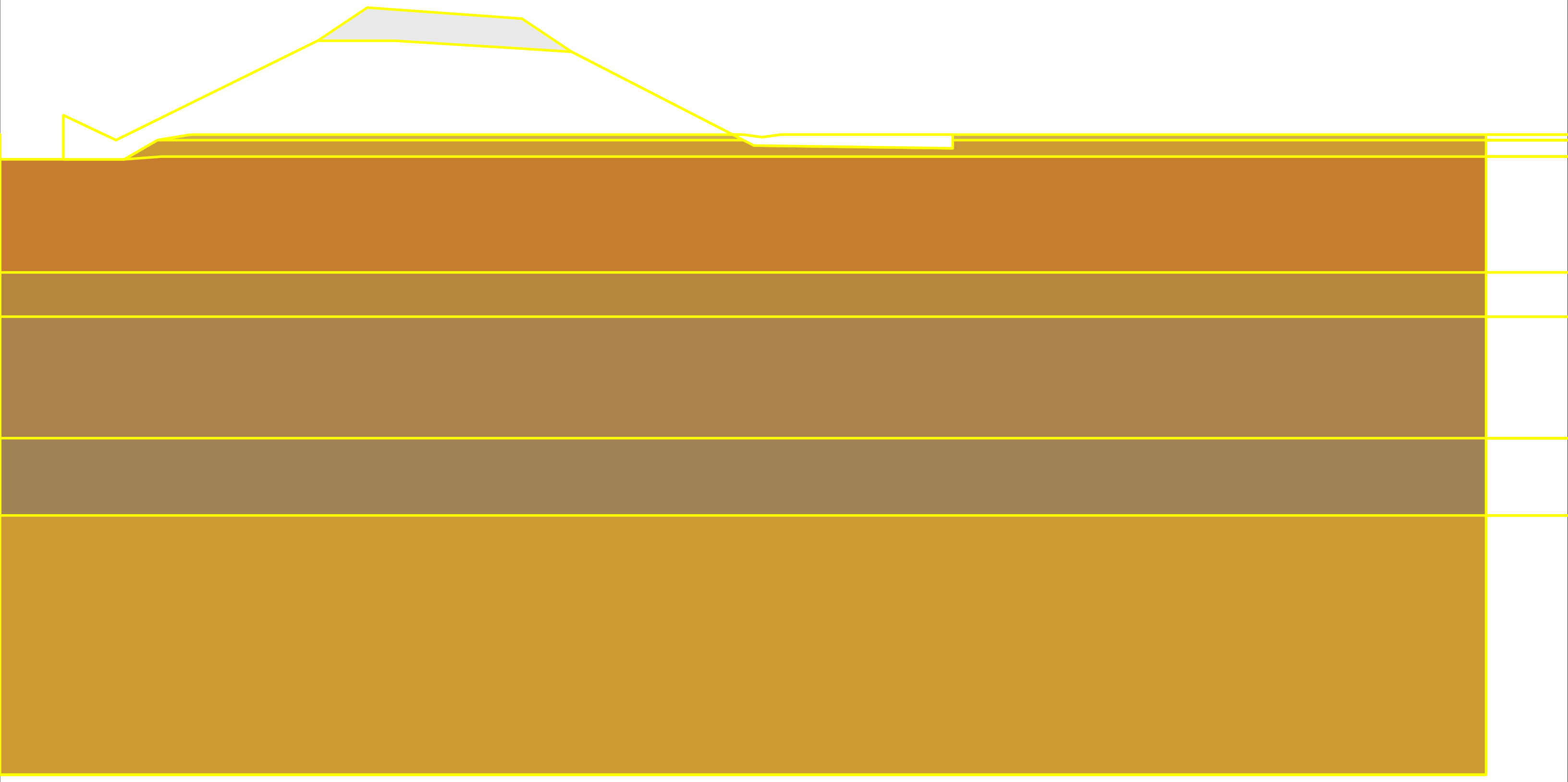
INPUT DATA – EMBANKMENT LAYERS -- 2 layers

	Wet Unit Weight, γ [lb/ft³]	**Description of Soil**
1	130.00	Proposed Fill
2	130.00	Surcharge

INPUT DATA OF WATER

Point #	**Coordinates (X, Z) : (X) [ft.]**	**(Z) [ft.]**
1	0.00	10.00
2	1000.00	10.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– α = 1/2

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :	PVD through Layer No/Yes	Ch=Coeff. for horiz. drainage [ft ²/day]
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	Yes	0.2153
3	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	Yes	0.2153
5	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	No	0.2153
7	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

PVD : Triangle Pattern where D = 1.05 x 5.00 = 5.25 ft.
dw = 2 x (a + b) / 3.14 = 2.607 inch --> F(n) = 2.44. Fs for disturbance = 0.000
and Fr' = 0.050

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	70.00	0.00	1	500000	0.3000	0.0000	9.50	9.47	0.03
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0132			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0153			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
2	73.27	0.00	1	500000	0.3000	0.0000	9.50	9.47	0.03
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0119			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0181			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
3	76.53	0.00	1	500000	0.3000	0.0000	9.81	9.78	0.03
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0115			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0211			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
4	79.80	0.00	1	500000	0.3000	0.0000	11.71	11.68	0.04
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0118			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0243			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
5	83.06	0.00	1	500000	0.3000	0.0000	13.18	13.14	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0133			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0278			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
6	86.33	0.00	1	500000	0.3000	0.0006	13.72	13.67	0.05
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0165			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0315			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
7	89.59	0.00	1	500000	0.3000	0.0011	14.00	13.94	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0208			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0355			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
8	92.86	0.00	1	500000	0.3000	0.0015	14.00	13.93	0.07
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0261			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0397			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
9	96.12	0.00	1	500000	0.3000	0.0018	14.00	13.92	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0318			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0441			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
10	99.39	0.00	1	500000	0.3000	0.0022	14.00	13.91	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0378			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0486			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
11	102.65	0.00	1	500000	0.3000	0.0025	14.00	13.90	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0438			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0531			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
12	105.92	0.00	1	500000	0.3000	0.0029	14.00	13.89	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0500			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0574			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
13	109.18	0.00	1	500000	0.3000	0.0032	14.00	13.88	0.12
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0564			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0616			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
14	112.45	0.00	1	500000	0.3000	0.0036	14.00	13.87	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0630			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0655			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
15	115.71	0.00	1	500000	0.3000	0.0041	14.00	13.86	0.14
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0697			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0690			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
16	118.98	0.00	1	500000	0.3000	0.0046	14.00	13.85	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0756			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0719			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
17	122.24	0.00	1	500000	0.3000	0.0047	14.00	13.84	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0785			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0742			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
18	125.51	0.00	1	500000	0.3000	0.0047	14.00	13.84	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0793			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0758			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
19	128.78	0.00	1	500000	0.3000	0.0046	14.00	13.84	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0792			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0768			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
20	132.04	0.00	1	500000	0.3000	0.0045	14.00	13.84	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0787			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0770			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
21	135.31	0.00	1	500000	0.3000	0.0045	14.00	13.84	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0779			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0765			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
22	138.57	0.00	1	500000	0.3000	0.0044	14.00	13.84	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0768			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0752			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
23	141.84	0.00	1	500000	0.3000	0.0044	14.00	13.85	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0754			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0733			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
24	145.10	0.00	1	500000	0.3000	0.0044	14.00	13.85	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0734			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0707			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
25	148.37	0.00	1	500000	0.3000	0.0042	14.00	13.86	0.14
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0700			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0675			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
26	151.63	0.00	1	500000	0.3000	0.0038	14.00	13.87	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0640			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0637			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
27	154.90	0.00	1	500000	0.3000	0.0033	14.00	13.88	0.12
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0571			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0595			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
28	158.16	0.00	1	500000	0.3000	0.0029	14.00	13.89	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0502			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0549			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
29	161.43	0.00	1	500000	0.3000	0.0025	14.00	13.90	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0436			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0500			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
30	164.69	0.00	1	500000	0.3000	0.0021	14.00	13.92	0.08
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0371			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0450			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
31	167.96	0.00	1	500000	0.3000	0.0018	14.00	13.93	0.07
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0307			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0399			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
32	171.22	0.00	1	500000	0.3000	0.0014	14.00	13.94	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0244			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0349			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
33	174.49	0.00	1	500000	0.3000	0.0011	14.00	13.95	0.05
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0182			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0300			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
34	177.76	0.00	1	500000	0.3000	0.0007	14.00	13.96	0.04
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0122			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0253			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
35	181.02	0.00	1	500000	0.3000	0.0003	14.00	13.97	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0065			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0210			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
36	184.29	0.00	1	500000	0.3000	-0.0000	14.00	13.98	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0016			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0170			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
37	187.55	0.00	1	500000	0.3000	-0.0002	14.00	13.99	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0016			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0135			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
38	190.82	0.00	1	500000	0.3000	-0.0001	13.60	13.59	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0029			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0104			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
39	194.08	0.00	1	500000	0.3000	-0.0001	13.87	13.86	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0034			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0077			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
40	197.35	0.00	1	500000	0.3000	-0.0001	14.00	14.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0035			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0055			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
41	200.61	0.00	1	500000	0.3000	-0.0001	14.00	14.00	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0034			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0036			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
42	203.88	0.00	1	500000	0.3000	-0.0001	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0032			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0020			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
43	207.14	0.00	1	500000	0.3000	-0.0001	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0030			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0008			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
44	210.41	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0028			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0002			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
45	213.67	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0026			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0010			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
46	216.94	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0024			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0016			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
47	220.20	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0022			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0021			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
48	223.47	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0021			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0025			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
49	226.73	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0019			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0028			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
50	230.00	0.00	1	500000	0.3000	-0.0000	14.00	14.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0018			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0030			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	70.00	0.00	9.50	0.03	9.47
2	73.27	0.00	9.50	0.04	9.46
3	76.53	0.00	9.81	0.10	9.71
4	79.80	0.00	11.71	0.15	11.57
5	83.06	0.00	13.18	0.15	13.03
6	86.33	0.00	13.72	0.15	13.57
7	89.59	0.00	14.00	0.19	13.81
8	92.86	0.00	14.00	0.24	13.76
9	96.12	0.00	14.00	0.29	13.71
10	99.39	0.00	14.00	0.34	13.66
11	102.65	0.00	14.00	0.38	13.62
12	105.92	0.00	14.00	0.43	13.57
13	109.18	0.00	14.00	0.47	13.53
14	112.45	0.00	14.00	0.50	13.50
15	115.71	0.00	14.00	0.54	13.46
16	118.98	0.00	14.00	0.57	13.43
17	122.24	0.00	14.00	0.58	13.42
18	125.51	0.00	14.00	0.59	13.41
19	128.78	0.00	14.00	0.59	13.41
20	132.04	0.00	14.00	0.59	13.41
21	135.31	0.00	14.00	0.59	13.41
22	138.57	0.00	14.00	0.58	13.42
23	141.84	0.00	14.00	0.57	13.43
24	145.10	0.00	14.00	0.55	13.45
25	148.37	0.00	14.00	0.53	13.47

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

Version 2.0 FoSSA Version 2.0

I-264 Witchduck NTLB STA 12+00
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ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
26	151.63	0.00	14.00	0.50	13.50
27	154.90	0.00	14.00	0.46	13.54
28	158.16	0.00	14.00	0.42	13.58
29	161.43	0.00	14.00	0.37	13.63
30	164.69	0.00	14.00	0.32	13.68
31	167.96	0.00	14.00	0.27	13.73
32	171.22	0.00	14.00	0.21	13.79
33	174.49	0.00	14.00	0.15	13.85
34	177.76	0.00	14.00	0.10	13.90
35	181.02	0.00	14.00	0.05	13.95
36	184.29	0.00	14.00	0.03	13.97
37	187.55	0.00	14.00	0.02	13.98
38	190.82	0.00	13.60	0.02	13.58
39	194.08	0.00	13.87	0.02	13.85
40	197.35	0.00	14.00	0.01	13.99
41	200.61	0.00	14.00	0.01	13.99
42	203.88	0.00	14.00	0.01	13.99
43	207.14	0.00	14.00	0.01	13.99
44	210.41	0.00	14.00	0.01	13.99
45	213.67	0.00	14.00	0.01	13.99
46	216.94	0.00	14.00	0.01	13.99
47	220.20	0.00	14.00	0.01	13.99
48	223.47	0.00	14.00	0.01	13.99
49	226.73	0.00	14.00	0.00	14.00
50	230.00	0.00	14.00	0.00	14.00

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	D E S C R I P T I O N
1	1	65.00	9.50	Layer 1 Existing Fill
	2	76.00	9.50	
	3	82.00	13.00	
	4	88.00	14.00	
	5	188.00	14.00	
	6	191.50	13.50	
	7	195.00	14.00	
	8	1000.00	14.00	
2	1	65.00	9.50	Layer 2 Upper Clay
	2	76.00	9.50	
	3	82.00	13.00	
	4	88.00	13.00	
	5	188.00	13.00	
	6	191.50	13.00	
	7	195.00	13.00	
	8	1000.00	13.00	
3	1	65.00	9.50	Layer 3 Upper Sand
	2	76.00	9.50	
	3	82.50	10.00	
	4	122.00	10.00	
	5	1000.00	10.00	
4	1	0.00	-11.00	Layer 4 Upper Clay
	2	1000.00	-11.00	
5	1	0.00	-19.00	Layer 5 Lower Sand
	2	1000.00	-19.00	
6	1	0.00	-41.00	Layer 6 Lower Clay
	2	1000.00	-41.00	
7	1	0.00	-55.00	Layer 7 Yorktown
	2	1000.00	-55.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 65.00 [ft]	1	65.00	17.50	Proposed Fill
	X2 = 226.00 [ft]	2	74.50	13.00	
		3	111.00	31.00	
		4	125.00	31.00	
		5	157.00	29.00	
		6	190.00	12.00	
		7	226.00	11.50	
2	X1 = 65.00 [ft]	1	65.00	17.50	Surcharge
	X2 = 226.00 [ft]	2	74.50	13.00	
		3	111.00	31.00	
		4	120.00	37.00	
		5	148.00	35.00	
		6	157.00	29.00	
		7	190.00	12.00	
		8	226.00	11.50	

```
                        NTLB 12+00 with 6' surcharge_90 days
    Results of Condolidation After 90.0 days.   (With PVD's)
  ======================================================================

------------------------------------------------------------------------------------
-
   Layer         PVD installed         Uv        Uh        Uave.   Sc-ult     Sc(t)
 Undergoing      Through Layer:
Consolidation
    NO / YES         NO / YES          [%]       [%]        [%]     [ft]      [ft]
------------------------------------------------------------------------------------
-
   1    NO             N/A              N/A       N/A       N/A       N/A       N/A
   2   YES             YES              0.00     88.91     88.91     0.000     0.000
   3    NO             N/A              N/A       N/A       N/A       N/A       N/A
   4   YES             YES             81.28     88.91     97.92     0.001     0.001
   5    NO             N/A              N/A       N/A       N/A       N/A       N/A
   6   YES              NO             57.23      0.00     57.23     0.003     0.002
   7    NO             N/A              N/A       N/A       N/A       N/A       N/A
```

```
                         NTLB 12+00 with 6' surcharge_120 days
    Results of Condolidation After 120.0 days.   (With PVD's)
  ======================================================================

-----------------------------------------------------------------------------------
-
   Layer         PVD installed        Uv        Uh        Uave.   Sc-ult     Sc(t)
 Undergoing      Through Layer:
Consolidation
    NO / YES         NO / YES         [%]       [%]        [%]     [ft]      [ft]
-----------------------------------------------------------------------------------
-
   1    NO            N/A              N/A       N/A       N/A       N/A       N/A
   2   YES            YES              0.00     94.67     94.67     0.000     0.000
   3    NO            N/A             N/A       N/A       N/A       N/A       N/A
   4   YES            YES             88.82     94.67     99.40     0.001     0.001
   5    NO            N/A             N/A       N/A       N/A       N/A       N/A
   6   YES             NO             65.48      0.00     65.48     0.003     0.002
   7    NO            N/A              N/A       N/A       N/A       N/A       N/A
```

Estimation of Secondary Settlement

Project Name:	**I-264 Witchduck - Newtown Loop B STA 12+00**
Date:	1/9/2017
Calculated by:	AW
Checked by:	

Project Life = **20** **years**

CASE II: Surcharge

Height of surcharge = **6** **feet**

Surcharge unit weight = **130** **pcf** (if surcharge placed below water, enter bouyant unit weight)

S No.	Clay Layer	Thickness (ft)	C_α' (NC, strain based)	t_{90} [3] (years)	Final Effective stress at layer midpoint[4] (psf)	Effective stress decrease due to surcharge removal (psf)	AAOS[5]	C_α' (surcharge)/ C_α' (NC) [6]	C_α' (surcharge)[6]	Secondary Settlement (ft)
1	UC-1	3	0.003	0.25	2515	780	31%	0.23	0.0007	0.00
2	UC	8	0.003	0.25	3998	780	20%	0.45	0.0013	0.02
3	LC	14	0.0003	0.25	5962.8	780	13%	0.64	0.0002	0.01

TOTAL SECONDARY SETTLEMENT = **0.03 ft**

or

0.36 in

Notes

1 C_α' (NC, strain based) is the coefficient of secondary settlement without the effect of oversolidation or surcharge.

2 t_{90} is the time to complete 90% primary consolidation.

3 t_{90} with surcharge might be less due to the use of wick drains.

4 The "final effective stress at layer mid point" is the effective stress after the removal of the surcharge.

5 AAOS is the Adjusted Amount of Surcharge, which is the effective stress reduction caused by surcharge removal.
It is calculated as stress decrease due to surcharge removal divided by final effective stress at the depth of interest.

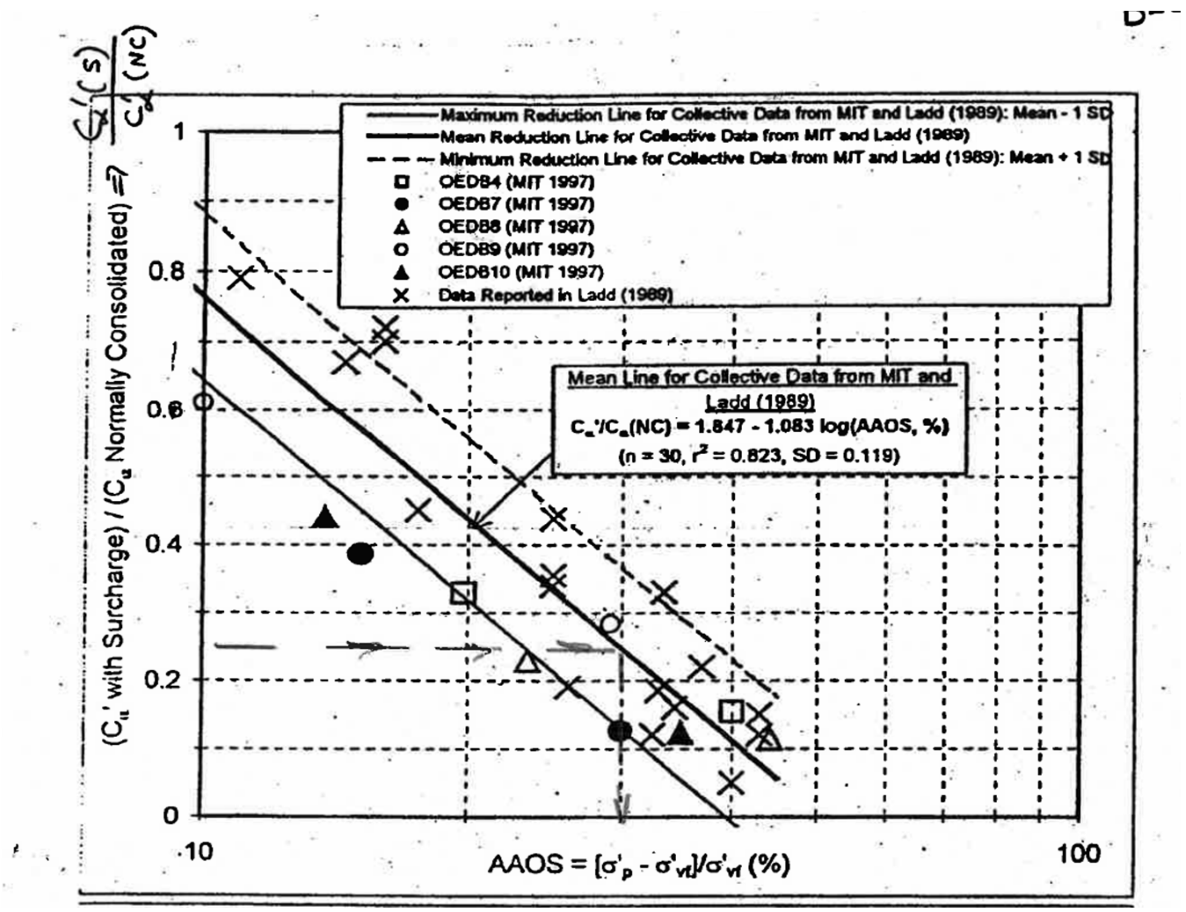
6 C_α' (surcharge) is the reduced coefficient of secondary settlement due to the application of surcharge.
This is estimated based on Ladd (1989) correlation shown in page 2.

7 Secondary settlement was calculated using the following equation:

$$S_{sec} = H.C'_{\propto}.\log(\frac{t_{project\ life}}{t_{90}})$$

8 It is assumed that surcharge, if placed, will be removed at 90% primary consolidation.

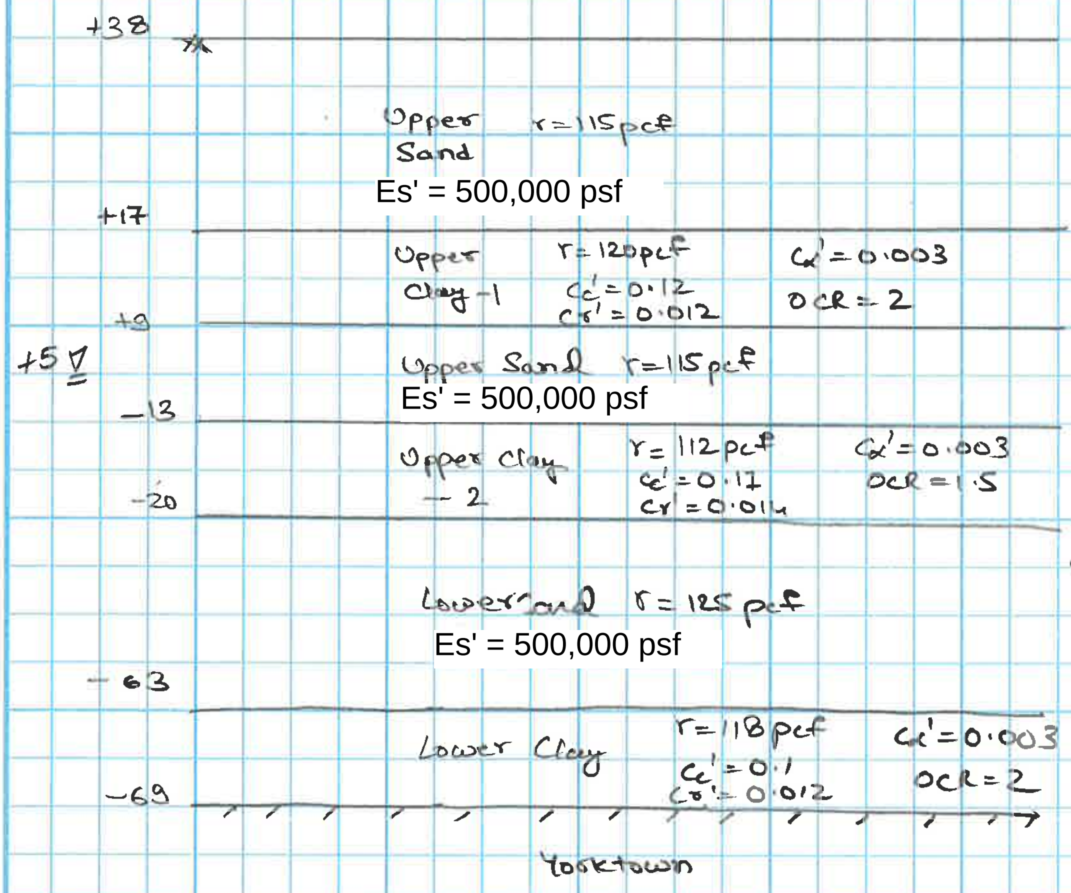
Ladd, 1989

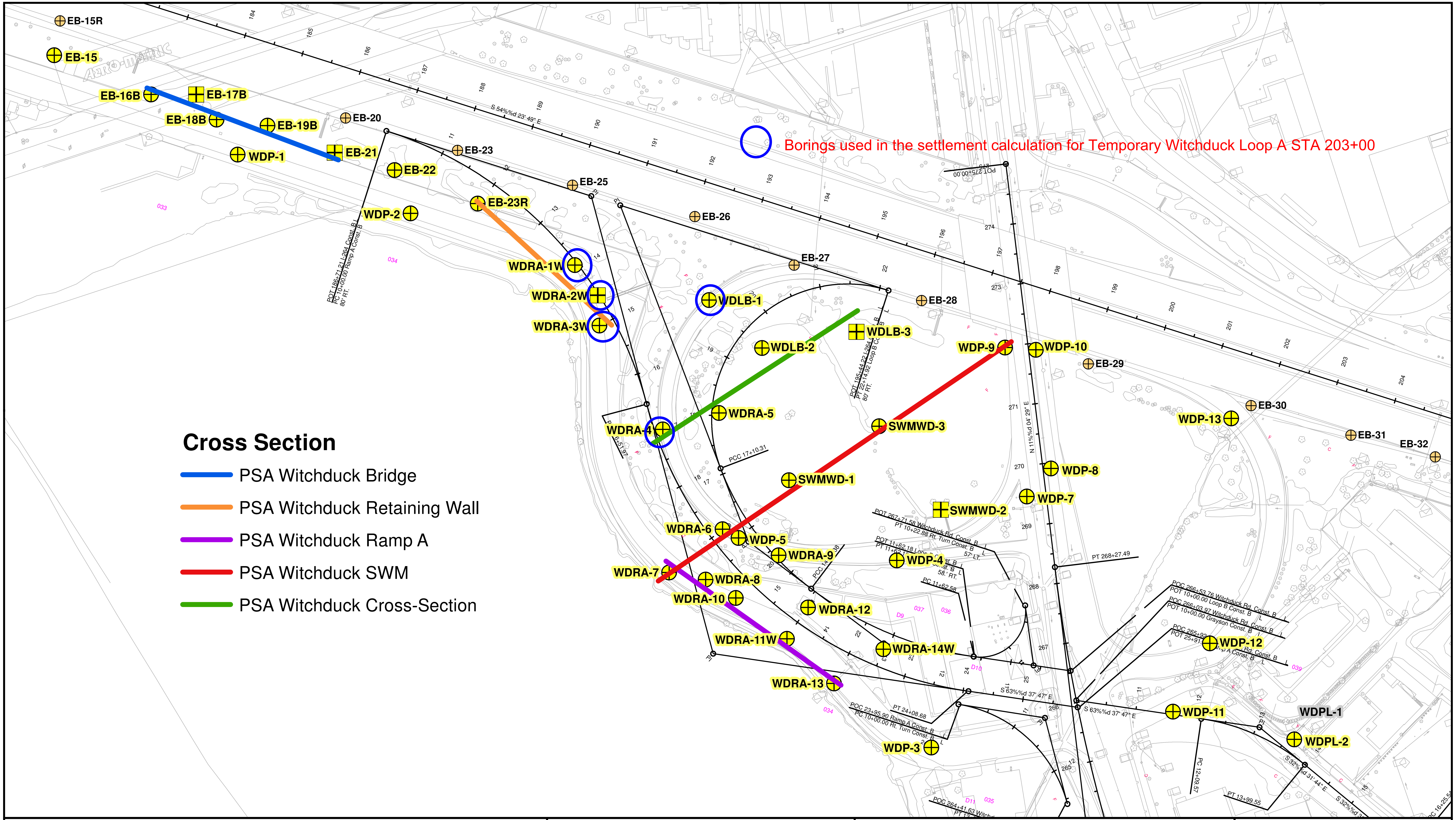

Maximum Reduction Line for Collective Data from MIT and Ladd (1989): Mean - 1 SD
Mean Reduction Line for Collective Data from MIT and Ladd (1989)
Minimum Reduction Line for Collective Data from MIT and Ladd (1989): Mean + 1 SD
□ OEDB4 (MIT 1997)
● OEDB7 (MIT 1997)
△ OEDB8 (MIT 1997)
○ OEDB9 (MIT 1997)
▲ OEDB10 (MIT 1997)
× Data Reported in Ladd (1989)
Mean Line for Collective Data from MIT and Ladd (1989)
$C_\alpha'/C_\alpha(NC) = 1.847 - 1.083 \log(AAOS, \%)$
$(n = 30, r^2 = 0.823, SD = 0.119)$
$(C_\alpha'$ with Surcharge) / $(C_\alpha$ Normally Consolidated) ⇒
$\frac{C_\alpha'(s)}{C_\alpha'(NC)}$
1
0.8
0.6
0.4
0.2
0
10
100
AAOS = $[\sigma'_p - \sigma'_{vf}]/\sigma'_{vf}$ (%)

Page ____ of ____
Sheet ____ of ____

Job 1-264 W.duck
Project No.
Description STA 203+00 Temp Witchduck On Ramp A
Computed by AS
Date 1/7/17
Checked by
Date

Reference





N

0 75 150 Feet

Scale: 1" = 150'

⊕ SPT Exploration

⊞ CPT Exploration

⊕ PSA I-264 CD Borings

Prepared by: HDR

Date: February 13, 2013

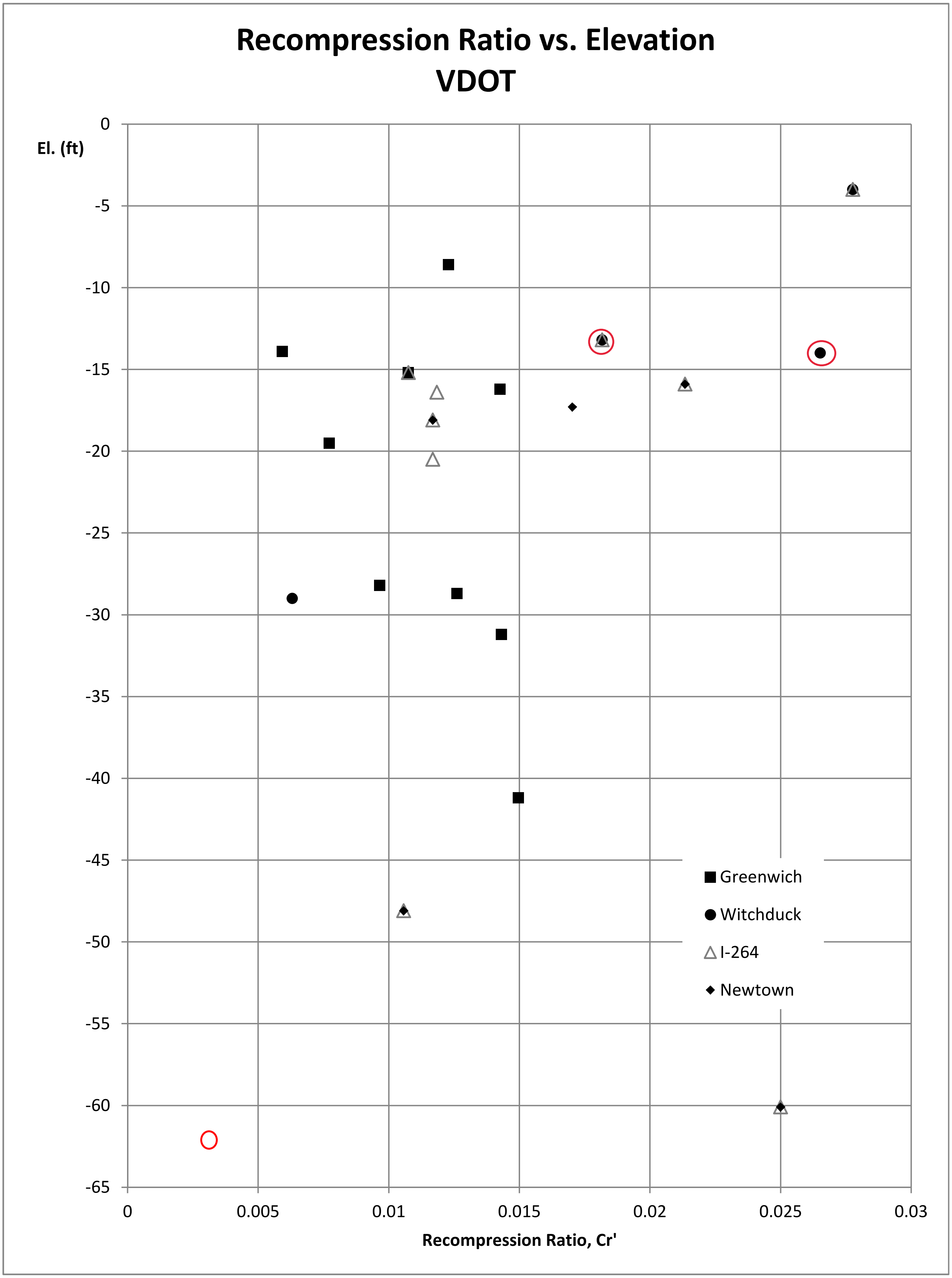
VDOT Virginia Department of Transportation

Project 0264-134-102

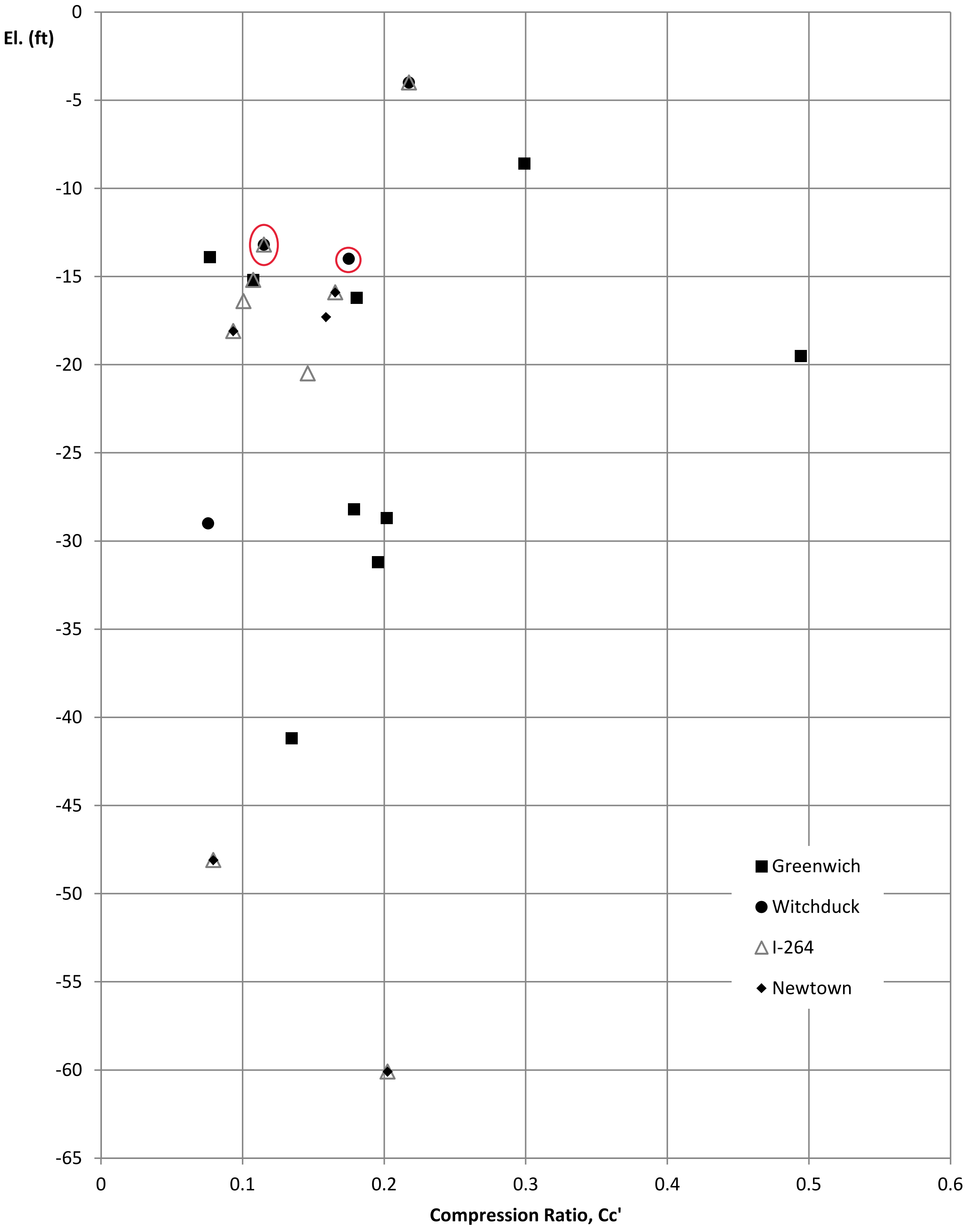
City of Virginia Beach

Project Study Area
Witchduck

Drawing 4: Subsurface
Cross Section Locations


Recompression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.005
0.01
0.015
0.02
0.025
0.03
Recompression Ratio, Cr'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

Compression Ratio vs. Elevation
VDOT



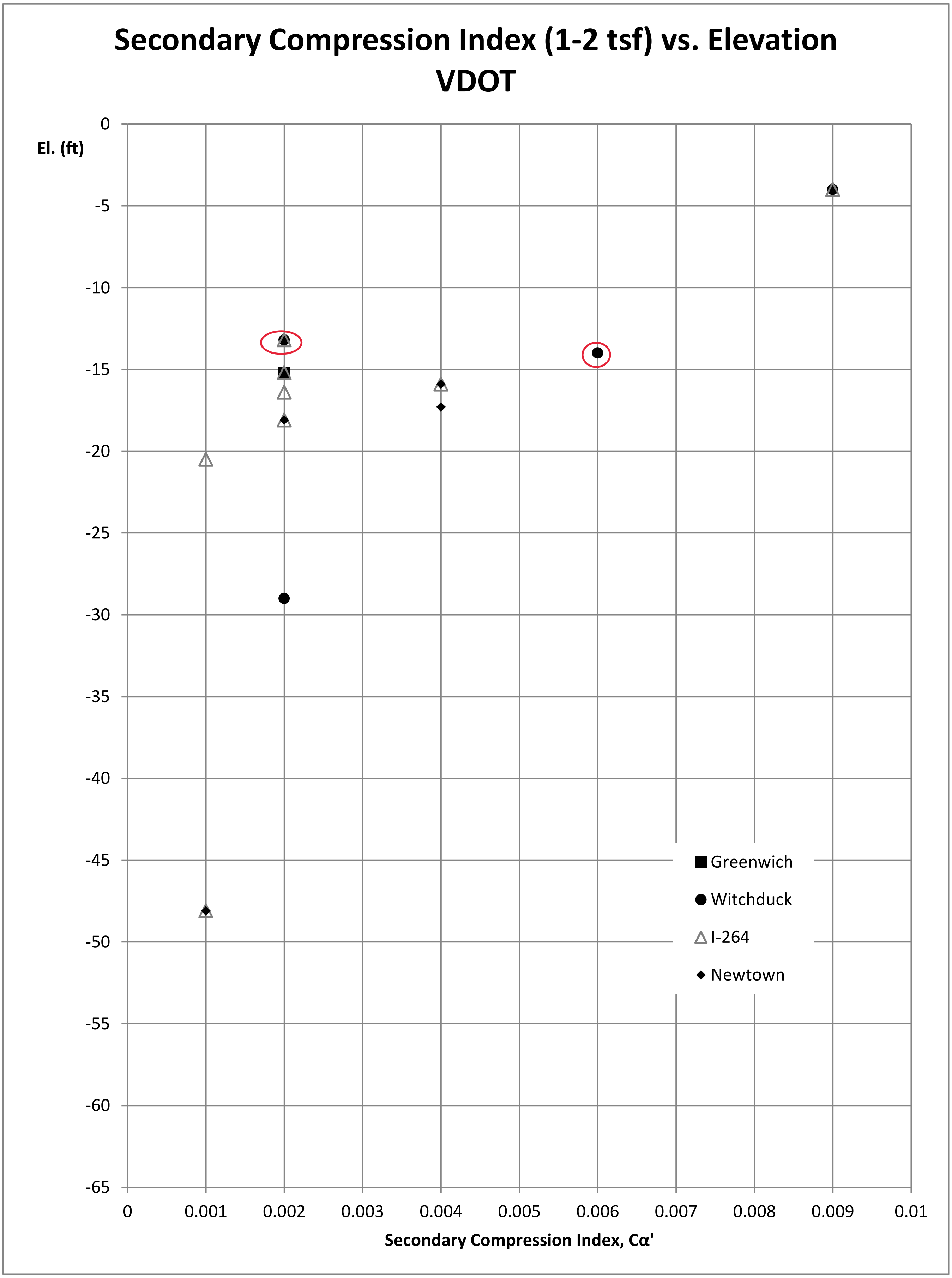

Secondary Compression Index (1-2 tsf) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
Secondary Compression Index, Cα'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

Table D-3

Typical Elastic Moduli

Soil	E_s, tsf
Clay	
Very soft clay	5 - 50
Soft clay	50 - 200
Medium clay	200 - 500
Stiff clay, silty clay	500 - 1000
Sandy clay	250 - 2000
Clay shale	1000 - 2000
Sand	
Loose sand	100 - 250
Dense sand	250 - 1000
Dense sand and gravel	1000 - 2000
Silty sand	250 - 2000

c. Laboratory Tests on Cohesive Soil. The elastic modulus is sensitive to soil disturbance which may increase pore water pressure and, therefore, decrease the effective stress in the specimen and reduce the stiffness and strength. Fissures, which may have little influence on field settlement, may reduce the measured modulus compared with the in situ modulus if confining pressures are not applied to the soil specimen.

(1) Initial hyperbolic tangent modulus. Triaxial unconsolidated undrained (Q or UU) compression tests may be performed on the best available undisturbed specimens at confining pressures equal to the total vertical overburden pressure σ_o for that specimen when in the field using the Q test procedure described in EM 1110-2-1906, Laboratory Soils Testing. An appropriate measure of E_s is the initial tangent modulus $E_{ti} = 1/a$ where a is the intercept of a plot of strain/deviator stress versus strain, Figure D-3 (item 14).

(2) Reload modulus. A triaxial consolidated undrained (R or CU) compression test may be performed on the best available undisturbed specimens. The specimen is initially fully consolidated to an isotropic confining pressure equal to the vertical overburden pressure σ_o for that specimen in the field. The R test procedure described in EM 1110-2-1906 may be used except as follows: stress is increased to the magnitude estimated for the field loading condition. The axial stress may then be reduced to zero and the cycle repeated until the reload curve shows no further increase in slope. The tangent modulus at 1/2 of the maximum applied stress is determined for each loading cycle and plotted versus the number of cycles, Figure D-4. An appropriate measure of E_s is the reload tangent modulus that approaches the asymptotic value at large cycles.

d. Field Tests. The elastic modulus may be estimated from empirical and semiempirical relationships based on results of field soil tests. Refer to

I-264 Witchduck Ramp A STA 203+00

PROJECT IDENTIFICATION

Title: I-264 Witchduck Ramp A STA 203+00
Project Number: -
Client:
Designer: AW
Station Number:

Description:

Witchduck Temporary Ramp A STA 203+00, 26' max fill, no GI

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... nt\FOSSA\Witchduck Loop A Temporary STA 203+00.2ST
Original date and time of creating this file: Sat Jan 07 16:09:50 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 8 layers

	Wet Unit Weight, γ [lb/ft³]	Poisson's Ratio μ	Description of Soil
1	115.00	0.30	Layer 1 Upper Sand
2	120.00	0.50	Layer 2 Upper Clay
3	115.00	0.30	Layer 3 Upper Sand
4	112.00	0.50	Layer 4 Upper Clay
5	125.00	0.30	Layer 5 Lower Sand
6	118.00	0.50	Layer 6 Lower Clay
7	125.00	0.30	Layer 7 Yorktown
8	125.00	0.30	Layer 8 Yorktown

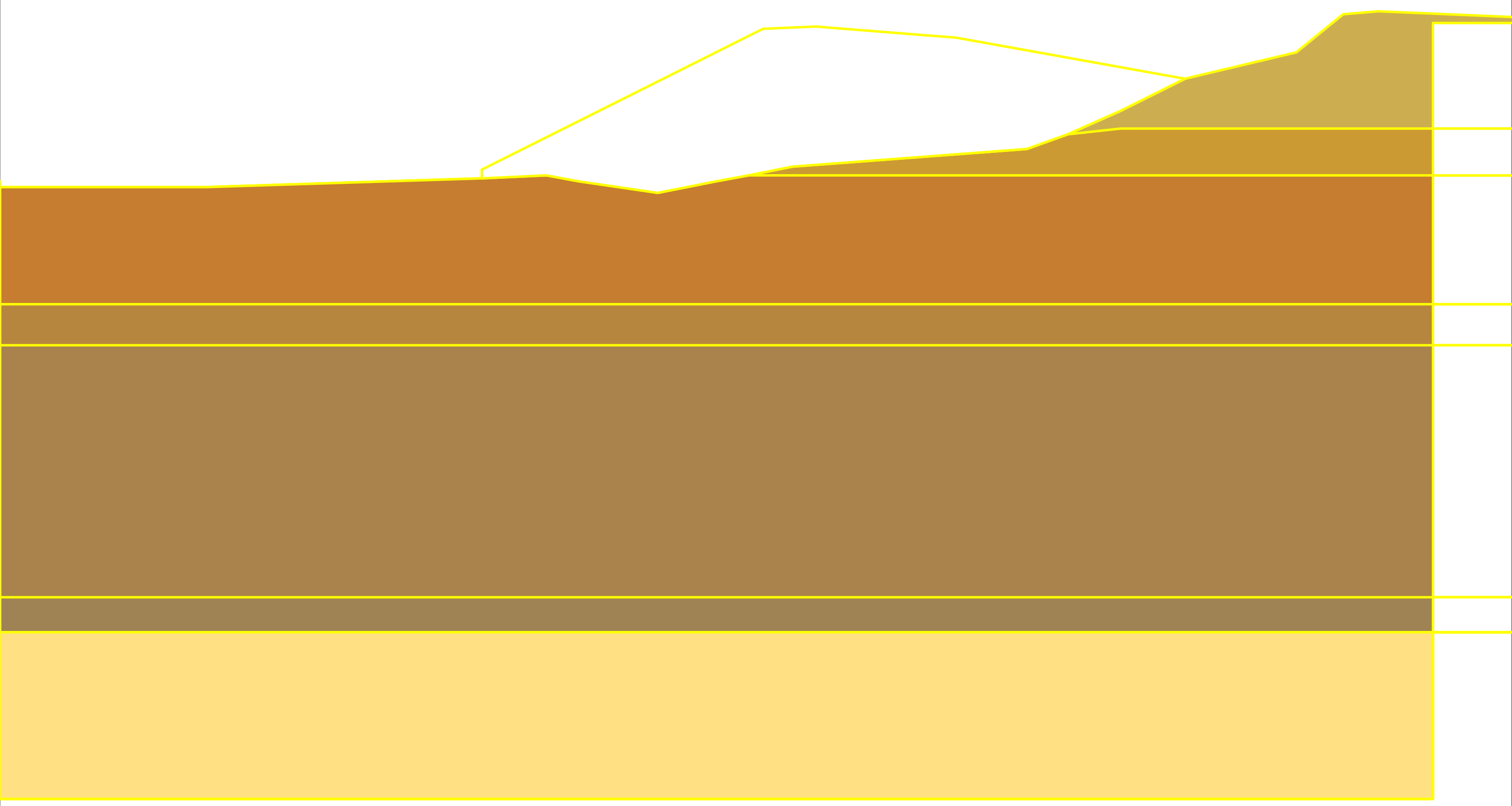
INPUT DATA – EMBANKMENT LAYERS -- 1 layers

	Wet Unit Weight, γ [lb/ft³]	Description of Soil
1	130.00	Proposed Fill

INPUT DATA OF WATER

Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]
1	0.00	5.00
2	1000.00	5.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :	CREEP Ca/Cc
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	0.0250
3	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	0.0176
5	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	0.0030
7	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Secondary Comprassion (Creep) : Settlement is calculated at t2/t1 = 40.0

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	30.00	0.00	1	500000	0.3000	0.0000	7.64	7.64	0.00
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	-0.0034			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0060			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
2	33.78	0.00	1	500000	0.3000	0.0000	7.76	7.75	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	-0.0038			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0089			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
3	37.55	0.00	1	500000	0.3000	0.0000	7.88	7.87	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	-0.0040			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0125			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
4	41.33	0.00	1	500000	0.3000	0.0000	8.00	7.99	0.01
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	-0.0041			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0168			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
5	45.10	0.00	1	500000	0.3000	0.0000	8.12	8.10	0.02
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	-0.0042			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0218			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
6	48.88	0.00	1	500000	0.3000	0.0000	8.24	8.22	0.02
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	-0.0038			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0277			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
7	52.65	0.00	1	500000	0.3000	0.0000	8.36	8.33	0.03
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	-0.0026			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0344			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
8	56.43	0.00	1	500000	0.3000	0.0000	8.48	8.44	0.04
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0006			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0420			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
9	60.20	0.00	1	500000	0.3000	0.0000	8.65	8.59	0.06
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0068			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0504			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
10	63.98	0.00	1	500000	0.3000	0.0000	8.82	8.74	0.07
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0137			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0596			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
11	67.76	0.00	1	500000	0.3000	0.0000	8.99	8.90	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0215			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0693			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
12	71.53	0.00	1	500000	0.3000	0.0000	8.36	8.25	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0295			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0795			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
13	75.31	0.00	1	500000	0.3000	0.0000	7.73	7.61	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0375			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0897			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
14	79.08	0.00	1	500000	0.3000	0.0000	7.17	7.03	0.14
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0450			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0999			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
15	82.86	0.00	1	500000	0.3000	0.0000	6.61	6.45	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0516			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1098			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
16	86.63	0.00	1	500000	0.3000	0.0000	6.05	5.88	0.18
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0580			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1191			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
17	90.41	0.00	1	500000	0.3000	0.0000	6.68	6.49	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0646			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1276			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
18	94.18	0.00	1	500000	0.3000	0.0000	7.44	7.23	0.21
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0725			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1352			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
19	97.96	0.00	1	500000	0.3000	0.0000	8.17	7.95	0.22
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0788			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1416			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
20	101.73	0.00	1	500000	0.3000	0.0000	8.86	8.63	0.23
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0846			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1469			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
21	105.51	0.00	1	500000	0.3000	0.0000	9.60	9.36	0.24
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0869			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1508			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
22	109.29	0.00	1	500000	0.3000	0.0000	10.36	10.12	0.24
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0868			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1534			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
23	113.06	0.00	1	500000	0.3000	0.0000	10.73	10.49	0.24
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0860			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1548			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
24	116.84	0.00	1	500000	0.3000	0.0000	11.01	10.77	0.24
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0845			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1548			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
25	120.61	0.00	1	500000	0.3000	0.0000	11.30	11.06	0.24
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0825			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1536			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
26	124.39	0.00	1	500000	0.3000	0.0000	11.58	11.35	0.23
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0803			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1513			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
27	128.16	0.00	1	500000	0.3000	0.0000	11.86	11.64	0.23
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0780			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1478			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
28	131.94	0.00	1	500000	0.3000	0.0000	12.15	11.93	0.22
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0757			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1433			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
29	135.71	0.00	1	500000	0.3000	0.0000	12.43	12.22	0.21
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0731			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1378			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
30	139.49	0.00	1	500000	0.3000	0.0000	12.71	12.51	0.20
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0700			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1313			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
31	143.27	0.00	1	500000	0.3000	0.0000	12.99	12.80	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0663			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1239			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
32	147.04	0.00	1	500000	0.3000	0.0000	13.28	13.10	0.18
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0620			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1158			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
33	150.82	0.00	1	500000	0.3000	0.0000	13.79	13.63	0.16
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0566			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1070			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
34	154.59	0.00	1	500000	0.3000	0.0000	15.14	14.99	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0495			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0977			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
35	158.37	0.00	1	500000	0.3000	0.0012	16.61	16.48	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0415			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0880			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
36	162.14	0.00	1	500000	0.3000	0.0029	18.29	18.17	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0328			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0781			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
37	165.92	0.00	1	500000	0.3000	0.0034	19.96	19.87	0.10
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0239			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0684			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
38	169.69	0.00	1	500000	0.3000	0.0030	21.85	21.77	0.08
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0149			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0589			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
39	173.47	0.00	1	500000	0.3000	0.0017	23.73	23.68	0.06
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0066			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0499			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
40	177.24	0.00	1	500000	0.3000	-0.0002	25.56	25.52	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0001			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0416			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
41	181.02	0.00	1	500000	0.3000	-0.0016	26.45	26.42	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0027			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0341			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
42	184.80	0.00	1	500000	0.3000	-0.0024	27.35	27.33	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0039			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0274			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
43	188.57	0.00	1	500000	0.3000	-0.0029	28.24	28.23	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0042			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0216			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
44	192.35	0.00	1	500000	0.3000	-0.0031	29.13	29.13	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0042			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0166			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
45	196.12	0.00	1	500000	0.3000	-0.0032	30.10	30.09	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0040			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0124			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
46	199.90	0.00	1	500000	0.3000	-0.0038	33.17	33.17	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0038			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0088			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
47	203.67	0.00	1	500000	0.3000	-0.0043	36.23	36.24	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0035			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0059			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
48	207.45	0.00	1	500000	0.3000	-0.0042	36.79	36.79	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0032			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0034			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
49	211.22	0.00	1	500000	0.3000	-0.0040	36.95	36.95	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0030			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0014			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
50	215.00	0.00	1	500000	0.3000	-0.0038	36.79	36.79	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0027			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0002			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	128.00	0.00	11.85	0.58	11.27

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

SECONDARY SETTLEMENT (Creep), Ss -- Total Secondary Compression (Creep) = 0.050 ft.

Layer #	Underging Consolidation	Cc / (1+e0)	C-alpha/ (1+e0)	e-zero	H [ft.]	t1/t2	Settlement Ss [ft.]
1	No	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	0.1200	0.0030	N/A	2.85	40.0	0.014
3	No	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	0.1700	0.0030	N/A	7.00	40.0	0.034
5	No	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	0.1000	0.0003	N/A	6.00	40.0	0.003
7	No	N/A	N/A	N/A	N/A	N/A	N/A
8	No	N/A	N/A	N/A	N/A	N/A	N/A

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	10.00	7.00	Layer 1 Upper Sand
	2	57.00	8.50	
	3	68.00	9.00	
	4	73.50	8.00	
	5	87.00	6.00	
	6	97.00	8.00	
	7	102.50	9.00	
	8	110.00	10.50	
	9	150.00	13.50	
	10	157.00	16.00	
	11	166.00	20.00	
	12	177.00	25.50	
	13	196.00	30.00	
	14	204.00	36.50	
	15	210.00	37.00	
	16	245.00	35.50	
	17	250.00	35.00	
2	1	10.00	7.00	Layer 2 Upper Clay
	2	57.00	8.50	
	3	68.00	9.00	
	4	73.50	8.00	
	5	87.00	6.00	
	6	97.00	8.00	
	7	102.50	9.00	
	8	110.00	10.50	
	9	150.00	13.50	
	10	157.00	16.00	
	11	166.00	17.00	
	12	177.00	17.00	
	13	196.00	17.00	
	14	204.00	17.00	
	15	210.00	17.00	
	16	245.00	17.00	
	17	250.00	17.00	
	18	1000.00	17.00	
3	1	10.00	7.00	Layer 3 Upper Sand
	2	57.00	8.50	
	3	68.00	9.00	
	4	73.50	8.00	
	5	87.00	6.00	
	6	97.00	8.00	
	7	102.50	9.00	
	8	110.00	9.00	
	9	1000.00	9.00	
4	1	0.00	-13.00	Layer 4 Upper Clay
	2	1000.00	-13.00	
5	1	0.00	-20.00	Layer 5 Lower Sand
	2	1000.00	-20.00	
6	1	0.00	-63.00	Layer 6 Lower Clay
	2	1000.00	-63.00	

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
7	1	0.00	-69.00	Layer 7 Yorktown
	2	1000.00	-69.00	
8	1	0.00	-69.00	Layer 8 Yorktown
	2	1000.00	-69.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 57.00 [ft]	1	57.00	10.00	Proposed Fill
	X2 = 177.00 [ft]	2	105.00	34.00	
		3	114.00	34.40	
		4	138.00	32.50	
		5	177.00	25.50	

URS

Page ____ of ____

Sheet ____ of ____

Job 1-264 W. duck

Project No. ____

Description STA 204+00 Temp Witchduck on Ramp A

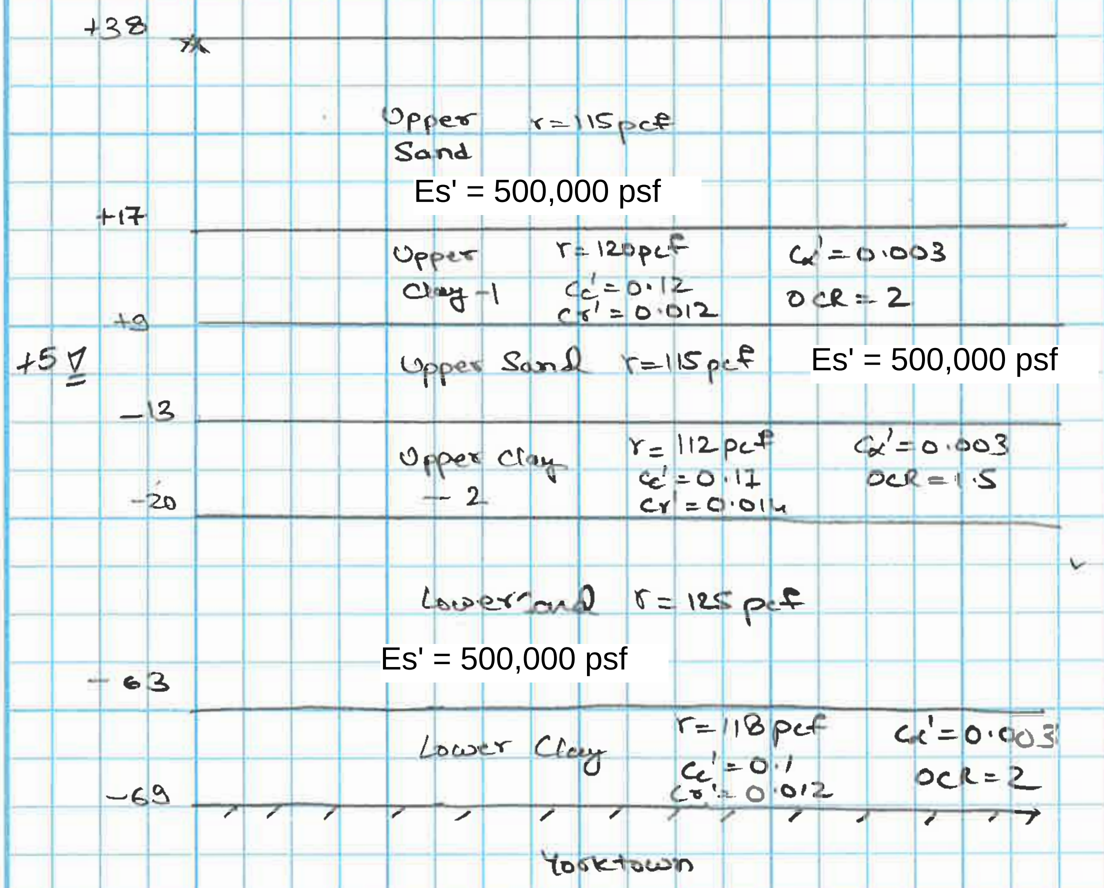
Computed by AS

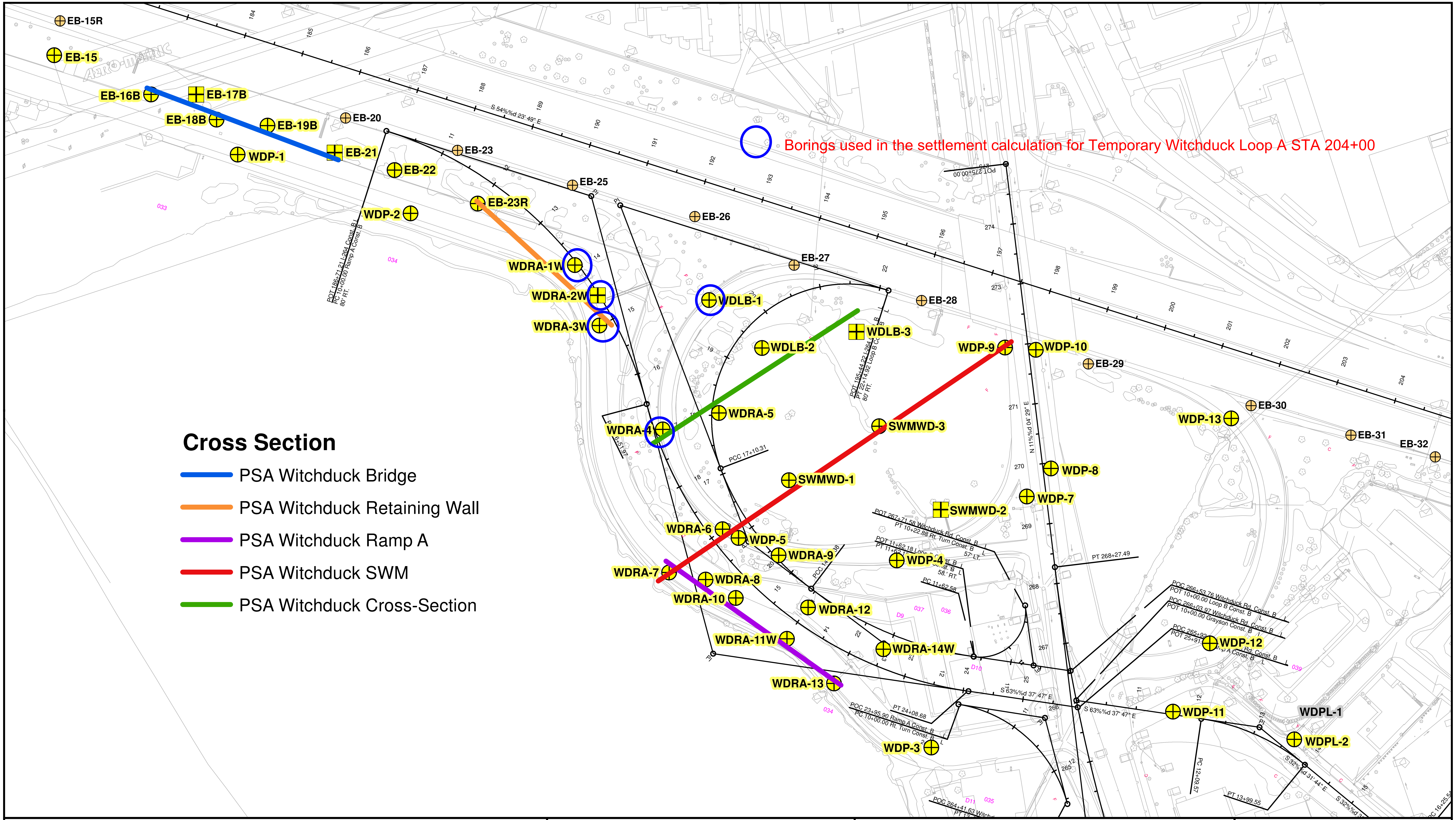
Date 1/7/17

Checked by ____

Date ____

Reference





Cross Section

- 🟦 PSA Witchduck Bridge
- 🟧 PSA Witchduck Retaining Wall
- 🟪 PSA Witchduck Ramp A
- 🟥 PSA Witchduck SWM
- 🟩 PSA Witchduck Cross-Section

N

0 75 150 Feet

Scale: 1" = 150'

- ⊕ SPT Exploration
- ⊞ CPT Exploration
- ⊕ PSA I-264 CD Borings

Prepared by: HDR

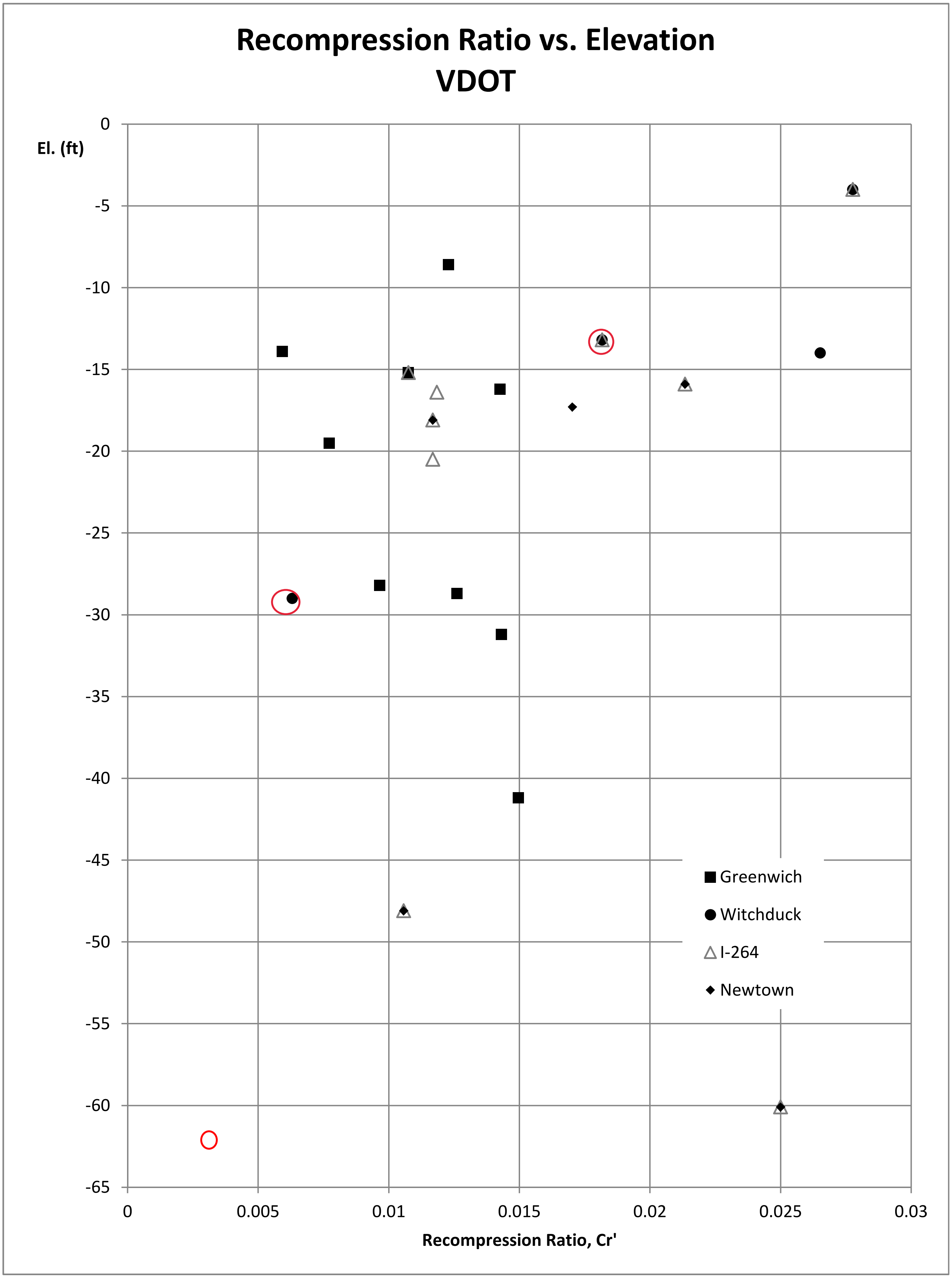
Date: February 13, 2013

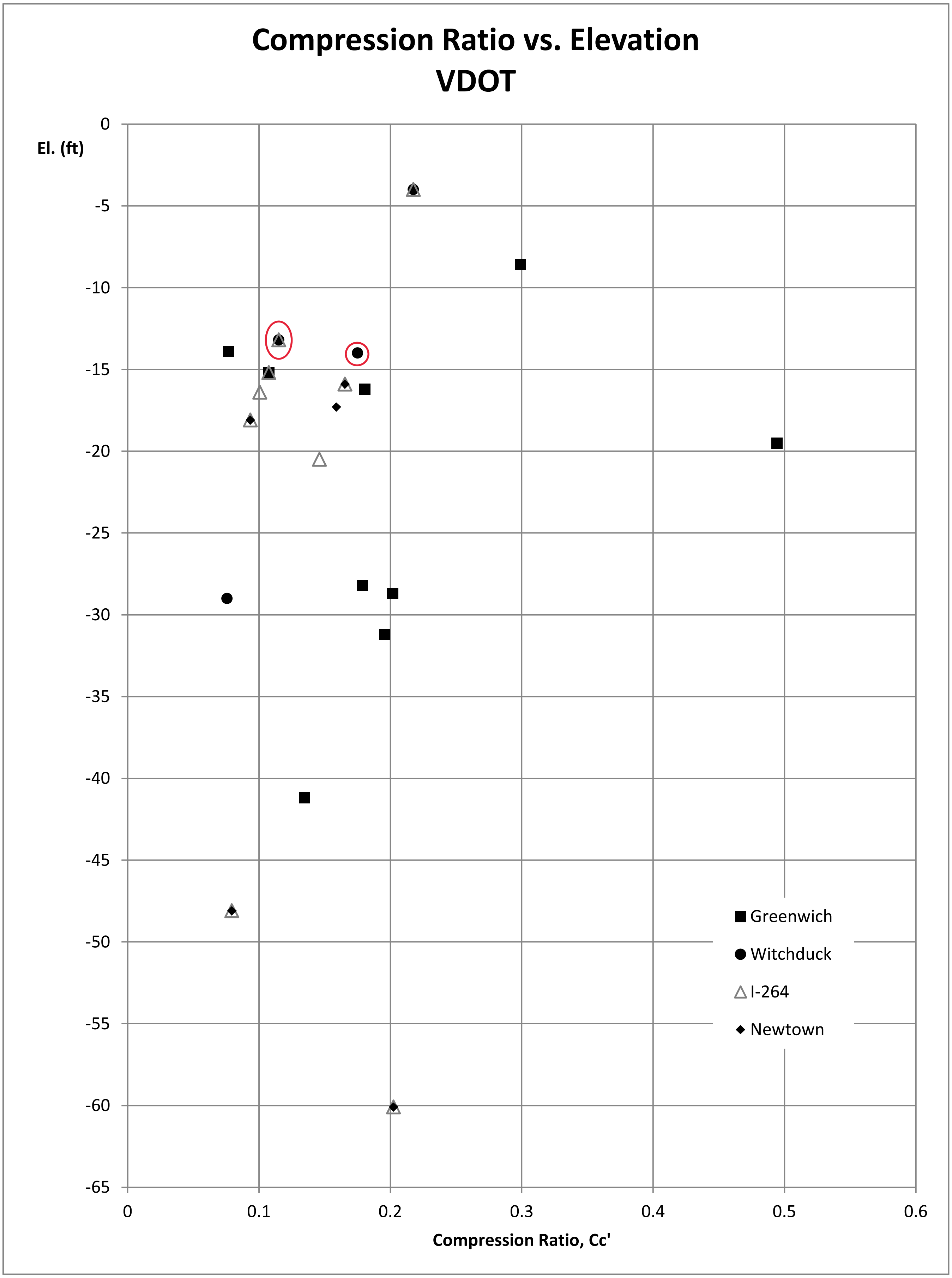
VDOT Virginia Department of Transportation

Project 0264-134-102
City of Virginia Beach

Project Study Area
Witchduck

Drawing 4: Subsurface Cross Section Locations


Recompression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.005
0.01
0.015
0.02
0.025
0.03
Recompression Ratio, Cr'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown


Compression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.1
0.2
0.3
0.4
0.5
0.6
Compression Ratio, Cc'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

Secondary Compression Index (1-2 tsf) vs. Elevation
VDOT

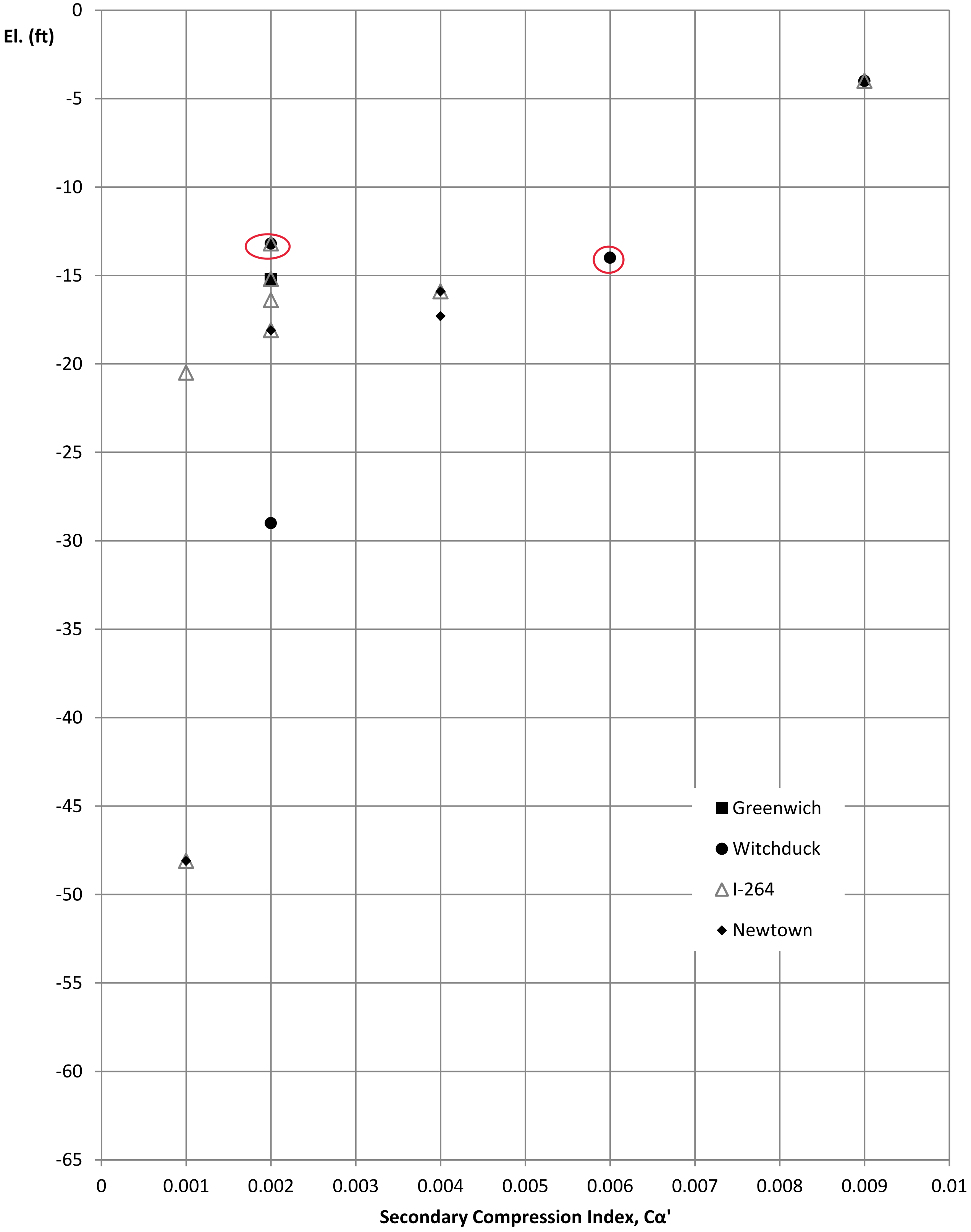


Table D-3

Typical Elastic Moduli

Soil	E_s, tsf
Clay	
Very soft clay	5 - 50
Soft clay	50 - 200
Medium clay	200 - 500
Stiff clay, silty clay	500 - 1000
Sandy clay	250 - 2000
Clay shale	1000 - 2000
Sand	
Loose sand	100 - 250
Dense sand	250 - 1000
Dense sand and gravel	1000 - 2000
Silty sand	250 - 2000

c. Laboratory Tests on Cohesive Soil. The elastic modulus is sensitive to soil disturbance which may increase pore water pressure and, therefore, decrease the effective stress in the specimen and reduce the stiffness and strength. Fissures, which may have little influence on field settlement, may reduce the measured modulus compared with the in situ modulus if confining pressures are not applied to the soil specimen.

(1) Initial hyperbolic tangent modulus. Triaxial unconsolidated undrained (Q or UU) compression tests may be performed on the best available undisturbed specimens at confining pressures equal to the total vertical overburden pressure σ_o for that specimen when in the field using the Q test procedure described in EM 1110-2-1906, Laboratory Soils Testing. An appropriate measure of E_s is the initial tangent modulus $E_{ti} = 1/a$ where a is the intercept of a plot of strain/deviator stress versus strain, Figure D-3 (item 14).

(2) Reload modulus. A triaxial consolidated undrained (R or CU) compression test may be performed on the best available undisturbed specimens. The specimen is initially fully consolidated to an isotropic confining pressure equal to the vertical overburden pressure σ_o for that specimen in the field. The R test procedure described in EM 1110-2-1906 may be used except as follows: stress is increased to the magnitude estimated for the field loading condition. The axial stress may then be reduced to zero and the cycle repeated until the reload curve shows no further increase in slope. The tangent modulus at 1/2 of the maximum applied stress is determined for each loading cycle and plotted versus the number of cycles, Figure D-4. An appropriate measure of E_s is the reload tangent modulus that approaches the asymptotic value at large cycles.

d. Field Tests. The elastic modulus may be estimated from empirical and semiempirical relationships based on results of field soil tests. Refer to

I-264 Witchduck Ramp A STA 204+00

PROJECT IDENTIFICATION

Title: I-264 Witchduck Ramp A STA 204+00
Project Number: -
Client:
Designer: AW
Station Number:

Description:
Witchduck Temporary Ramp A STA 204+00, 6' surcharge + PVD

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... A Temporary STA 204+00 with 6' surcharge + PVD.2ST
Original date and time of creating this file: Sat Jan 07 16:09:50 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 8 layers

	Wet Unit Weight, γ [lb/ft³]	**Poisson's Ratio μ**	**Description of Soil**
1	115.00	0.30	Layer 1 Upper Sand
2	120.00	0.50	Layer 2 Upper Clay
3	115.00	0.30	Layer 3 Upper Sand
4	112.00	0.50	Layer 4 Upper Clay
5	125.00	0.30	Layer 5 Lower Sand
6	118.00	0.50	Layer 6 Lower Clay
7	125.00	0.30	Layer 7 Yorktown
8	125.00	0.30	Layer 8 Yorktown

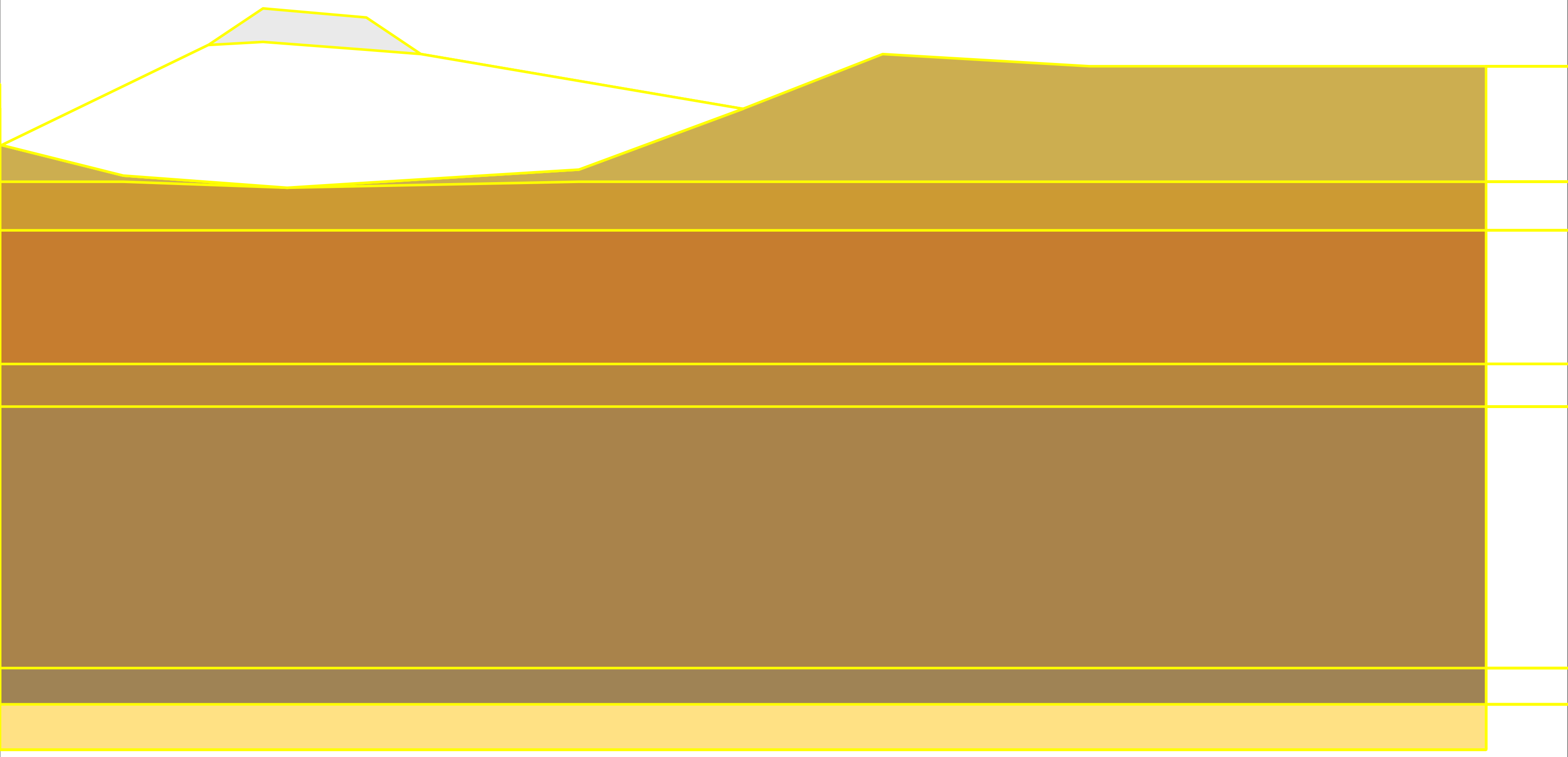
INPUT DATA – EMBANKMENT LAYERS -- 2 layers

	Wet Unit Weight, γ [lb/ft³]	**Description of Soil**
1	130.00	Proposed Fill
2	130.00	Surcharge

INPUT DATA OF WATER

Point #	**Coordinates (X, Z) :** **(X) [ft.]**	**(Z) [ft.]**
1	0.00	5.00
2	1000.00	5.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :	PVD through Layer No/Yes	Ch=Coeff. for horiz. drainage [ft ²/day]
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	Yes	0.2153
3	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	Yes	0.2153
5	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	No	0.2153
7	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

PVD : Triangle Pattern where D = 1.05 x 5.00 = 5.25 ft.
dw = 2 x (a + b) / 3.14 = 2.607 inch --> F(n) = 2.44. Fs for disturbance = 0.000
and Fr' = 0.050

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	-120.00	0.00	1	500000	0.3000	-0.0008	33.00	33.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0035			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0028			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
2	-115.10	0.00	1	500000	0.3000	-0.0009	33.00	33.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0037			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0017			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
3	-110.20	0.00	1	500000	0.3000	-0.0010	33.00	33.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0040			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0003			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
4	-105.31	0.00	1	500000	0.3000	-0.0011	33.00	33.00	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0043			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0015			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
5	-100.41	0.00	1	500000	0.3000	-0.0013	32.86	32.86	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0047			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0037			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
6	-95.51	0.00	1	500000	0.3000	-0.0012	31.69	31.69	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0050			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0065			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
7	-90.61	0.00	1	500000	0.3000	-0.0012	30.53	30.52	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0053			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0100			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
8	-85.71	0.00	1	500000	0.3000	-0.0011	29.36	29.35	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0055			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0142			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
9	-80.82	0.00	1	500000	0.3000	-0.0011	28.19	28.18	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0055			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0194			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
10	-75.92	0.00	1	500000	0.3000	-0.0010	27.03	27.01	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0051			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0256			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
11	-71.02	0.00	1	500000	0.3000	-0.0010	25.86	25.83	0.03
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0041			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0329			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
12	-66.12	0.00	1	500000	0.3000	-0.0009	24.70	24.66	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0017			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0415			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
13	-61.22	0.00	1	500000	0.3000	-0.0008	23.53	23.48	0.05
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0028			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0513			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
14	-56.33	0.00	1	500000	0.3000	0.0011	22.33	22.26	0.07
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0104			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0622			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
15	-51.43	0.00	1	500000	0.3000	0.0034	21.11	21.01	0.10
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0209			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0740			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
16	-46.53	0.00	1	500000	0.3000	0.0040	19.88	19.76	0.12
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0333			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0864			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
17	-41.63	0.00	1	500000	0.3000	0.0037	18.66	18.51	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0463			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0991			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
18	-36.73	0.00	1	500000	0.3000	0.0023	17.83	17.66	0.17
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0592			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1115			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
19	-31.84	0.00	1	500000	0.3000	0.0027	17.47	17.27	0.20
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0716			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1233			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
20	-26.94	0.00	1	500000	0.3000	0.0021	17.11	16.89	0.22
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0832			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1338			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
21	-22.04	0.00	1	500000	0.3000	0.0024	16.74	16.50	0.24
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0937			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1428			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
22	-17.14	0.00	1	500000	0.3000	0.0000	16.38	16.13	0.25
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.1019			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1498			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
23	-12.24	0.00	1	500000	0.3000	0.0000	16.02	15.76	0.26
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.1063			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1547			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
24	-7.35	0.00	1	500000	0.3000	0.0000	16.29	16.03	0.26
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.1068			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1571			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
25	-2.45	0.00	1	500000	0.3000	0.0027	16.60	16.33	0.26
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.1039			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1573			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
26	2.45	0.00	1	500000	0.3000	0.0025	16.90	16.65	0.26
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0982			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1552			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
27	7.35	0.00	1	500000	0.3000	0.0032	17.21	16.96	0.24
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0906			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1511			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
28	12.24	0.00	1	500000	0.3000	0.0038	17.52	17.28	0.23
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0828			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1452			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
29	17.14	0.00	1	500000	0.3000	0.0037	17.82	17.60	0.22
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0758			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1378			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
30	22.04	0.00	1	500000	0.3000	0.0043	18.13	17.92	0.20
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0694			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1293			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
31	26.94	0.00	1	500000	0.3000	0.0040	18.43	18.25	0.19
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0631			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1197			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
32	31.84	0.00	1	500000	0.3000	0.0045	18.74	18.57	0.17
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0564			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.1095			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
33	36.73	0.00	1	500000	0.3000	0.0049	19.27	19.12	0.15
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0487			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0987			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
34	41.63	0.00	1	500000	0.3000	0.0074	21.09	20.95	0.13
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0400			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0876			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
35	46.53	0.00	1	500000	0.3000	0.0078	22.90	22.79	0.11
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0305			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0766			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
36	51.43	0.00	1	500000	0.3000	0.0070	24.71	24.62	0.09
			2	9999999999	0.5000	0.0000			
			3	500000	0.3000	0.0210			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0658			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
37	56.33	0.00	1	500000	0.3000	0.0043	26.53	26.46	0.07
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0122			
			4	9999999999	0.5000	0.0000			
			5	500000	0.3000	0.0555			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
38	61.22	0.00	1	500000	0.3000	0.0002	28.34	28.29	0.05
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	0.0049			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0460			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
39	66.12	0.00	1	500000	0.3000	-0.0020	30.22	30.19	0.04
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0001			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0373			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
40	71.02	0.00	1	500000	0.3000	-0.0025	32.14	32.11	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0030			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0297			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
41	75.92	0.00	1	500000	0.3000	-0.0028	34.06	34.04	0.02
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0044			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0230			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
42	80.82	0.00	1	500000	0.3000	-0.0030	35.97	35.96	0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0049			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0174			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
43	85.71	0.00	1	500000	0.3000	-0.0031	37.89	37.88	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0051			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0127			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
44	90.61	0.00	1	500000	0.3000	-0.0028	37.73	37.73	0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0049			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0088			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
45	95.51	0.00	1	500000	0.3000	-0.0024	37.44	37.44	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0047			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0056			
			6	9999999999	0.5000	0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
46	100.41	0.00	1	500000	0.3000	-0.0021	37.15	37.16	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0044			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0030			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
47	105.31	0.00	1	500000	0.3000	-0.0018	36.86	36.87	-0.00
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0041			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	0.0010			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
48	110.20	0.00	1	500000	0.3000	-0.0015	36.58	36.58	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0038			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0007			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
49	115.10	0.00	1	500000	0.3000	-0.0013	36.29	36.29	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0036			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0020			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			
50	120.00	0.00	1	500000	0.3000	-0.0011	36.00	36.01	-0.01
			2	9999999999	0.5000	-0.0000			
			3	500000	0.3000	-0.0033			
			4	9999999999	0.5000	-0.0000			
			5	500000	0.3000	-0.0030			
			6	9999999999	0.5000	-0.0000			
			7	9999999999	0.3000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	-120.00	0.00	33.00	0.00	33.00
2	-115.10	0.00	33.00	0.00	33.00
3	-110.20	0.00	33.00	0.00	33.00
4	-105.31	0.00	33.00	0.00	33.00
5	-100.41	0.00	32.86	0.00	32.86
6	-95.51	0.00	31.69	0.00	31.69
7	-90.61	0.00	30.53	0.00	30.52
8	-85.71	0.00	29.36	0.00	29.36
9	-80.82	0.00	28.19	0.01	28.19
10	-75.92	0.00	27.03	0.01	27.02
11	-71.02	0.00	25.86	0.01	25.85
12	-66.12	0.00	24.70	0.01	24.68
13	-61.22	0.00	23.53	0.01	23.51
14	-56.33	0.00	22.33	0.03	22.31
15	-51.43	0.00	21.11	0.05	21.06
16	-46.53	0.00	19.88	0.16	19.72
17	-41.63	0.00	18.66	0.34	18.32
18	-36.73	0.00	17.83	0.50	17.33
19	-31.84	0.00	17.47	0.59	16.88
20	-26.94	0.00	17.11	0.68	16.43
21	-22.04	0.00	16.74	0.76	15.99
22	-17.14	0.00	16.38	0.83	15.56
23	-12.24	0.00	16.02	0.86	15.15
24	-7.35	0.00	16.29	0.84	15.45
25	-2.45	0.00	16.60	0.81	15.79

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
26	2.45	0.00	16.90	0.76	16.14
27	7.35	0.00	17.21	0.70	16.51
28	12.24	0.00	17.52	0.63	16.88
29	17.14	0.00	17.82	0.58	17.24
30	22.04	0.00	18.13	0.52	17.60
31	26.94	0.00	18.43	0.47	17.97
32	31.84	0.00	18.74	0.41	18.33
33	36.73	0.00	19.27	0.32	18.95
34	41.63	0.00	21.09	0.17	20.92
35	46.53	0.00	22.90	0.07	22.83
36	51.43	0.00	24.71	0.04	24.68
37	56.33	0.00	26.53	0.02	26.50
38	61.22	0.00	28.34	0.01	28.33
39	66.12	0.00	30.22	0.01	30.21
40	71.02	0.00	32.14	0.01	32.13
41	75.92	0.00	34.06	0.01	34.05
42	80.82	0.00	35.97	0.00	35.97
43	85.71	0.00	37.89	0.00	37.88
44	90.61	0.00	37.73	0.00	37.73
45	95.51	0.00	37.44	0.00	37.44
46	100.41	0.00	37.15	0.00	37.15
47	105.31	0.00	36.86	0.00	36.86
48	110.20	0.00	36.58	0.00	36.57
49	115.10	0.00	36.29	0.00	36.29
50	120.00	0.00	36.00	0.00	36.00

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	-101.00	33.00	Layer 1 Upper Sand
	2	-59.00	23.00	
	3	-39.00	18.00	
	4	-12.00	16.00	
	5	36.00	19.00	
	6	63.00	29.00	
	7	86.00	38.00	
	8	120.00	36.00	
2	1	-101.00	17.00	Layer 2 Upper Clay
	2	-59.00	17.00	
	3	-39.00	17.00	
	4	-12.00	16.00	
	5	36.00	17.00	
	6	63.00	17.00	
	7	86.00	17.00	
	8	120.00	17.00	
3	1	-101.00	9.00	Layer 3 Upper Sand
	2	-59.00	9.00	
	3	-39.00	9.00	
	4	-12.00	9.00	
	5	36.00	9.00	
	6	63.00	9.00	
	7	86.00	9.00	
	8	120.00	9.00	
4	1	0.00	-13.00	Layer 4 Upper Clay
	2	1000.00	-13.00	
5	1	0.00	-20.00	Layer 5 Lower Sand
	2	1000.00	-20.00	
6	1	0.00	-63.00	Layer 6 Lower Clay
	2	1000.00	-63.00	
7	1	0.00	-69.00	Layer 7 Yorktown
	2	1000.00	-69.00	
8	1	0.00	-69.00	Layer 8 Yorktown
	2	1000.00	-69.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = -59.00 [ft]	1	-59.00	23.00	Proposed Fill
	X2 = 63.00 [ft]	2	-25.00	39.50	
		3	-16.00	40.00	
		4	10.00	38.00	
		5	63.00	29.00	
2	X1 = -59.00 [ft]	1	-59.00	23.00	Surcharge
	X2 = 63.00 [ft]	2	-25.00	39.50	
		3	-16.00	45.50	
		4	1.00	44.00	
		5	10.00	38.00	
		6	63.00	29.00	

HISTORY OF SETTLEMENT ANALYSES

Case #	Location of 1D Section : (X) [ft.]	(Y) [ft.]	Ultimate Settlement, Sc [ft.]	After... [days]	Actual Settlement, [ft.]	U-ave (min.for all consol.layers) [%]	USER'S DESCRIPTION
1	---	---	---	---	---	---	
2	---	---	---	---	---	---	
3	---	---	---	---	---	---	
4	---	---	---	---	---	---	
5	---	---	---	---	---	---	
6	---	---	---	---	---	---	
7	---	---	---	---	---	---	
8	---	---	---	---	---	---	
9	---	---	---	---	---	---	
10	---	---	---	---	---	---	
11	---	---	---	---	---	---	
12	---	---	---	---	---	---	
13	---	---	---	---	---	---	
14	---	---	---	---	---	---	
15	---	---	---	---	---	---	

```
                    STA 204+00 with 6' surcharge + PVD_120 days
    Results of Condolidation After 120.0 days.   (With PVD's)
  ======================================================================

------------------------------------------------------------------------------------
-
   Layer         PVD installed         Uv        Uh        Uave.   Sc-ult     Sc(t)
 Undergoing      Through Layer:
Consolidation
    NO / YES         NO / YES          [%]       [%]        [%]     [ft]      [ft]
------------------------------------------------------------------------------------
-
   1    NO             N/A              N/A       N/A       N/A       N/A       N/A
   2   YES             YES             93.86     94.67     99.67     0.661     0.659
   3    NO             N/A              N/A       N/A       N/A       N/A       N/A
   4   YES             YES             93.87     94.67     99.67     0.196     0.195
   5    NO             N/A              N/A       N/A       N/A       N/A       N/A
   6   YES              NO             99.39      0.00     99.39     0.008     0.008
   7    NO             N/A              N/A       N/A       N/A       N/A       N/A
   8    NO             N/A              N/A       N/A       N/A       N/A       N/A
```

Estimation of Secondary Settlement

Project Name:	**I-264 Witchduck Temp Ramp A**
Date:	1/7/2017
Calculated by:	AW
Checked by:	

Project Life = **20** **years**

CASE II: Surcharge

Height of surcharge = **6** **feet**

Surcharge unit weight = **130** **pcf** (if surcharge placed below water, enter bouyant unit weight)

S No.	Clay Layer	Thickness (ft)	C_α' (NC, strain based)	t_{90} [3] (years)	Final Effective stress at layer midpoint[4] (psf)	Effective stress decrease due to surcharge removal (psf)	AAOS[5]	C_α' (surcharge)/ C_α' (NC) [6]	C_α' (surcharge)[6]	Secondary Settlement (ft)
1	UC-1	8	0.003	0.25	3600	780	22%	0.40	0.0012	0.02
2	UC	7	0.003	0.25	5660.4	780	14%	0.61	0.0018	0.02
3	LC	6	0.0003	0.25	8692.6	780	9%	0.81	0.0002	0.00

TOTAL SECONDARY SETTLEMENT = **0.05 ft**
or
0.55 in

Notes

1 C_α' (NC, strain based) is the coefficient of secondary settlement without the effect of oversolidation or surcharge.

2 t_{90} is the time to complete 90% primary consolidation.

3 t_{90} with surcharge might be less due to the use of wick drains.

4 The "final effective stress at layer mid point" is the effective stress after the removal of the surcharge.

5 AAOS is the Adjusted Amount of Surcharge, which is the effective stress reduction caused by surcharge removal.
It is calculated as stress decrease due to surcharge removal divided by final effective stress at the depth of interest.

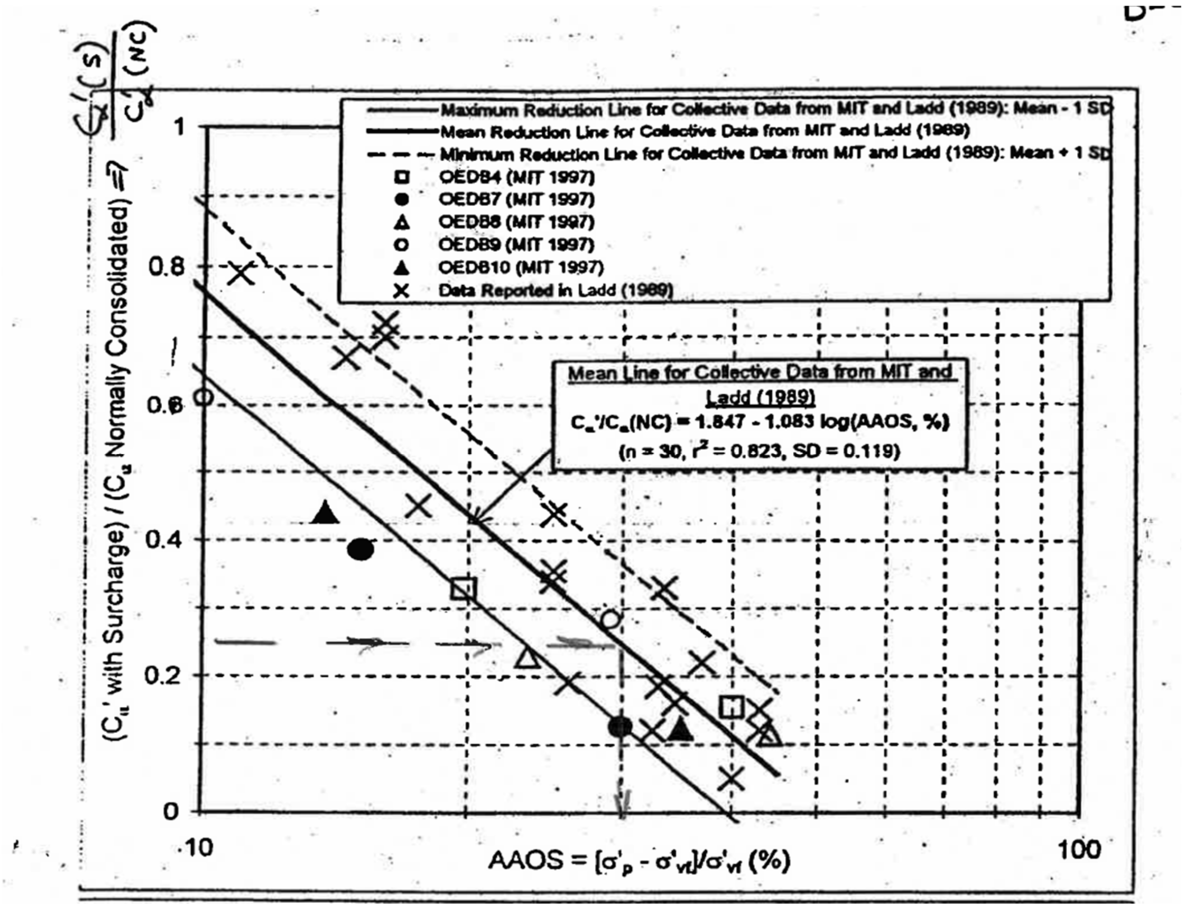
6 C_α' (surcharge) is the reduced coefficient of secondary settlement due to the application of surcharge.
This is estimated based on Ladd (1989) correlation shown in page 2.

7 Secondary settlement was calculated using the following equation:

$$S_{sec} = H.C'_{\propto}.\log(\frac{t_{project\ life}}{t_{90}})$$

8 It is assumed that surcharge, if placed, will be removed at 90% primary consolidation.

Ladd, 1989


Cα'(s) / Cα'(NC) =>
(Cα' with Surcharge) / (Cα Normally Consolidated)
Maximum Reduction Line for Collective Data from MIT and Ladd (1989): Mean - 1 SD
Mean Reduction Line for Collective Data from MIT and Ladd (1989)
Minimum Reduction Line for Collective Data from MIT and Ladd (1989): Mean + 1 SD
□ OED84 (MIT 1997)
● OED87 (MIT 1997)
△ OED88 (MIT 1997)
○ OED89 (MIT 1997)
▲ OED810 (MIT 1997)
× Data Reported in Ladd (1989)
Mean Line for Collective Data from MIT and Ladd (1989)
Cα'/Cα(NC) = 1.847 - 1.083 log(AAOS, %)
(n = 30, r² = 0.823, SD = 0.119)
1
0.8
0.6
0.4
0.2
0
10
100
AAOS = [σ'p - σ'vf]/σ'vf (%)

URS

Page ______ of ______

Job Soil Profile I-264 Witchduck

Project No. ______

Sheet ______ of ______

Description STA 406 Witchduck
Temp On Ramp B

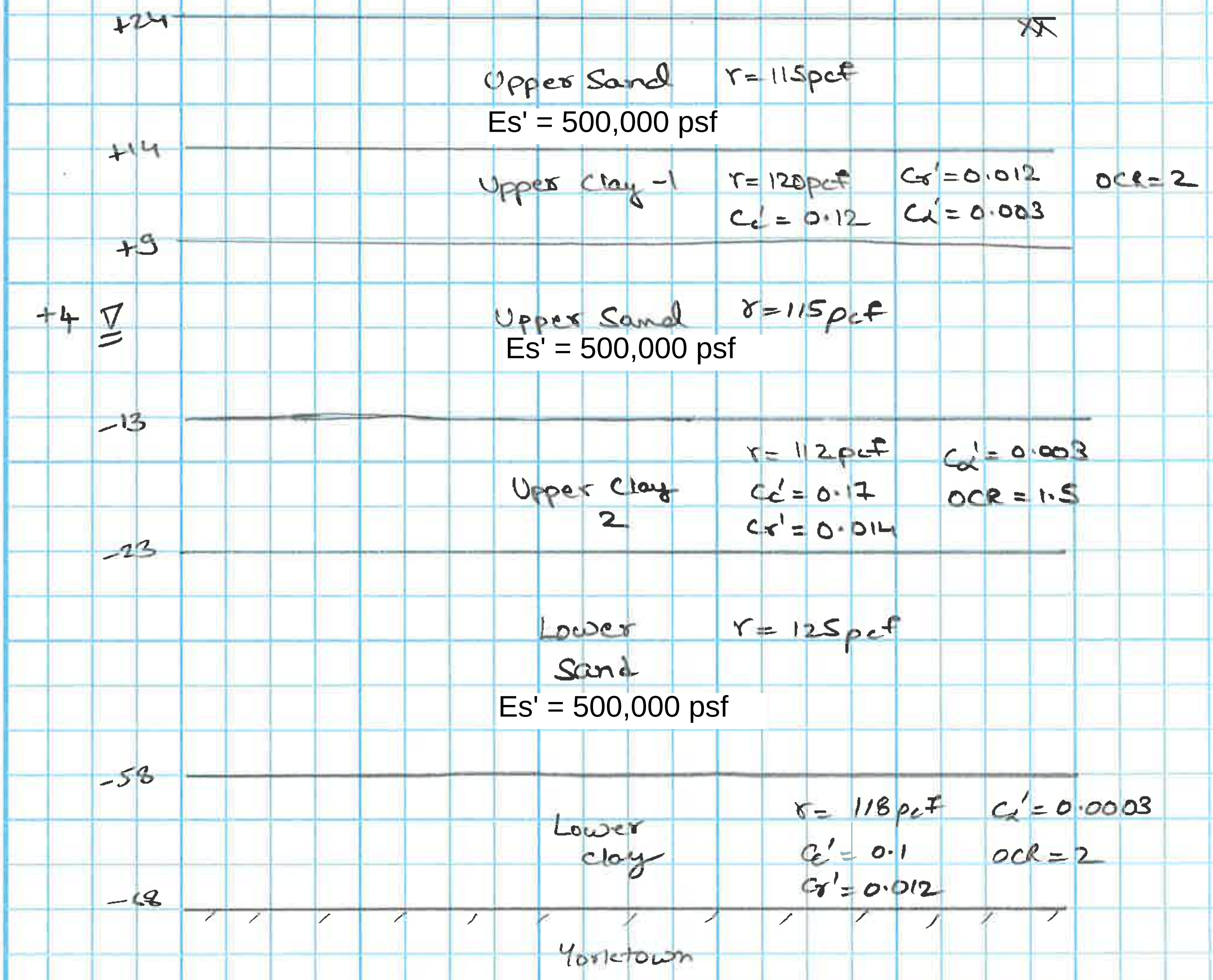
Computed by AS

Date 1/7/12

Checked by ______

Date ______

Reference



Upper Sand $\gamma = 115$pcf
Es' = 500,000 psf

Upper Clay -1 $\gamma = 120$pcf $C_r' = 0.012$ OCR = 2
$C_c' = 0.12$ $C_\alpha' = 0.003$

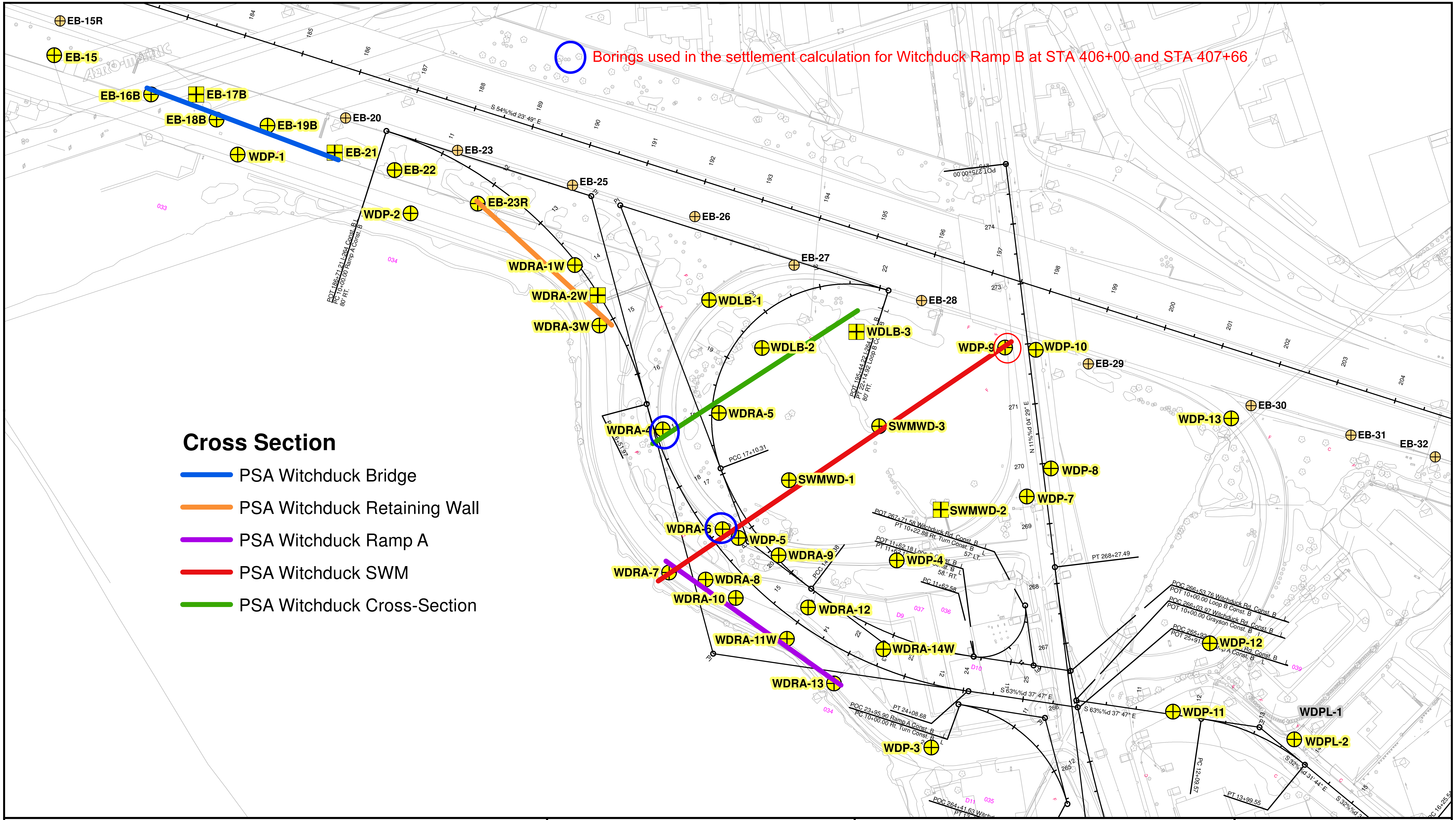
Upper Sand $\gamma = 115$pcf
Es' = 500,000 psf

Upper Clay 2 $\gamma = 112$pcf $C_\alpha' = 0.003$
$C_c' = 0.17$ OCR = 1.5
$C_r' = 0.014$

Lower Sand $\gamma = 125$pcf
Es' = 500,000 psf

Lower clay $\gamma = 118$pcf $C_\alpha' = 0.0003$
$C_c' = 0.1$ OCR = 2
$C_r' = 0.012$

Yorktown



N

0 75 150 Feet

Scale: 1" = 150'

⊕ SPT Exploration

⊞ CPT Exploration

⊕ PSA I-264 CD Borings

Prepared by: HDR

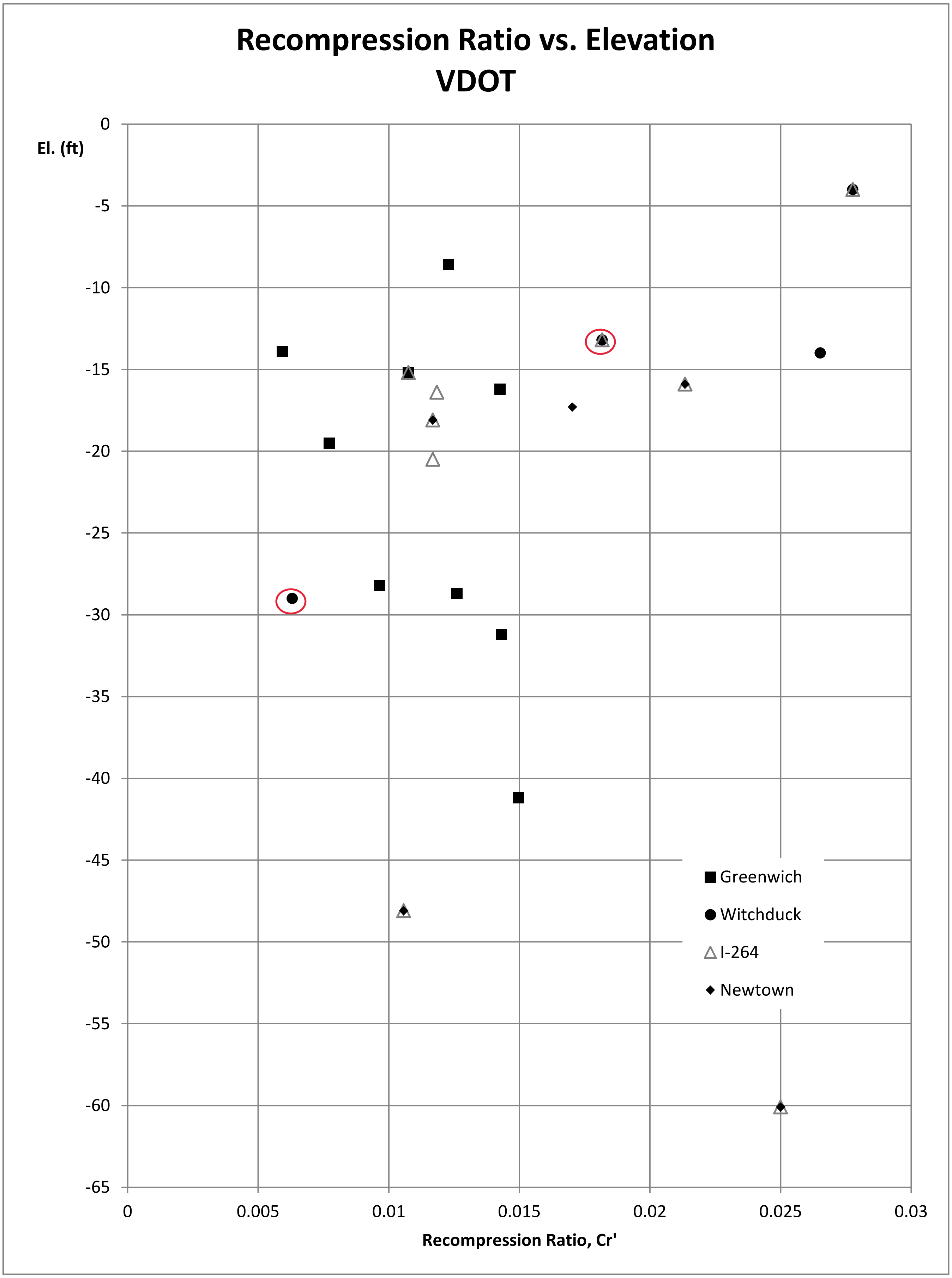
Date: February 13, 2013

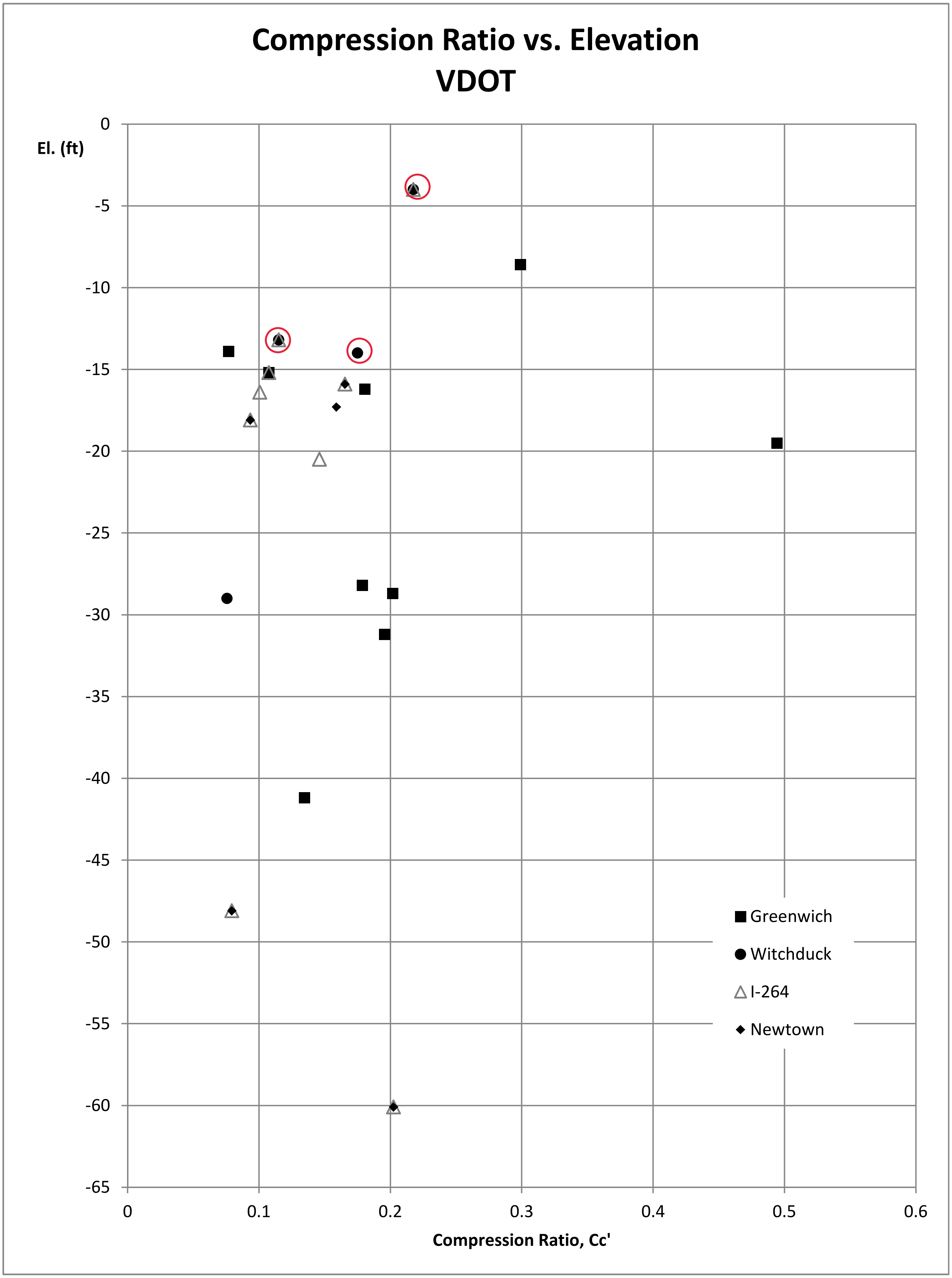
VDOT Virginia Department of Transportation

Project 0264-134-102
City of Virginia Beach

Project Study Area
Witchduck

Drawing 4: Subsurface Cross Section Locations


Recompression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.005
0.01
0.015
0.02
0.025
0.03
Recompression Ratio, Cr'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown


Compression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.1
0.2
0.3
0.4
0.5
0.6
Compression Ratio, Cc'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

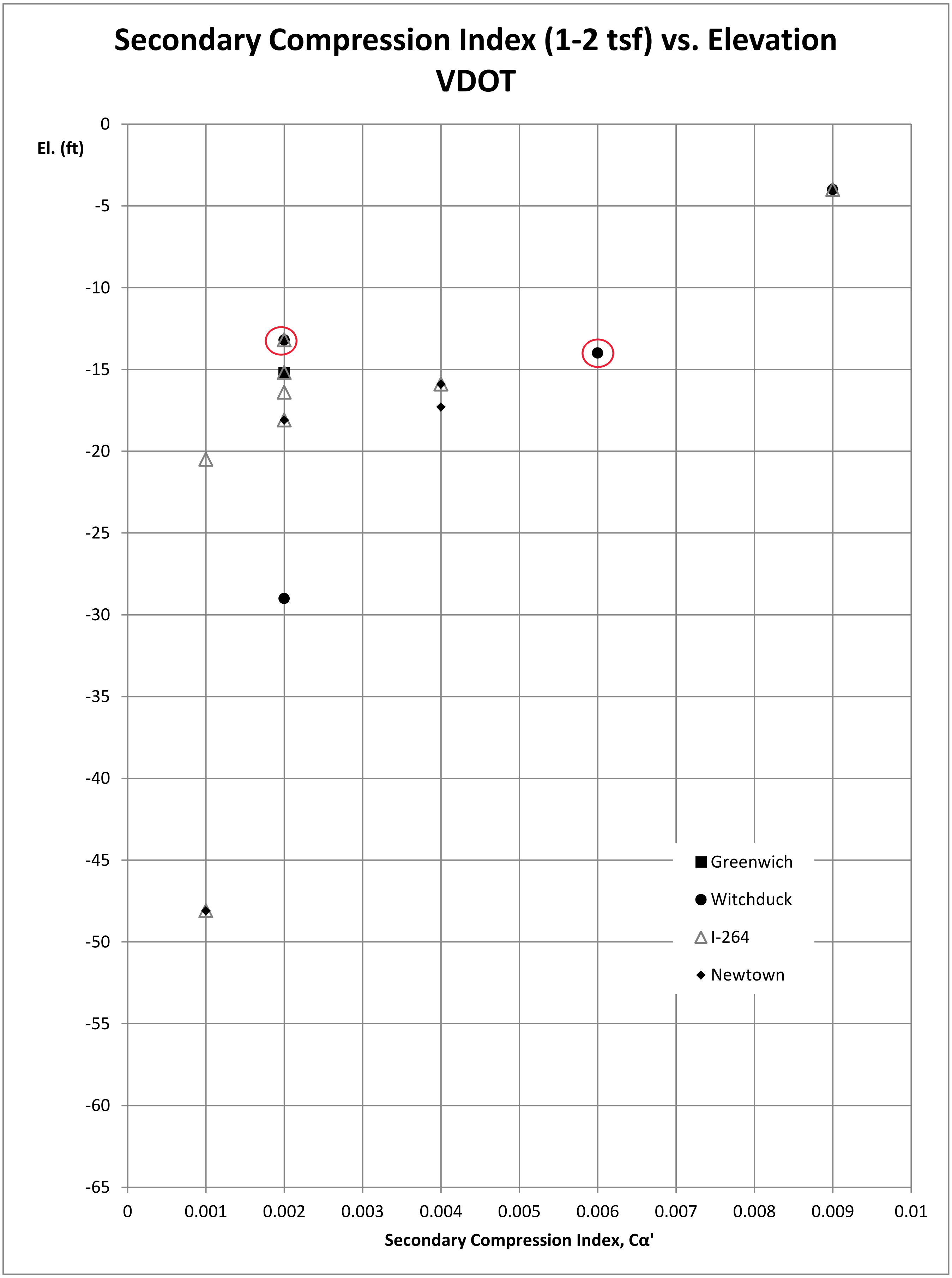

Secondary Compression Index (1-2 tsf) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
Secondary Compression Index, Cα'
Greenwich
Witchduck
I-264
Newtown

Table D-3

Typical Elastic Moduli

Soil	E_s, tsf
Clay	
Very soft clay	5 - 50
Soft clay	50 - 200
Medium clay	200 - 500
Stiff clay, silty clay	500 - 1000
Sandy clay	250 - 2000
Clay shale	1000 - 2000
Sand	
Loose sand	100 - 250
Dense sand	250 - 1000
Dense sand and gravel	1000 - 2000
Silty sand	250 - 2000

c. Laboratory Tests on Cohesive Soil. The elastic modulus is sensitive to soil disturbance which may increase pore water pressure and, therefore, decrease the effective stress in the specimen and reduce the stiffness and strength. Fissures, which may have little influence on field settlement, may reduce the measured modulus compared with the in situ modulus if confining pressures are not applied to the soil specimen.

(1) Initial hyperbolic tangent modulus. Triaxial unconsolidated undrained (Q or UU) compression tests may be performed on the best available undisturbed specimens at confining pressures equal to the total vertical overburden pressure σ_o for that specimen when in the field using the Q test procedure described in EM 1110-2-1906, Laboratory Soils Testing. An appropriate measure of E_s is the initial tangent modulus $E_{ti} = 1/a$ where a is the intercept of a plot of strain/deviator stress versus strain, Figure D-3 (item 14).

(2) Reload modulus. A triaxial consolidated undrained (R or CU) compression test may be performed on the best available undisturbed specimens. The specimen is initially fully consolidated to an isotropic confining pressure equal to the vertical overburden pressure σ_o for that specimen in the field. The R test procedure described in EM 1110-2-1906 may be used except as follows: stress is increased to the magnitude estimated for the field loading condition. The axial stress may then be reduced to zero and the cycle repeated until the reload curve shows no further increase in slope. The tangent modulus at 1/2 of the maximum applied stress is determined for each loading cycle and plotted versus the number of cycles, Figure D-4. An appropriate measure of E_s is the reload tangent modulus that approaches the asymptotic value at large cycles.

d. Field Tests. The elastic modulus may be estimated from empirical and semiempirical relationships based on results of field soil tests. Refer to

I-264, Witchduck Ramp B STA 406+00

PROJECT IDENTIFICATION

Title:	I-264, Witchduck Ramp B STA 406+00
Project Number:	-
Client:	
Designer:	AW
Station Number:	

Description:
Witchduck Ramp B STA 406+00.00, 5' surcharge + PVD

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... OSSA\Witchduck Loop B 406+00 with 5' surcharge.2ST
Original date and time of creating this file: Fri Jan 06 16:39:14 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 8 layers

	Wet Unit Weight, γ [lb/ft³]	Poisson's Ratio μ	Description of Soil
1	115.00	0.30	Layer 1 Upper Sand
2	115.00	0.30	Layer 2 Upper Sand
3	120.00	0.50	Layer 3 Upper Clay
4	115.00	0.30	Layer 4 Upper Sand
5	112.00	0.50	Layer 5 Upper Clay
6	125.00	0.30	Layer 6 Lower Sand
7	118.00	0.50	Layer 7 Lower Clay
8	125.00	0.30	Layer 8 Yorktown

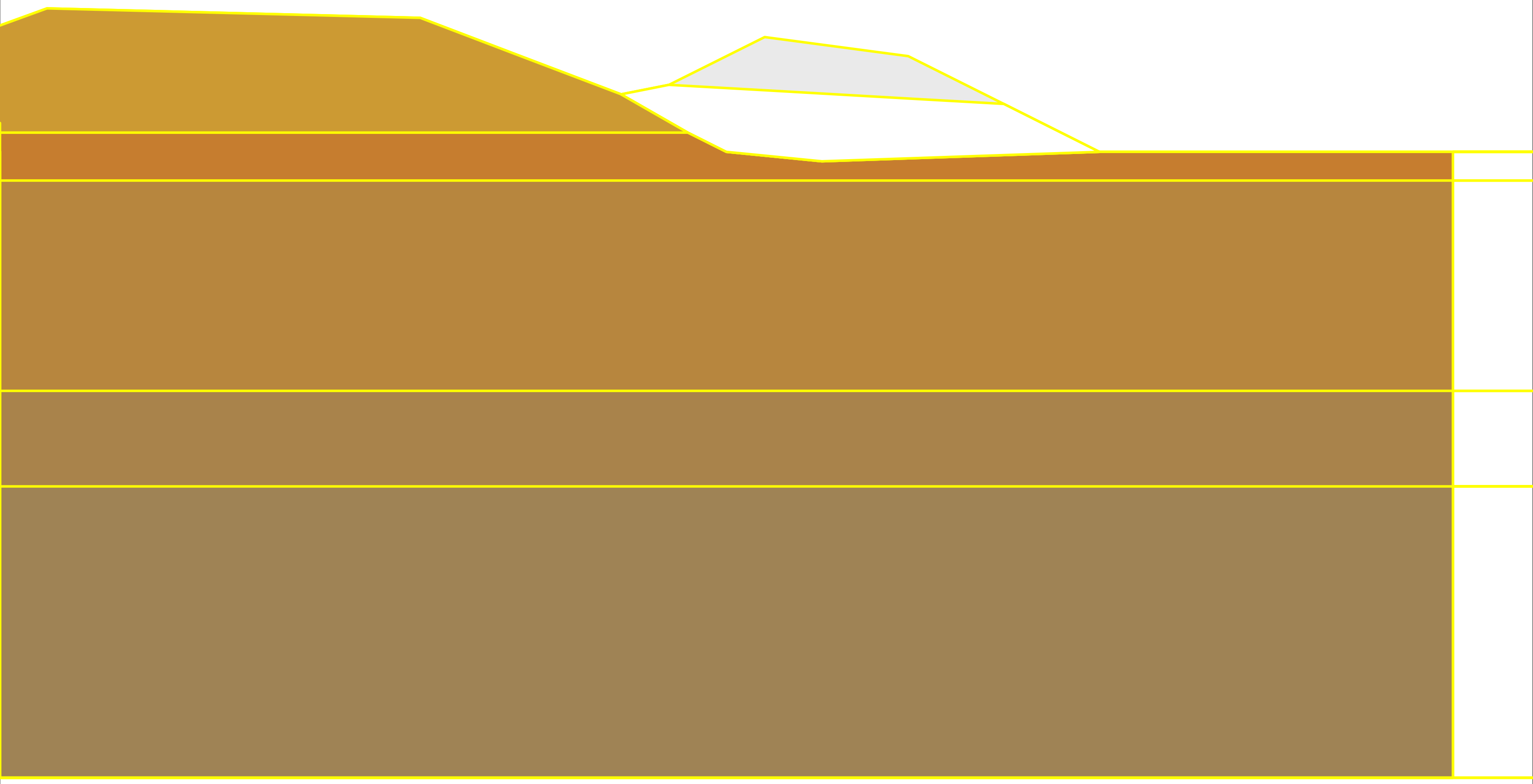
INPUT DATA – EMBANKMENT LAYERS -- 2 layers

	Wet Unit Weight, γ [lb/ft³]	Description of Soil
1	130.00	Proposed Fill
2	130.00	Surcharge

INPUT DATA OF WATER

Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]
1	0.00	4.00
2	1000.00	4.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft ²/day]	Drains at :	PVD through Layer No/Yes	Ch=Coeff. for horiz. drainage [ft ²/day]
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	No	0.2153
4	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	No	0.2153
6	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	No	0.2153
8	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

PVD : Triangle Pattern where D = 1.05 x 5.00 = 5.25 ft.
dw = 2 x (a + b) / 3.14 = 2.607 inch --> F(n) = 2.44. Fs for disturbance = 0.000
and Fr' = 0.050

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	60.00	0.00	1	500000	0.3000	0.0000	26.31	26.30	0.00
			2	500000	0.3000	-0.0004			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0015			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0053			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
2	62.04	0.00	1	500000	0.3000	0.0000	26.26	26.25	0.00
			2	500000	0.3000	-0.0005			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0015			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0059			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
3	64.08	0.00	1	500000	0.3000	0.0000	26.20	26.20	0.00
			2	500000	0.3000	-0.0005			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0015			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0067			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
4	66.12	0.00	1	500000	0.3000	0.0000	26.15	26.15	0.01
			2	500000	0.3000	-0.0006			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0015			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0075			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
5	68.16	0.00	1	500000	0.3000	0.0000	26.10	26.09	0.01
			2	500000	0.3000	-0.0006			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0015			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0083			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
6	70.20	0.00	1	500000	0.3000	0.0000	26.05	26.04	0.01
			2	500000	0.3000	-0.0007			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0015			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0093			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
7	72.24	0.00	1	500000	0.3000	0.0000	25.91	25.90	0.01
			2	500000	0.3000	-0.0007			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0014			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0103			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
8	74.29	0.00	1	500000	0.3000	0.0000	25.13	25.12	0.01
			2	500000	0.3000	-0.0007			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0013			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0114			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
9	76.33	0.00	1	500000	0.3000	0.0000	24.35	24.34	0.01
			2	500000	0.3000	-0.0007			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0011			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0125			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
10	78.37	0.00	1	500000	0.3000	0.0000	23.57	23.56	0.01
			2	500000	0.3000	-0.0007			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0008			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0138			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
11	80.41	0.00	1	500000	0.3000	0.0000	22.80	22.78	0.01
			2	500000	0.3000	-0.0006			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0004			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0151			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
12	82.45	0.00	1	500000	0.3000	0.0000	22.02	22.00	0.02
			2	500000	0.3000	-0.0006			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0002			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0164			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
13	84.49	0.00	1	500000	0.3000	0.0000	21.24	21.22	0.02
			2	500000	0.3000	-0.0006			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0010			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0178			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
14	86.53	0.00	1	500000	0.3000	0.0000	20.46	20.44	0.02
			2	500000	0.3000	-0.0006			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0021			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0193			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
15	88.57	0.00	1	500000	0.3000	0.0000	19.69	19.66	0.02
			2	500000	0.3000	-0.0005			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0036			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0208			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
16	90.61	0.00	1	500000	0.3000	0.0000	18.91	18.88	0.03
			2	500000	0.3000	-0.0005			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0056			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0223			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
17	92.65	0.00	1	500000	0.3000	0.0000	18.13	18.10	0.03
			2	500000	0.3000	-0.0003			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0083			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0239			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
18	94.69	0.00	1	500000	0.3000	0.0000	17.03	16.99	0.04
			2	500000	0.3000	0.0004			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0119			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0254			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section:		Layer (k)	Young's Modulus, E	Poisson's Ratio, μ	Settlement of each layer, Si(k)	Initial Z	Final Z *	Total Settlement Sum of Si(k),
	X [ft.]	Y [ft.]		[lb/ft ²]		[ft.]	[ft.]	[ft.]	[ft.]
19	96.73	0.00	1	500000	0.3000	0.0000	15.87	15.82	0.04
			2	500000	0.3000	0.0008			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0161			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0268			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
20	98.78	0.00	1	500000	0.3000	0.0000	14.70	14.65	0.05
			2	500000	0.3000	0.0007			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0208			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0282			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
21	100.82	0.00	1	500000	0.3000	0.0000	13.59	13.54	0.06
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0258			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0296			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
22	102.86	0.00	1	500000	0.3000	0.0000	12.57	12.51	0.06
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0305			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0308			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
23	104.90	0.00	1	500000	0.3000	0.0000	11.91	11.84	0.07
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0348			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0319			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
24	106.94	0.00	1	500000	0.3000	0.0000	11.71	11.64	0.07
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0383			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0328			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
25	108.98	0.00	1	500000	0.3000	0.0000	11.50	11.43	0.07
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0408			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0336			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
26	111.02	0.00	1	500000	0.3000	0.0000	11.30	11.22	0.08
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0425			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0342			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
27	113.06	0.00	1	500000	0.3000	0.0000	11.09	11.02	0.08
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0432			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0346			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
28	115.10	0.00	1	500000	0.3000	0.0000	11.04	10.96	0.08
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0433			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0348			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
29	117.14	0.00	1	500000	0.3000	0.0000	11.11	11.03	0.08
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0427			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0347			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
30	119.18	0.00	1	500000	0.3000	0.0000	11.18	11.10	0.08
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0415			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0345			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft^2]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
31	121.22	0.00	1	500000	0.3000	0.0000	11.25	11.18	0.07
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0397			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0341			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
32	123.27	0.00	1	500000	0.3000	0.0000	11.32	11.25	0.07
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0374			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0335			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
33	125.31	0.00	1	500000	0.3000	0.0000	11.39	11.32	0.07
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0346			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0327			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
34	127.35	0.00	1	500000	0.3000	0.0000	11.46	11.40	0.06
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0314			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0318			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
35	129.39	0.00	1	500000	0.3000	0.0000	11.53	11.47	0.06
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0279			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0307			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
36	131.43	0.00	1	500000	0.3000	0.0000	11.60	11.55	0.05
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0242			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0295			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
37	133.47	0.00	1	500000	0.3000	0.0000	11.67	11.62	0.05
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0205			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0281			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
38	135.51	0.00	1	500000	0.3000	0.0000	11.74	11.70	0.04
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0168			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0267			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
39	137.55	0.00	1	500000	0.3000	0.0000	11.81	11.77	0.04
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0133			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0253			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
40	139.59	0.00	1	500000	0.3000	0.0000	11.88	11.85	0.03
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0100			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0238			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
41	141.63	0.00	1	500000	0.3000	0.0000	11.95	11.92	0.03
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0071			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0223			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
42	143.67	0.00	1	500000	0.3000	0.0000	12.00	11.97	0.03
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0048			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0208			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
43	145.71	0.00	1	500000	0.3000	0.0000	12.00	11.98	0.02
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0030			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0193			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
44	147.76	0.00	1	500000	0.3000	0.0000	12.00	11.98	0.02
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0017			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0179			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
45	149.80	0.00	1	500000	0.3000	0.0000	12.00	11.98	0.02
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0007			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0165			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
46	151.84	0.00	1	500000	0.3000	0.0000	12.00	11.98	0.02
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0000			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0151			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
47	153.88	0.00	1	500000	0.3000	0.0000	12.00	11.99	0.01
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0005			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0139			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
48	155.92	0.00	1	500000	0.3000	0.0000	12.00	11.99	0.01
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0009			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0126			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
49	157.96	0.00	1	500000	0.3000	0.0000	12.00	11.99	0.01
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0011			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0115			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
50	160.00	0.00	1	500000	0.3000	0.0000	12.00	11.99	0.01
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0013			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0104			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	60.00	0.00	26.31	0.00	26.31
2	62.04	0.00	26.26	0.00	26.25
3	64.08	0.00	26.20	0.00	26.20
4	66.12	0.00	26.15	0.00	26.15
5	68.16	0.00	26.10	0.00	26.09
6	70.20	0.00	26.05	0.00	26.04
7	72.24	0.00	25.91	0.00	25.90
8	74.29	0.00	25.13	0.00	25.12
9	76.33	0.00	24.35	0.01	24.35
10	78.37	0.00	23.57	0.01	23.57
11	80.41	0.00	22.80	0.01	22.79
12	82.45	0.00	22.02	0.01	22.01
13	84.49	0.00	21.24	0.01	21.23
14	86.53	0.00	20.46	0.01	20.46
15	88.57	0.00	19.69	0.01	19.68
16	90.61	0.00	18.91	0.01	18.90
17	92.65	0.00	18.13	0.01	18.12
18	94.69	0.00	17.03	0.02	17.01
19	96.73	0.00	15.87	0.03	15.84
20	98.78	0.00	14.70	0.12	14.58
21	100.82	0.00	13.59	0.23	13.36
22	102.86	0.00	12.57	0.25	12.32
23	104.90	0.00	11.91	0.25	11.66
24	106.94	0.00	11.71	0.00	11.71
25	108.98	0.00	11.50	0.26	11.24

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
26	111.02	0.00	11.30	0.25	11.05
27	113.06	0.00	11.09	0.24	10.85
28	115.10	0.00	11.04	0.24	10.80
29	117.14	0.00	11.11	0.24	10.87
30	119.18	0.00	11.18	0.24	10.94
31	121.22	0.00	11.25	0.24	11.01
32	123.27	0.00	11.32	0.23	11.09
33	125.31	0.00	11.39	0.22	11.17
34	127.35	0.00	11.46	0.21	11.25
35	129.39	0.00	11.53	0.20	11.33
36	131.43	0.00	11.60	0.18	11.42
37	133.47	0.00	11.67	0.16	11.51
38	135.51	0.00	11.74	0.13	11.61
39	137.55	0.00	11.81	0.10	11.71
40	139.59	0.00	11.88	0.06	11.83
41	141.63	0.00	11.95	0.02	11.93
42	143.67	0.00	12.00	0.02	11.98
43	145.71	0.00	12.00	0.01	11.99
44	147.76	0.00	12.00	0.01	11.99
45	149.80	0.00	12.00	0.01	11.99
46	151.84	0.00	12.00	0.01	11.99
47	153.88	0.00	12.00	0.01	11.99
48	155.92	0.00	12.00	0.01	11.99
49	157.96	0.00	12.00	0.01	11.99
50	160.00	0.00	12.00	0.01	11.99

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	 (Z) [ft.]	DESCRIPTION
1	1	0.00	15.00	Layer 1 Upper Sand
	2	33.00	27.00	
	3	72.00	26.00	
	4	93.00	18.00	
	5	100.00	14.00	
	6	104.00	12.00	
	7	114.00	11.00	
	8	143.00	12.00	
	9	1000.00	12.00	
2	1	0.00	15.00	Layer 2 Upper Sand
	2	33.00	27.00	
	3	72.00	26.00	
	4	93.00	18.00	
	5	100.00	14.00	
	6	104.00	12.00	
	7	114.00	11.00	
	8	143.00	12.00	
	9	1000.00	12.00	
3	1	0.00	14.00	Layer 3 Upper Clay
	2	13.00	14.00	
	3	82.00	14.00	
	4	100.00	14.00	
	5	104.00	12.00	
	6	114.00	11.00	
	7	143.00	12.00	
	8	1000.00	12.00	
4	1	0.00	9.00	Layer 4 Upper Sand
	2	1000.00	9.00	
5	1	0.00	-13.00	Layer 5 Upper Clay
	2	1000.00	-13.00	
6	1	0.00	-23.00	Layer 6 Lower Sand
	2	1000.00	-23.00	
7	1	0.00	-58.00	Layer 7 Lower Clay
	2	1000.00	-58.00	
8	1	0.00	-68.00	Layer 8 Yorktown
	2	1000.00	-68.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 93.00 [ft]	1	93.00	18.00	Proposed Fill
	X2 = 143.00 [ft]	2	98.00	19.00	
		3	133.00	17.00	
		4	143.00	12.00	
2	X1 = 93.00 [ft]	1	98.00	19.00	Surcharge
	X2 = 143.00 [ft]	2	108.00	24.00	
		3	123.00	22.00	
		4	133.00	17.00	

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                    STA 406+00 with 5' surcharge + PVD_120 days
    Results of Condolidation After 120.0 days.   (With PVD's)
  ======================================================================

------------------------------------------------------------------------------------
-
   Layer         PVD installed         Uv        Uh        Uave.   Sc-ult     Sc(t)
 Undergoing      Through Layer:
Consolidation
    NO / YES         NO / YES          [%]       [%]        [%]    [ft]      [ft]
------------------------------------------------------------------------------------
-
   1    NO             N/A              N/A       N/A       N/A       N/A       N/A
   2    NO             N/A              N/A       N/A       N/A       N/A       N/A
   3   YES              NO            100.00      0.00    100.00     0.000     0.000
   4    NO             N/A              N/A       N/A       N/A       N/A       N/A
   5   YES              NO             77.09      0.00     77.09     0.000     0.000
   6    NO             N/A              N/A       N/A       N/A       N/A       N/A
   7   YES              NO             86.02      0.00     86.02     0.000     0.000
   8    NO             N/A              N/A       N/A       N/A       N/A       N/A
```

Estimation of Secondary Settlement

Project Name:	**I-264 Witchduck Ramp B STA 406+00**
Date:	1/8/2017
Calculated by:	AW
Checked by:	

Project Life = **20** **years**

CASE II: Surcharge

Height of surcharge = **5** **feet**

Surcharge unit weight = **130** **pcf** (if surcharge placed below water, enter bouyant unit weight)

S No.	Clay Layer	Thickness (ft)	C_α' (NC, strain based)	t_{90}[3] (years)	Final Effective stress at layer midpoint[4] (psf)	Effective stress decrease due to surcharge removal (psf)	AAOS[5]	C_α' (surcharge)/ C_α' (NC) [6]	C_α' (surcharge)[6]	Secondary Settlement (ft)
1	UC-1	2.5	0.003	0.25	1060	650	61%	-0.09	0.0000	0.00
2	UC	10	0.003	0.25	2927.2	650	22%	0.39	0.0012	0.02
3	LC	10	0.0003	0.25	5644.2	650	12%	0.70	0.0002	0.00

TOTAL SECONDARY SETTLEMENT = **0.03 ft**

or

0.31 in

Notes

1 C_α' (NC, strain based) is the coefficient of secondary settlement without the effect of oversolidation or surcharge.

2 t_{90} is the time to complete 90% primary consolidation.

3 t_{90} with surcharge might be less due to the use of wick drains.

4 The "final effective stress at layer mid point" is the effective stress after the removal of the surcharge.

5 AAOS is the Adjusted Amount of Surcharge, which is the effective stress reduction caused by surcharge removal.
It is calculated as stress decrease due to surcharge removal divided by final effective stress at the depth of interest.

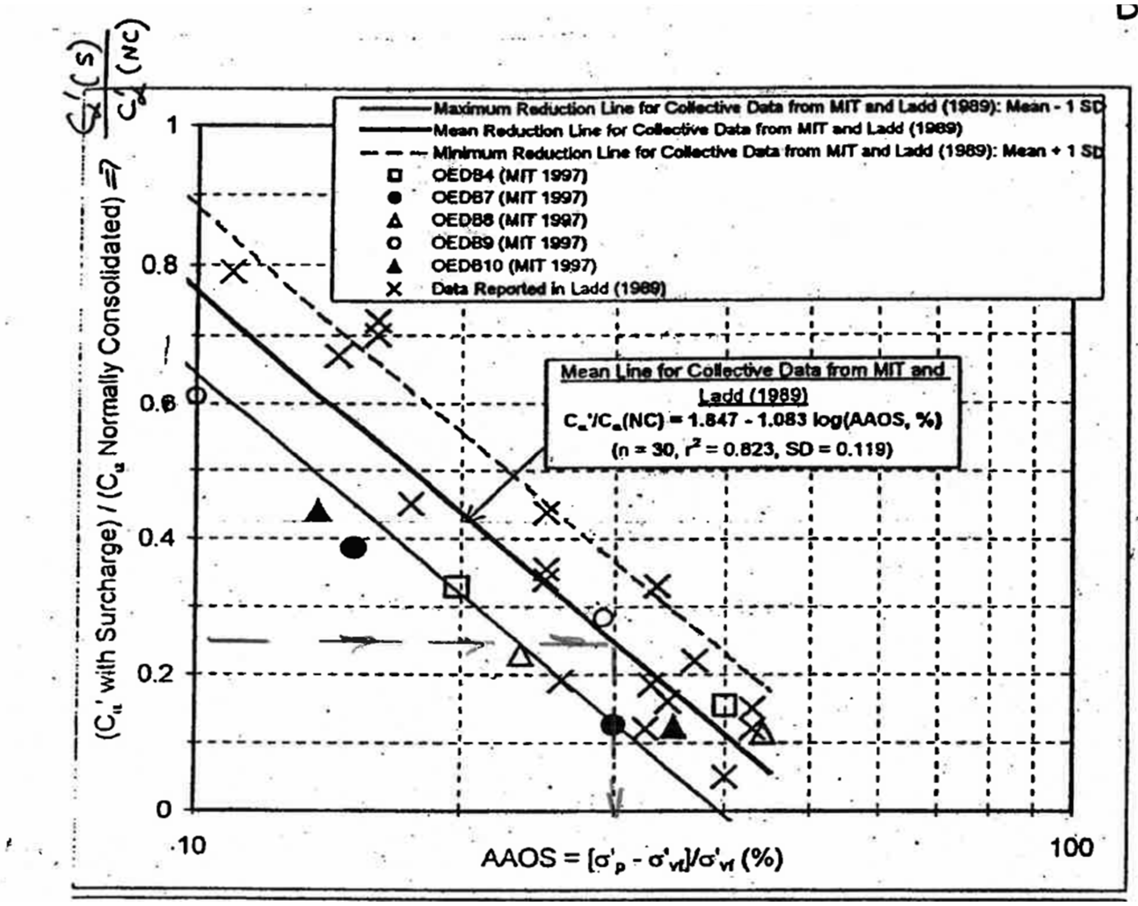
6 C_α' (surcharge) is the reduced coefficient of secondary settlement due to the application of surcharge.
This is estimated based on Ladd (1989) correlation shown in page 2.

7 Secondary settlement was calculated using the following equation:

$$S_{sec} = H.C'_{\propto}.\log(\frac{t_{project\ life}}{t_{90}})$$

8 It is assumed that surcharge, if placed, will be removed at 90% primary consolidation.

Ladd, 1989



Maximum Reduction Line for Collective Data from MIT and Ladd (1989): Mean - 1 SD
Mean Reduction Line for Collective Data from MIT and Ladd (1989)
Minimum Reduction Line for Collective Data from MIT and Ladd (1989): Mean + 1 SD
□ OEDB4 (MIT 1997)
● OEDB7 (MIT 1997)
△ OEDB8 (MIT 1997)
○ OEDB9 (MIT 1997)
▲ OEDB10 (MIT 1997)
× Data Reported in Ladd (1989)
Mean Line for Collective Data from MIT and Ladd (1989)
$C_\alpha'/C_\alpha(NC) = 1.847 - 1.083 \log(AAOS, \%)$
($n = 30$, $r^2 = 0.823$, $SD = 0.119$)
(C_α' with Surcharge) / (C_α Normally Consolidated) ⇒
$\frac{C_\alpha'(s)}{C_\alpha'(NC)}$
1
0.8
0.6
0.4
0.2
0
10
100
$AAOS = [\sigma'_p - \sigma'_{vf}]/\sigma'_{vf}$ (%)

URS

Page ______ of ______

Job Soil Profile I-264 Witchduck

Project No. ______

Sheet ______ of ______

Description STA 407+66 Witchduck Temp On Ramp B

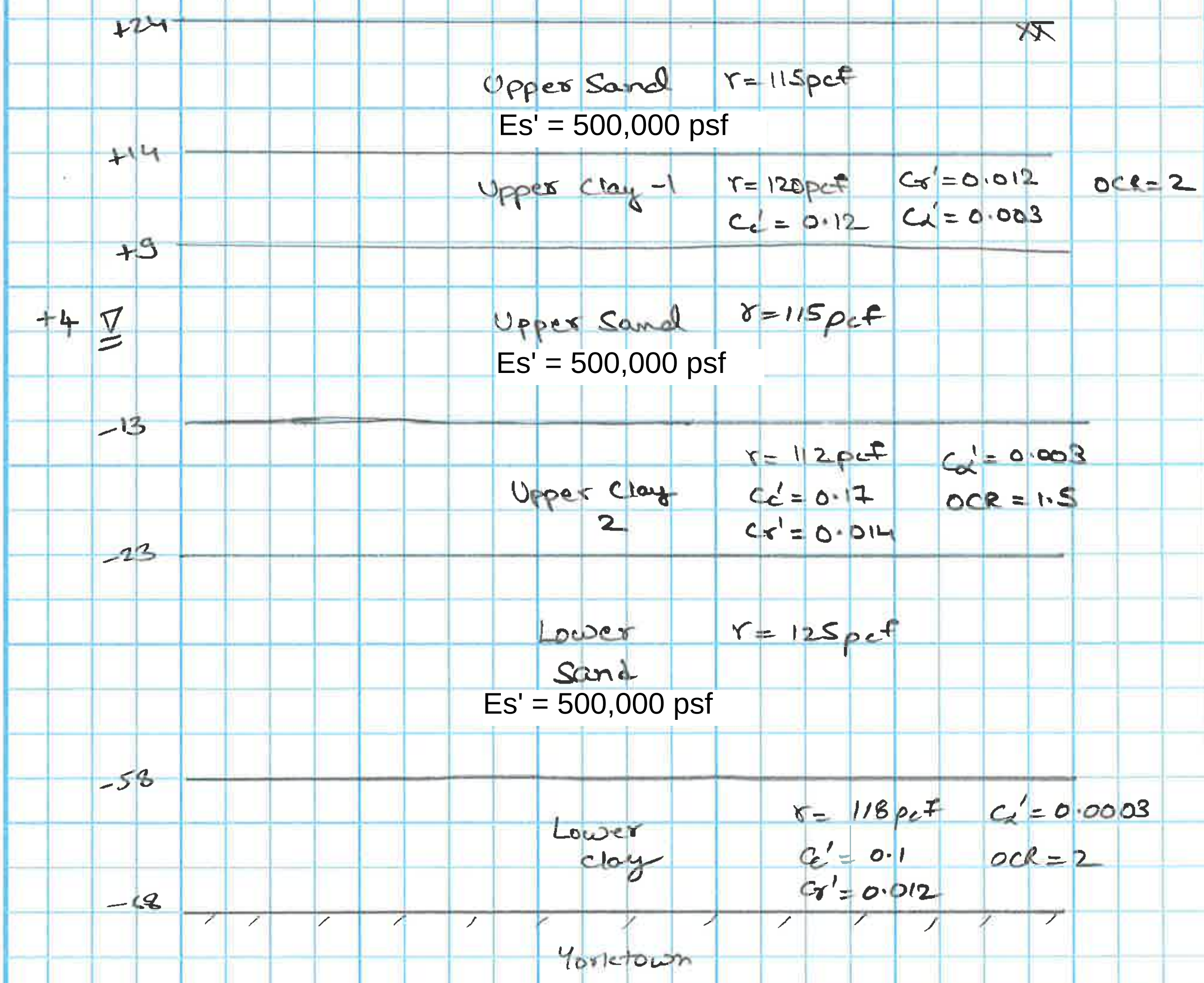
Computed by AS

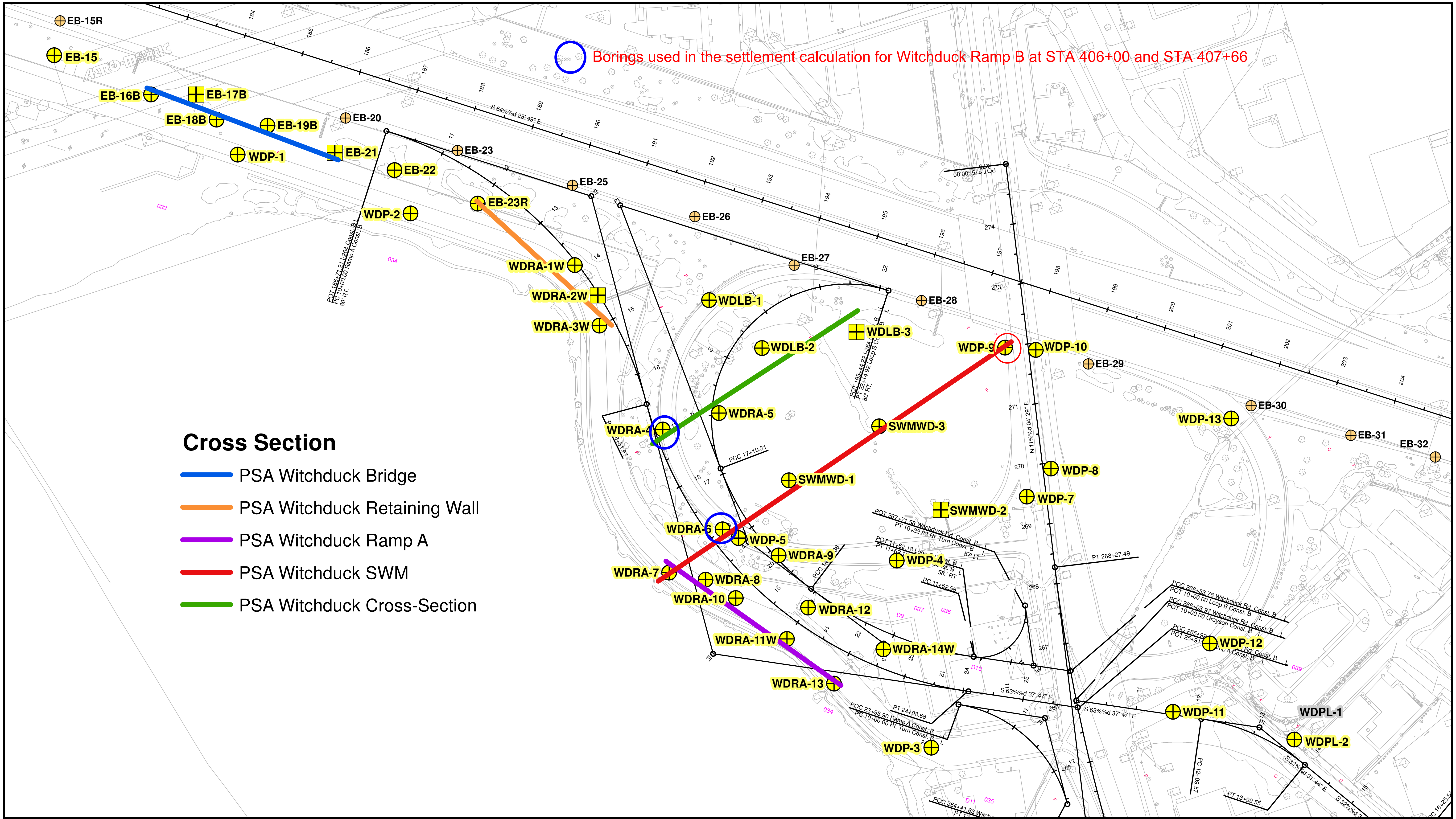
Date 1/7/12

Checked by ______

Date ______

Reference





Borings used in the settlement calculation for Witchduck Ramp B at STA 406+00 and STA 407+66

Cross Section

🟦 PSA Witchduck Bridge
🟧 PSA Witchduck Retaining Wall
🟪 PSA Witchduck Ramp A
🟥 PSA Witchduck SWM
🟩 PSA Witchduck Cross-Section

0 75 150 Feet
Scale: 1" = 150'

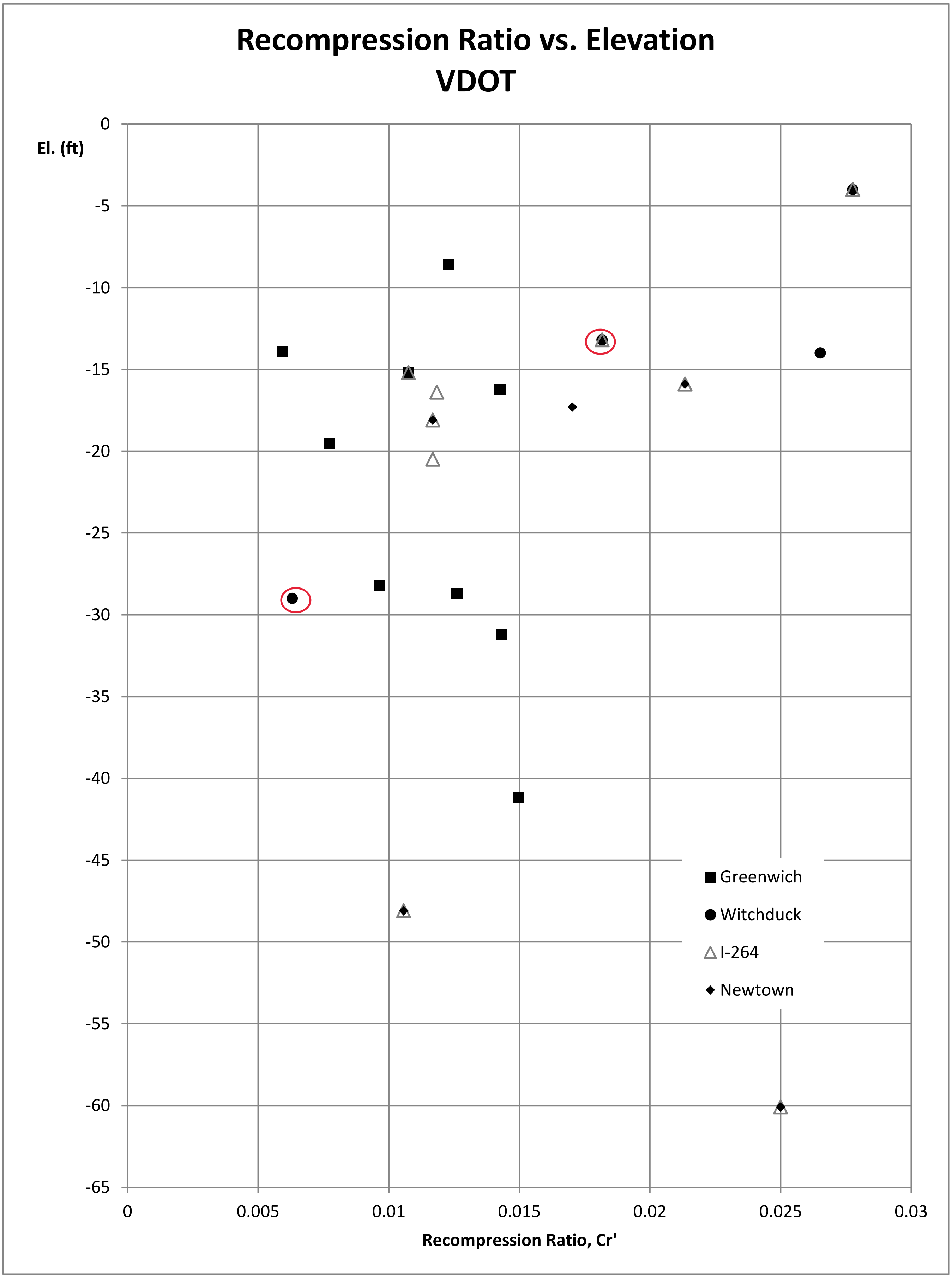
⊕ SPT Exploration
⊞ CPT Exploration
⊕ PSA I-264 CD Borings

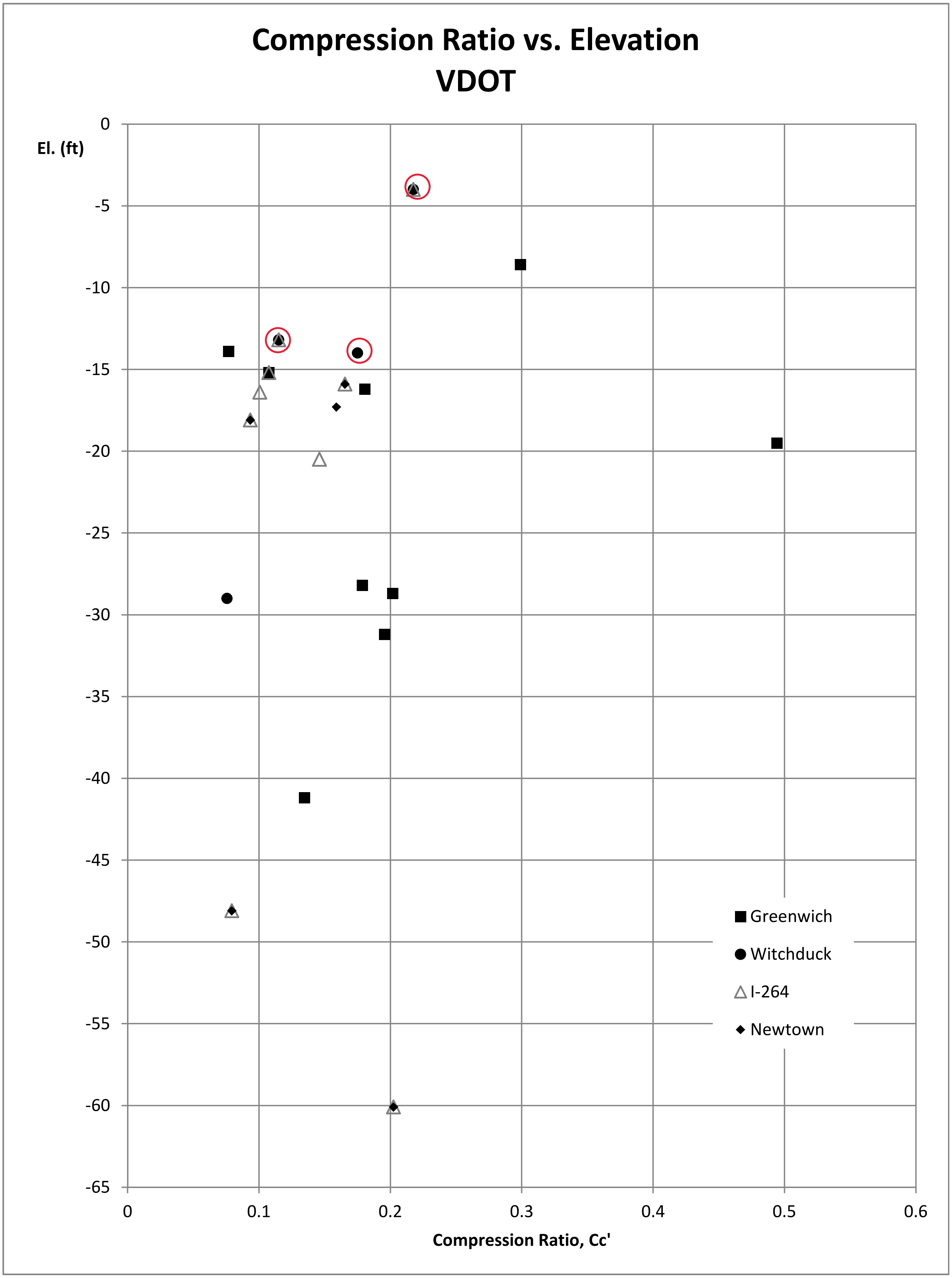
Prepared by: HDR
Date: February 13, 2013

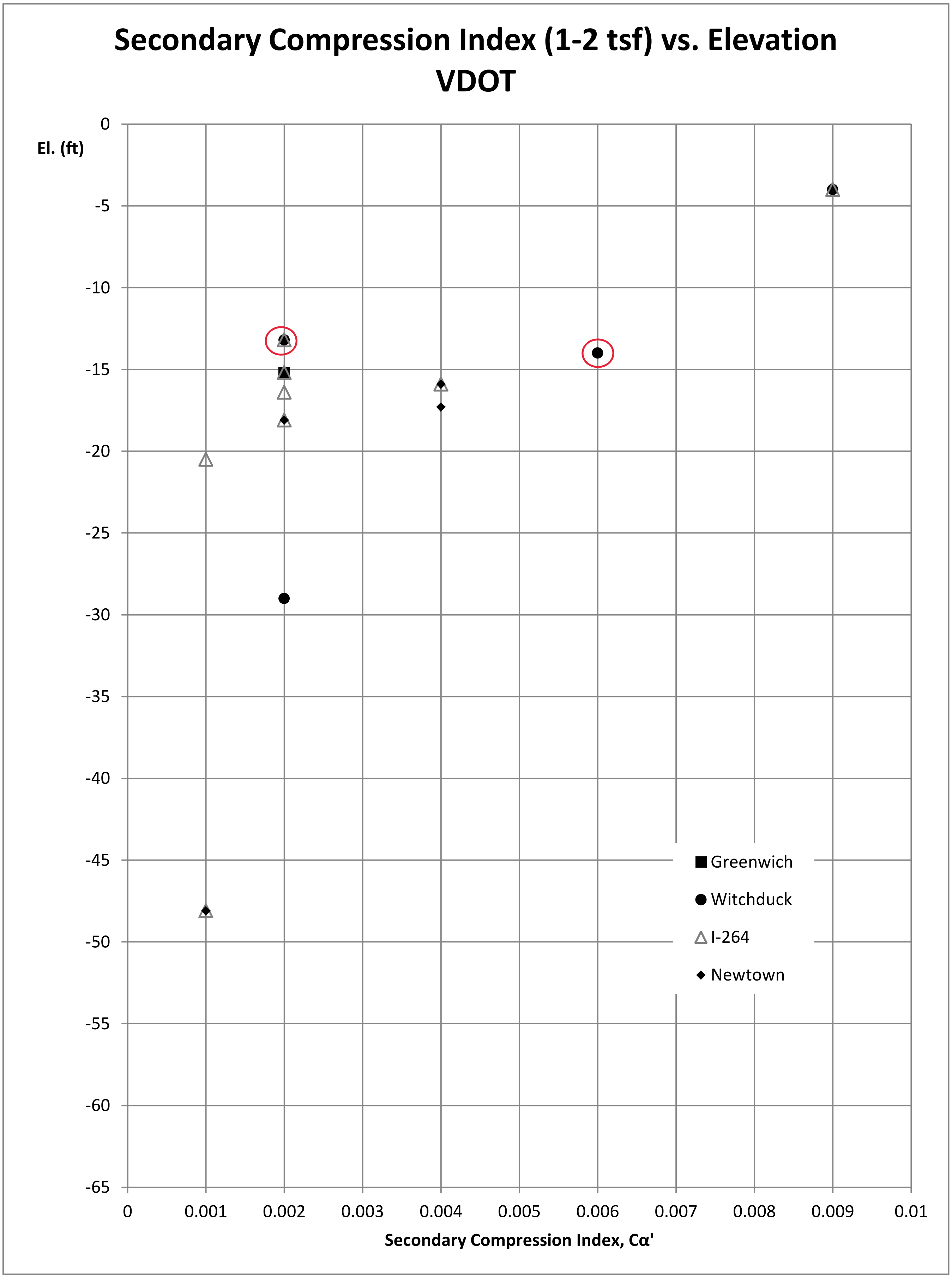
VDOT Virginia Department of Transportation
Project 0264-134-102
City of Virginia Beach

Project Study Area
Witchduck

Drawing 4: Subsurface Cross Section Locations


Recompression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.005
0.01
0.015
0.02
0.025
0.03
Recompression Ratio, Cr'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown


Compression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.1
0.2
0.3
0.4
0.5
0.6
Compression Ratio, Cc'
Greenwich
Witchduck
I-264
Newtown



Secondary Compression Index (1-2 tsf) vs. Elevation
VDOT

Table D-3

Typical Elastic Moduli

Soil	E_s, tsf
Clay	
Very soft clay	5 - 50
Soft clay	50 - 200
Medium clay	200 - 500
Stiff clay, silty clay	500 - 1000
Sandy clay	250 - 2000
Clay shale	1000 - 2000
Sand	
Loose sand	100 - 250
Dense sand	250 - 1000
Dense sand and gravel	1000 - 2000
Silty sand	250 - 2000

c. Laboratory Tests on Cohesive Soil. The elastic modulus is sensitive to soil disturbance which may increase pore water pressure and, therefore, decrease the effective stress in the specimen and reduce the stiffness and strength. Fissures, which may have little influence on field settlement, may reduce the measured modulus compared with the in situ modulus if confining pressures are not applied to the soil specimen.

(1) Initial hyperbolic tangent modulus. Triaxial unconsolidated undrained (Q or UU) compression tests may be performed on the best available undisturbed specimens at confining pressures equal to the total vertical overburden pressure σ_o for that specimen when in the field using the Q test procedure described in EM 1110-2-1906, Laboratory Soils Testing. An appropriate measure of E_s is the initial tangent modulus $E_{ti} = 1/a$ where a is the intercept of a plot of strain/deviator stress versus strain, Figure D-3 (item 14).

(2) Reload modulus. A triaxial consolidated undrained (R or CU) compression test may be performed on the best available undisturbed specimens. The specimen is initially fully consolidated to an isotropic confining pressure equal to the vertical overburden pressure σ_o for that specimen in the field. The R test procedure described in EM 1110-2-1906 may be used except as follows: stress is increased to the magnitude estimated for the field loading condition. The axial stress may then be reduced to zero and the cycle repeated until the reload curve shows no further increase in slope. The tangent modulus at 1/2 of the maximum applied stress is determined for each loading cycle and plotted versus the number of cycles, Figure D-4. An appropriate measure of E_s is the reload tangent modulus that approaches the asymptotic value at large cycles.

d. Field Tests. The elastic modulus may be estimated from empirical and semiempirical relationships based on results of field soil tests. Refer to

I-264 Witchduck Temp Ramp B STA 407+66

PROJECT IDENTIFICATION

Title: I-264 Witchduck Temp Ramp B STA 407+66
Project Number: -
Client:
Designer: AW
Station Number:

Description:

Witchduck Temp Ramp B STA 407+66, 15' max fill, no GI

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: \\ursgerma ..... tions\Settlement\FOSSA\Witchduck Loop B 407+66.2ST
Original date and time of creating this file: Mon Jan 09 11:25:52 2017

GEOMETRY: Analysis of a 2D geometry

INPUT DATA – FOUNDATION LAYERS – 8 layers

	Wet Unit Weight, γ [lb/ft³]	**Poisson's Ratio μ**	**Description of Soil**
1	125.00	0.30	Layer 1 Existing Fill
2	110.00	0.30	Layer 2 Upper Sand
3	120.00	0.50	Layer 3 Upper Clay
4	115.00	0.30	Layer 4 Upper Sand
5	112.00	0.50	Layer 5 Upper Clay
6	125.00	0.30	Layer 6 Lower Sand
7	118.00	0.50	Layer 7 Lower Clay
8	125.00	0.30	Layer 8 Yorktown

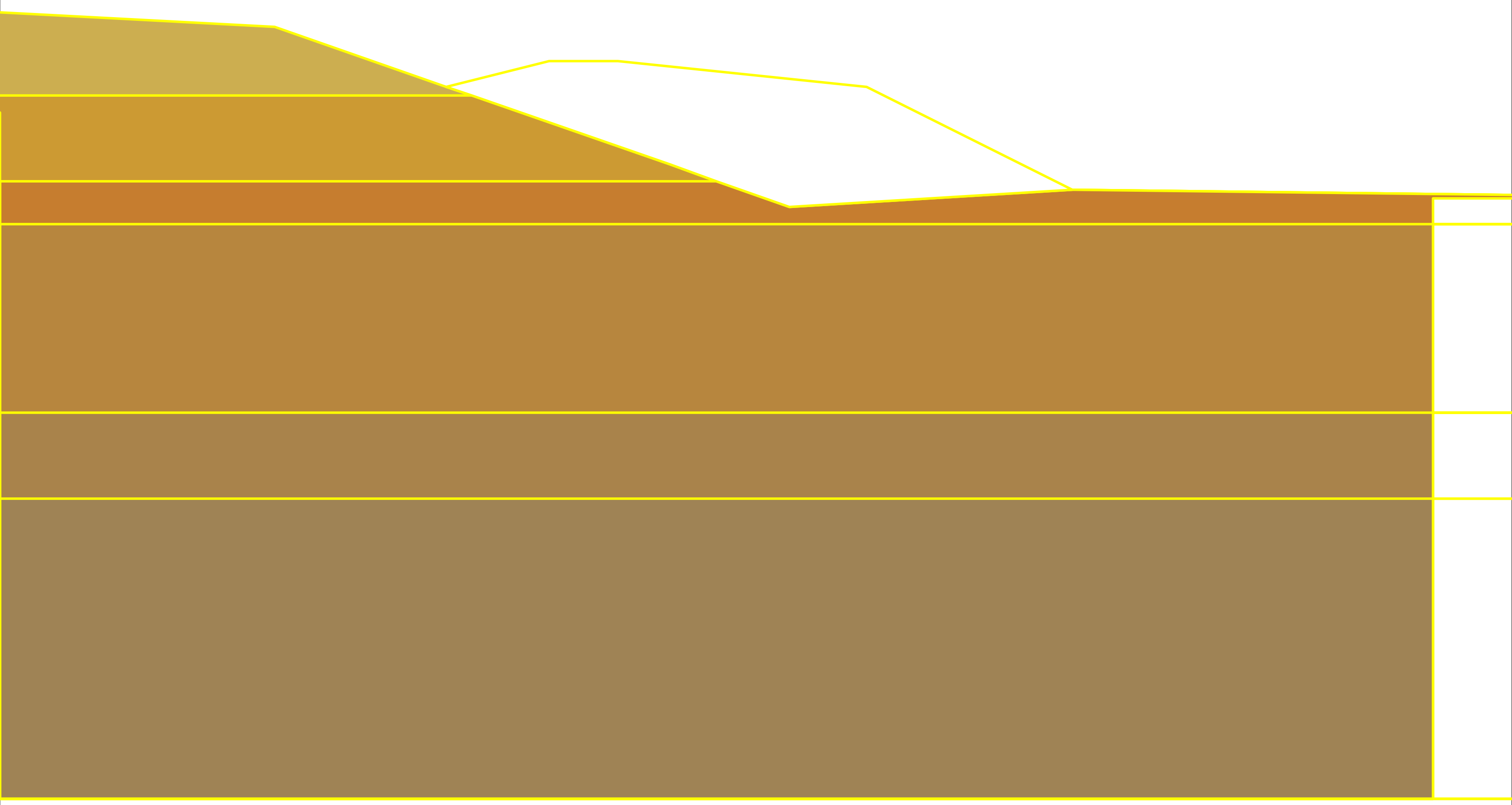
INPUT DATA – EMBANKMENT LAYERS -- 1 layers

	Wet Unit Weight, γ [lb/ft³]	**Description of Soil**
1	130.00	Proposed Fill

INPUT DATA OF WATER

Point #	**Coordinates (X, Z) :** (X) [ft.]	(Z) [ft.]
1	0.00	4.00
2	1000.00	4.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc / (1+e0)	Cr / (1+e0)	e0	Cv [ft^2/day]	Drains at :	CREEP Ca/Cc
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	Yes	2.00	0.120	0.012	N/A	0.1000	Top & Bot.	0.0250
4	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	Yes	1.50	0.170	0.014	N/A	0.1000	Top & Bot.	0.0176
6	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	Yes	2.00	0.100	0.012	N/A	0.1400	Top & Bot.	0.0030
8	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Secondary Comprassion (Creep) : Settlement is calculated at t2/t1 = 40.0

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ^{2}]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	50.00	0.00	1	500000	0.3000	-0.0002	32.63	32.63	0.01
			2	500000	0.3000	-0.0003			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0018			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0074			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
2	52.65	0.00	1	500000	0.3000	-0.0002	32.49	32.49	0.01
			2	500000	0.3000	-0.0004			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0017			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0085			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
3	55.31	0.00	1	500000	0.3000	-0.0003	32.35	32.34	0.01
			2	500000	0.3000	-0.0004			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0015			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0096			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
4	57.96	0.00	1	500000	0.3000	-0.0003	32.21	32.20	0.01
			2	500000	0.3000	-0.0005			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0013			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0109			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
5	60.61	0.00	1	500000	0.3000	-0.0003	32.07	32.06	0.01
			2	500000	0.3000	-0.0005			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0010			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0122			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
6	63.27	0.00	1	500000	0.3000	-0.0003	31.56	31.54	0.01
			2	500000	0.3000	-0.0006			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0005			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0137			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
7	65.92	0.00	1	500000	0.3000	-0.0003	30.63	30.61	0.01
			2	500000	0.3000	-0.0007			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0001			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0152			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
8	68.57	0.00	1	500000	0.3000	-0.0002	29.70	29.68	0.02
			2	500000	0.3000	-0.0008			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0009			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0169			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
9	71.22	0.00	1	500000	0.3000	-0.0002	28.77	28.75	0.02
			2	500000	0.3000	-0.0009			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0020			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0187			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
10	73.88	0.00	1	500000	0.3000	-0.0001	27.84	27.82	0.02
			2	500000	0.3000	-0.0010			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0034			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0206			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
11	76.53	0.00	1	500000	0.3000	-0.0001	26.91	26.89	0.03
			2	500000	0.3000	-0.0010			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0051			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0225			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
12	79.18	0.00	1	500000	0.3000	-0.0001	25.99	25.95	0.03
			2	500000	0.3000	-0.0009			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0073			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0246			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section:		Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
	X [ft.]	Y [ft.]							
13	81.84	0.00	1	500000	0.3000	-0.0000	25.06	25.02	0.04
			2	500000	0.3000	-0.0004			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0098			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0267			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
14	84.49	0.00	1	500000	0.3000	0.0000	24.17	24.13	0.04
			2	500000	0.3000	0.0015			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0128			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0288			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
15	87.14	0.00	1	500000	0.3000	0.0000	23.25	23.20	0.05
			2	500000	0.3000	0.0038			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0162			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0309			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
16	89.80	0.00	1	500000	0.3000	0.0000	22.33	22.27	0.06
			2	500000	0.3000	0.0057			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0198			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0330			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
17	92.45	0.00	1	500000	0.3000	0.0000	21.41	21.34	0.07
			2	500000	0.3000	0.0070			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0235			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0351			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
18	95.10	0.00	1	500000	0.3000	0.0000	20.49	20.41	0.07
			2	500000	0.3000	0.0076			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0273			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0372			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
19	97.76	0.00	1	500000	0.3000	0.0000	19.56	19.49	0.08
			2	500000	0.3000	0.0076			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0309			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0391			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
20	100.41	0.00	1	500000	0.3000	0.0000	18.64	18.56	0.08
			2	500000	0.3000	0.0076			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0344			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0408			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
21	103.06	0.00	1	500000	0.3000	0.0000	17.72	17.63	0.09
			2	500000	0.3000	0.0067			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0376			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0425			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
22	105.71	0.00	1	500000	0.3000	0.0000	16.80	16.71	0.09
			2	500000	0.3000	0.0054			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0406			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0439			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
23	108.37	0.00	1	500000	0.3000	0.0000	15.87	15.77	0.09
			2	500000	0.3000	0.0039			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0432			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0451			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
24	111.02	0.00	1	500000	0.3000	0.0000	14.90	14.81	0.09
			2	500000	0.3000	0.0021			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0454			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0461			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
25	113.67	0.00	1	500000	0.3000	0.0000	13.94	13.84	0.09
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0472			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0468			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
26	116.33	0.00	1	500000	0.3000	0.0000	13.00	12.91	0.10
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0485			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0473			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
27	118.98	0.00	1	500000	0.3000	0.0000	12.07	11.97	0.10
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0492			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0474			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
28	121.63	0.00	1	500000	0.3000	0.0000	11.13	11.03	0.10
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0493			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0473			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
29	124.29	0.00	1	500000	0.3000	0.0000	11.14	11.04	0.10
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0486			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0469			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
30	126.94	0.00	1	500000	0.3000	0.0000	11.30	11.21	0.09
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0473			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0462			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ^{2}]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
31	129.59	0.00	1	500000	0.3000	0.0000	11.46	11.37	0.09
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0453			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0453			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
32	132.24	0.00	1	500000	0.3000	0.0000	11.62	11.53	0.09
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0426			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0441			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
33	134.90	0.00	1	500000	0.3000	0.0000	11.78	11.70	0.08
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0394			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0427			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
34	137.55	0.00	1	500000	0.3000	0.0000	11.94	11.87	0.08
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0358			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0411			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
35	140.20	0.00	1	500000	0.3000	0.0000	12.10	12.03	0.07
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0318			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0393			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
36	142.86	0.00	1	500000	0.3000	0.0000	12.26	12.20	0.06
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0276			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0373			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
37	145.51	0.00	1	500000	0.3000	0.0000	12.42	12.37	0.06
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0235			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0353			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
38	148.16	0.00	1	500000	0.3000	0.0000	12.59	12.53	0.05
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	0.0000			
			4	500000	0.3000	0.0195			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0332			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
39	150.82	0.00	1	500000	0.3000	0.0000	12.75	12.70	0.05
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0157			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0310			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
40	153.47	0.00	1	500000	0.3000	0.0000	12.91	12.87	0.04
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0122			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0289			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
41	156.12	0.00	1	500000	0.3000	0.0000	12.99	12.95	0.04
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0092			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0267			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
42	158.78	0.00	1	500000	0.3000	0.0000	12.96	12.92	0.03
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0067			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0246			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
43	161.43	0.00	1	500000	0.3000	0.0000	12.92	12.90	0.03
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0046			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0225			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
44	164.08	0.00	1	500000	0.3000	0.0000	12.89	12.87	0.02
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0030			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0205			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
45	166.73	0.00	1	500000	0.3000	0.0000	12.86	12.84	0.02
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0017			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0187			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
46	169.39	0.00	1	500000	0.3000	0.0000	12.83	12.81	0.02
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	0.0007			
			5	9999999999	0.5000	0.0000			
			6	500000	0.3000	0.0169			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
47	172.04	0.00	1	500000	0.3000	0.0000	12.80	12.78	0.02
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0001			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0152			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
48	174.69	0.00	1	500000	0.3000	0.0000	12.77	12.76	0.01
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0007			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0136			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
49	177.35	0.00	1	500000	0.3000	0.0000	12.74	12.73	0.01
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0011			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0121			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			
50	180.00	0.00	1	500000	0.3000	0.0000	12.71	12.70	0.01
			2	500000	0.3000	0.0000			
			3	9999999999	0.5000	-0.0000			
			4	500000	0.3000	-0.0014			
			5	9999999999	0.5000	-0.0000			
			6	500000	0.3000	0.0108			
			7	9999999999	0.5000	0.0000			
			8	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	114.00	0.00	13.82	0.36	13.46

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

SECONDARY SETTLEMENT (Creep), Ss -- Total Secondary Compression (Creep) = 0.076 ft.

Layer #	Underging Consolidation	Cc / (1+e0)	C-alpha/ (1+e0)	e-zero	H [ft.]	t1/t2	Settlement Ss [ft.]
1	No	N/A	N/A	N/A	N/A	N/A	N/A
2	No	N/A	N/A	N/A	N/A	N/A	N/A
3	Yes	0.1200	0.0030	N/A	4.82	40.0	0.023
4	No	N/A	N/A	N/A	N/A	N/A	N/A
5	Yes	0.1700	0.0030	N/A	10.00	40.0	0.048
6	No	N/A	N/A	N/A	N/A	N/A	N/A
7	Yes	0.1000	0.0003	N/A	10.00	40.0	0.005
8	No	N/A	N/A	N/A	N/A	N/A	N/A

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	0.00	22.00	Layer 1 Existing Fill
	2	4.00	24.00	
	3	20.50	32.00	
	4	24.00	34.00	
	5	62.00	32.00	
	6	82.00	25.00	
	7	85.00	24.00	
	8	108.00	16.00	
	9	113.50	14.00	
	10	122.00	11.00	
	11	155.00	13.00	
	12	240.00	12.00	
2	1	0.00	22.00	Layer 2 Upper Sand
	2	4.00	24.00	
	3	20.50	24.00	
	4	24.00	24.00	
	5	62.00	24.00	
	6	82.00	24.00	
	7	85.00	24.00	
	8	108.00	16.00	
	9	113.50	14.00	
	10	122.00	11.00	
	11	155.00	13.00	
	12	240.00	12.00	
3	1	0.00	14.00	Layer 3 Upper Clay
	2	108.00	14.00	
	3	113.50	14.00	
	4	122.00	11.00	
	5	155.00	13.00	
	6	240.00	12.00	
4	1	0.00	9.00	Layer 4 Upper Sand
	2	1000.00	9.00	
5	1	0.00	-13.00	Layer 5 Upper Clay
	2	1000.00	-13.00	
6	1	0.00	-23.00	Layer 6 Lower Sand
	2	1000.00	-23.00	
7	1	0.00	-58.00	Layer 7 Lower Clay
	2	1000.00	-58.00	
8	1	0.00	-68.00	Layer 8 Yorktown
	2	1000.00	-68.00	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 82.00 [ft]	1	82.00	25.00	Proposed Fill
	X2 = 155.00 [ft]	2	94.00	28.00	
		3	102.00	28.00	
		4	131.00	25.00	
		5	155.00	13.00	

Time rate of primary consolidation

VDOT I-64: 90% Consolidation

	Vertical Drainage				Horizontal Drainage						
t (day)	c_v (ft^2/day)	h_{dr} (ft)	T_v	U_v (%)	c_h (ft^2/day)	s (ft)	D (ft)	d (ft)	n	U_h (%)	U_c (%)
a	b	c	d	e	f	g	h	i	j	k	m
102.5	0.100	10.0	0.10	36.10	0.150	5	5.25	0.225	1.86	84.4	90.0
89.2	0.100	10.0	0.09	33.69	0.175	5	5.25	0.225	1.89	84.9	90.0
79.3	0.100	10.0	0.08	31.77	0.200	5	5.25	0.225	1.92	85.3	90.0
71.5	0.100	10.0	0.07	30.17	0.225	5	5.25	0.225	1.95	85.7	90.0
65.0	0.100	10.0	0.07	28.76	0.250	5	5.25	0.225	1.97	86.0	90.0
111.0	0.100	15.0	0.05	25.06	0.150	5	5.25	0.225	2.01	86.7	90.0
96.4	0.100	15.0	0.04	23.35	0.175	5	5.25	0.225	2.04	87.0	90.0
85.0	0.100	15.0	0.04	21.93	0.200	5	5.25	0.225	2.06	87.2	90.0
76.0	0.100	15.0	0.03	20.74	0.225	5	5.25	0.225	2.07	87.4	90.0
69.0	0.100	15.0	0.03	19.76	0.250	5	5.25	0.225	2.09	87.6	90.0

VDOT I-64: 95% Consolidation

	Vertical Drainage				Horizontal Drainage						
t (day)	c_v (ft^2/day)	h_{dr} (ft)	T_v	U_v (%)	c_h (ft^2/day)	s (ft)	D (ft)	d (ft)	n	U_h (%)	U_c (%)
a	b	c	d	e	f	g	h	i	j	k	m
136.0	0.100	10.0	0.14	41.56	0.150	5	5.25	0.225	2.47	91.5	95.0
118.0	0.100	10.0	0.12	38.73	0.175	5	5.25	0.225	2.50	91.8	95.0
105.0	0.100	10.0	0.11	36.54	0.200	5	5.25	0.225	2.54	92.1	95.0
94.5	0.100	10.0	0.09	34.67	0.225	5	5.25	0.225	2.57	92.4	95.0
86.0	0.100	10.0	0.09	33.08	0.250	5	5.25	0.225	2.60	92.6	95.0
146.0	0.100	15.0	0.06	28.74	0.150	5	5.25	0.225	2.65	92.9	95.0
127.0	0.100	15.0	0.06	26.81	0.175	5	5.25	0.225	2.69	93.2	95.0
112.0	0.100	15.0	0.05	25.17	0.200	5	5.25	0.225	2.71	93.3	95.0
100.0	0.100	15.0	0.04	23.79	0.225	5	5.25	0.225	2.72	93.4	95.0
90.5	0.100	15.0	0.04	22.63	0.250	5	5.25	0.225	2.74	93.5	95.0

Appendix D

C-1: Plaxis Modelling Results for the I-264 Expansion at STA 53+00

C-2: Plaxis Modelling Results for the I-264 Expansion at STA 182+50

Appendix C-1

Plaxis Modelling Results for the I-264 Expansion at STA 53+00

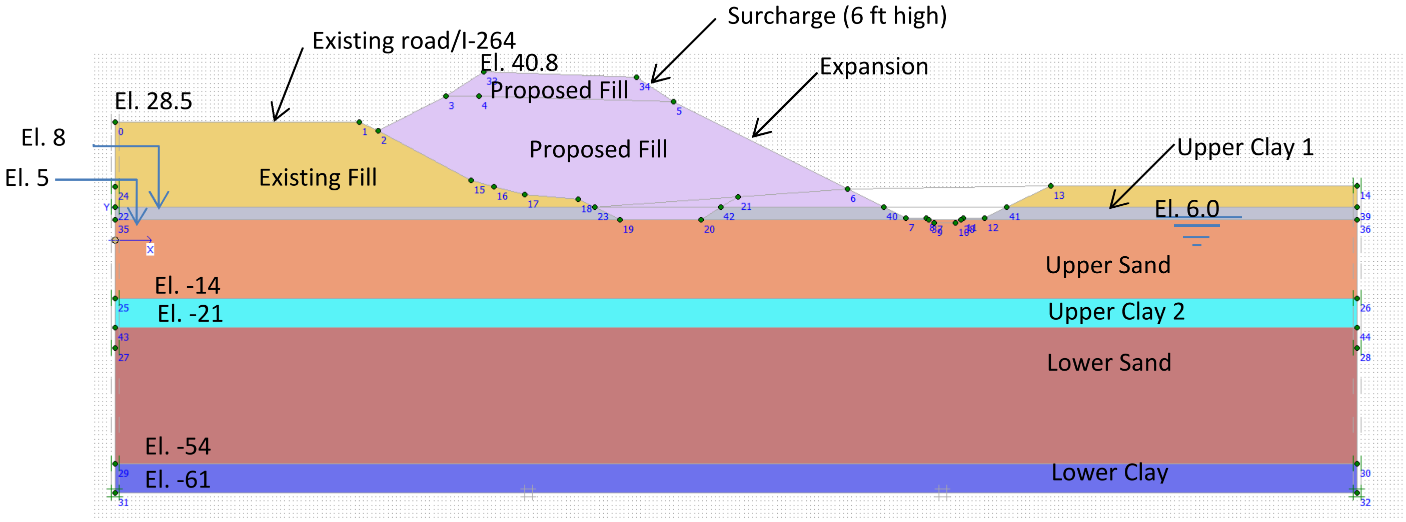
1. Introduction

This document summarizes the results of the numerical analyses to model the expansion of I-264 at STA 53+00 for the WitchDuck Project. Plaxis 8.5 was used to analyze the deformation of the existing roadway and the expansion.

The global stability of the existing road and the expansion was not analyzed and is not included in this report.

2. Geometry

The cross section of the existing road and the expansion is shown in Figure 1. A 6-foot high surcharge is added on top of the expansion to accelerate the consolidation of the soft soils below the expansion. The subsurface ground conditions consist of (from top bottom) upper clay 1, upper and sand, upper clay 2, lower sand, and lower clay.



Unit: ft

Figure 1 Cross Section at STA 53+00

3. Plaxis Model

The deformation of the existing road and the expansion was considered as a two-dimensional plain strain problem. Figure 2 shows the finite element mesh of the Plaxis model. Plain strain, 15-noded elements were used. Detailed model information is included in the attachment.

The following 3 construction stages/phases were modelled:

- Initial Phase: establishment of the initial stress conditions before the construction of the existing roadway
- Phase 1: construction of the existing roadway and placement of the existing fill
- Phase 2: construction of the proposed expansion and surcharge

Below are the assumptions and limitations of the model:

- No secondary compression was modeled
- Model assumed the surcharge will be on long enough for full primary consolidation to occur
- Any settlement resulting from the original embankment construction has completed

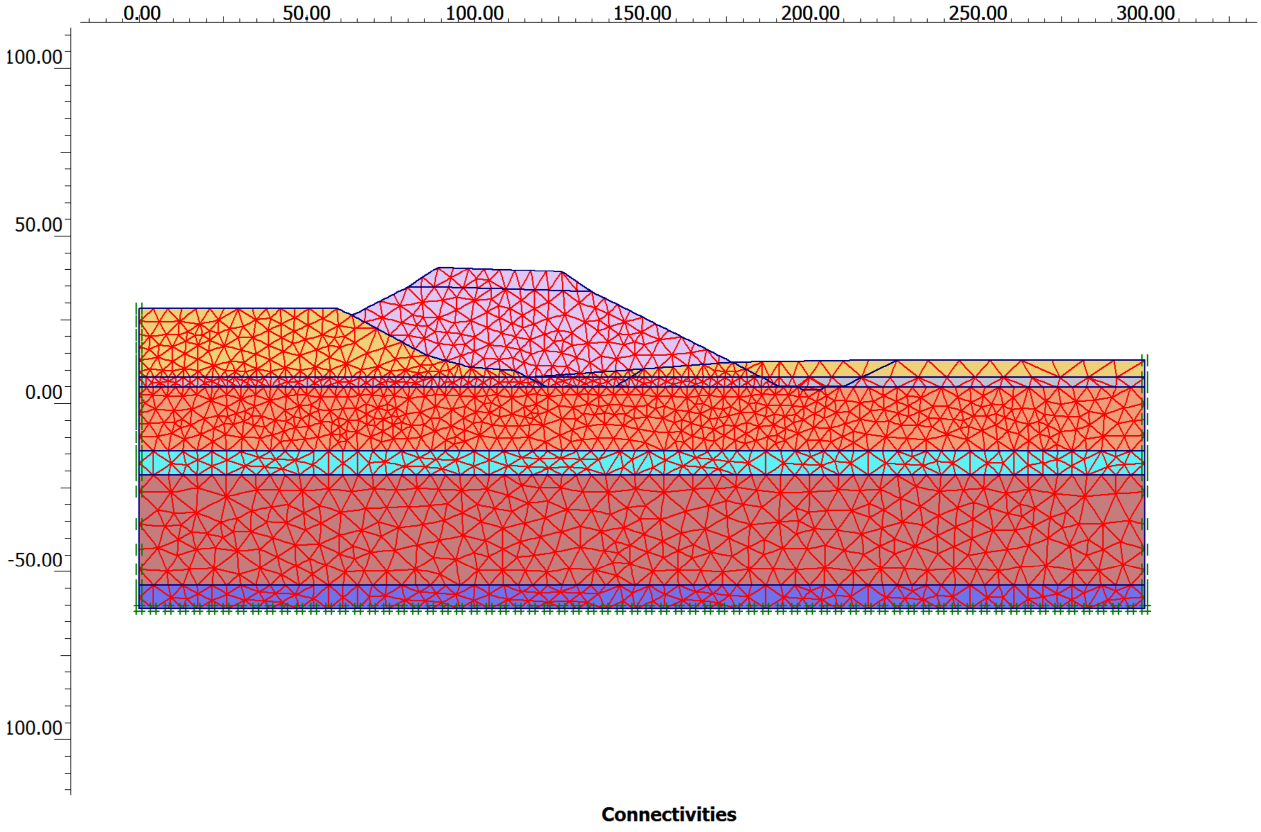


Figure 2 Finite Element Mesh

4. Soil Parameters

The parameters for the soils in Figure 1 are included in Table 1. The Mohr-Coulomb model was used for the existing Fill, proposed Fill, upper sand, and lower sand. The soft soil model was used for the long term consolidation analysis of the upper clay 1, upper clay 2, and lower clay. All soils were modelled for the drained conditions to calculate the long-term deformation of the roadway and the expansion.

Table 1 Soil Parameters

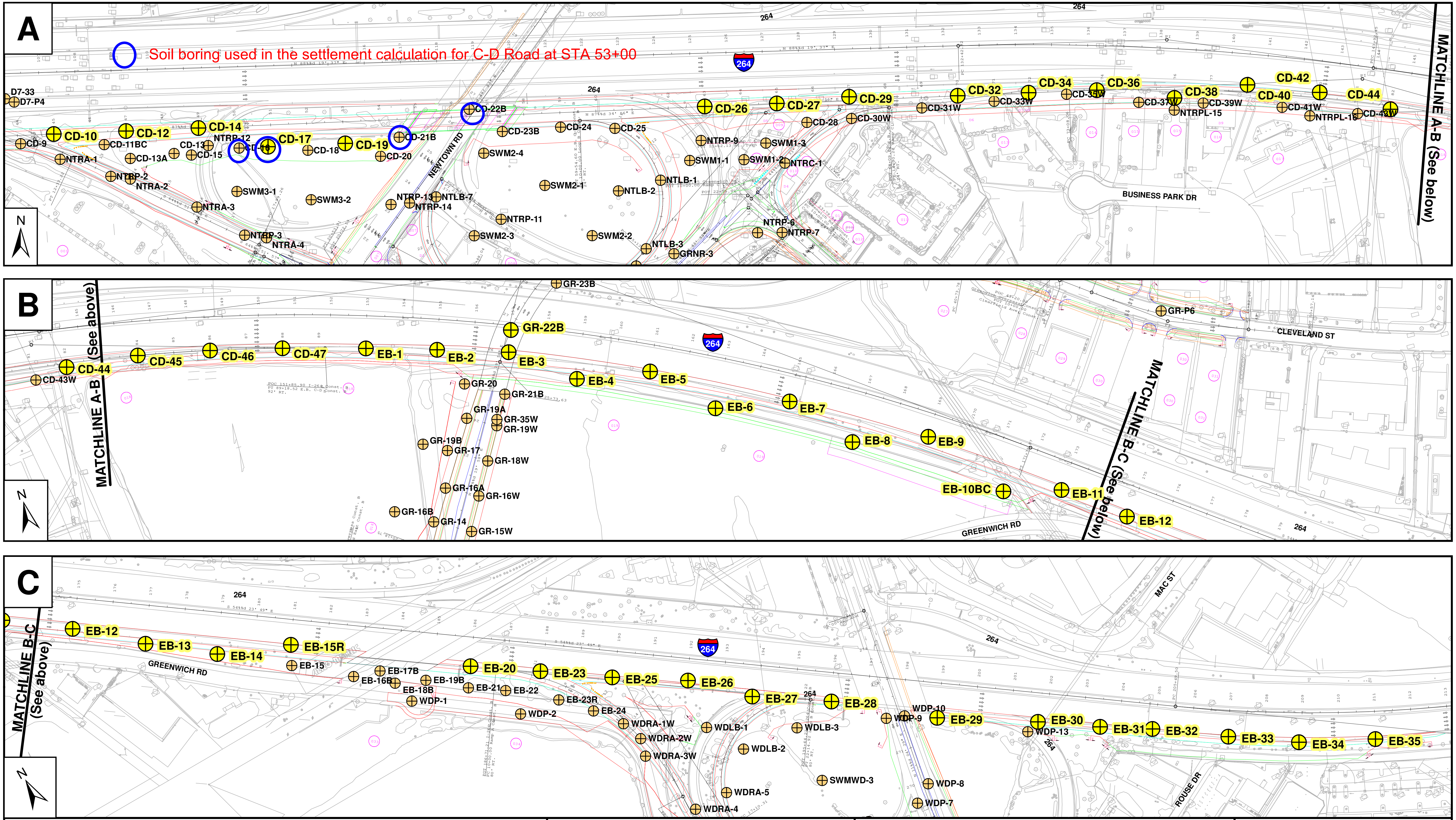
Layer	Total Unit Weight (pcf)	C' (psf)	ϕ' (degree)	μ	K_0^{NC}	K_0^{OC}	C_c'	C_r'	e_0	OCR	E (psf)
Proposed Fill	130	25	34	0.3	0.44	NA	NA	NA	NA	NA	1,000,000
Existing Fill	115	25	32	0.3	0.47	NA	NA	NA	NA	NA	750,000
Upper Clay 1	120	25	23	NA	0.61	0.8	0.12	0.012	0.97	2	NA
Upper Clay 2	112	25	23	NA	0.61	0.71	0.17	0.014	0.97	1.5	NA
Upper Sand	118	25	30	0.3	0.50	0.6	NA	NA	NA	1.5	500,000
Lower Clay	115	25	25	NA	0.58	0.78	0.1	0.012	1.2	2	NA
Lower Sand	125	25	32	0.3	0.47	0.6	NA	NA	NA	1.5	500,000

Notes:

1. $C_c' = C_c/(1+e_0)$.
2. $C_r' = C_r/(1+e_0)$
3. $K_0^{OC} = K_0^{NC}\ OCR^{\sin\phi'}$, where K_0^{NC} is the coefficient of earth pressure at rest for normally consoliadted soils and K_0^{OC} is the coefficient of earth pressure at rest for over-consoliadted soils.
4. A samll C' value (i.e., 25 psf) was used for all soils to improve the peformance of modelling.
5. The OCR values for the Upper Sand and the Lower Sand was assumed the same as that of the Upper Clay 2.

5. Analysis Results

Figures 3, 4, and 5 show the deformed mesh, the vertical displacements, and the settlements along the existing roadway. Detailed analysis results are included in the attachment.



0 125 250 Feet

⊕ SPT Exploration Locations

⊕ Borings in other PSAs

Prepared by: HDR

Date: November 2011

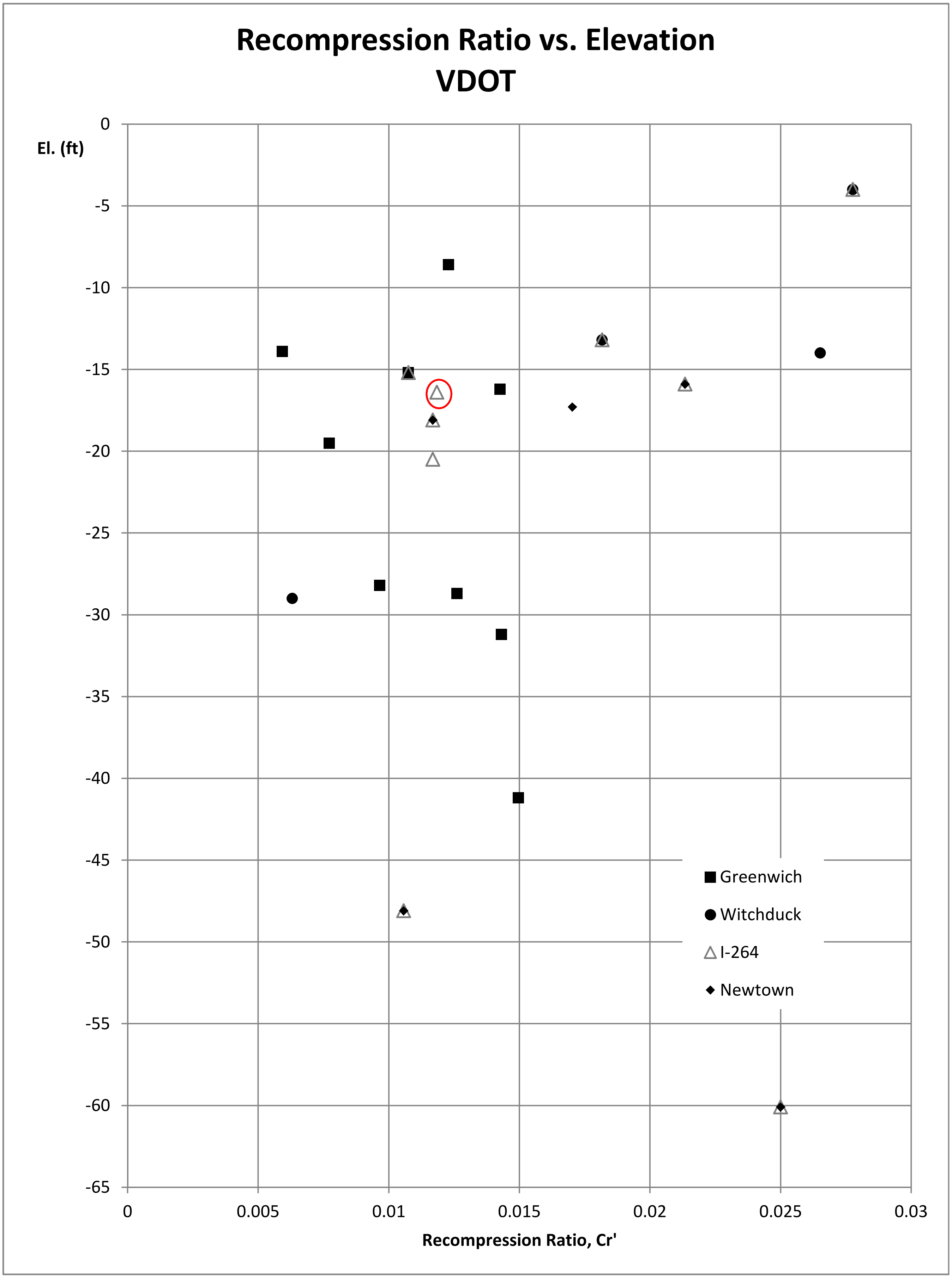
VDOT Virginia Department of Transportation

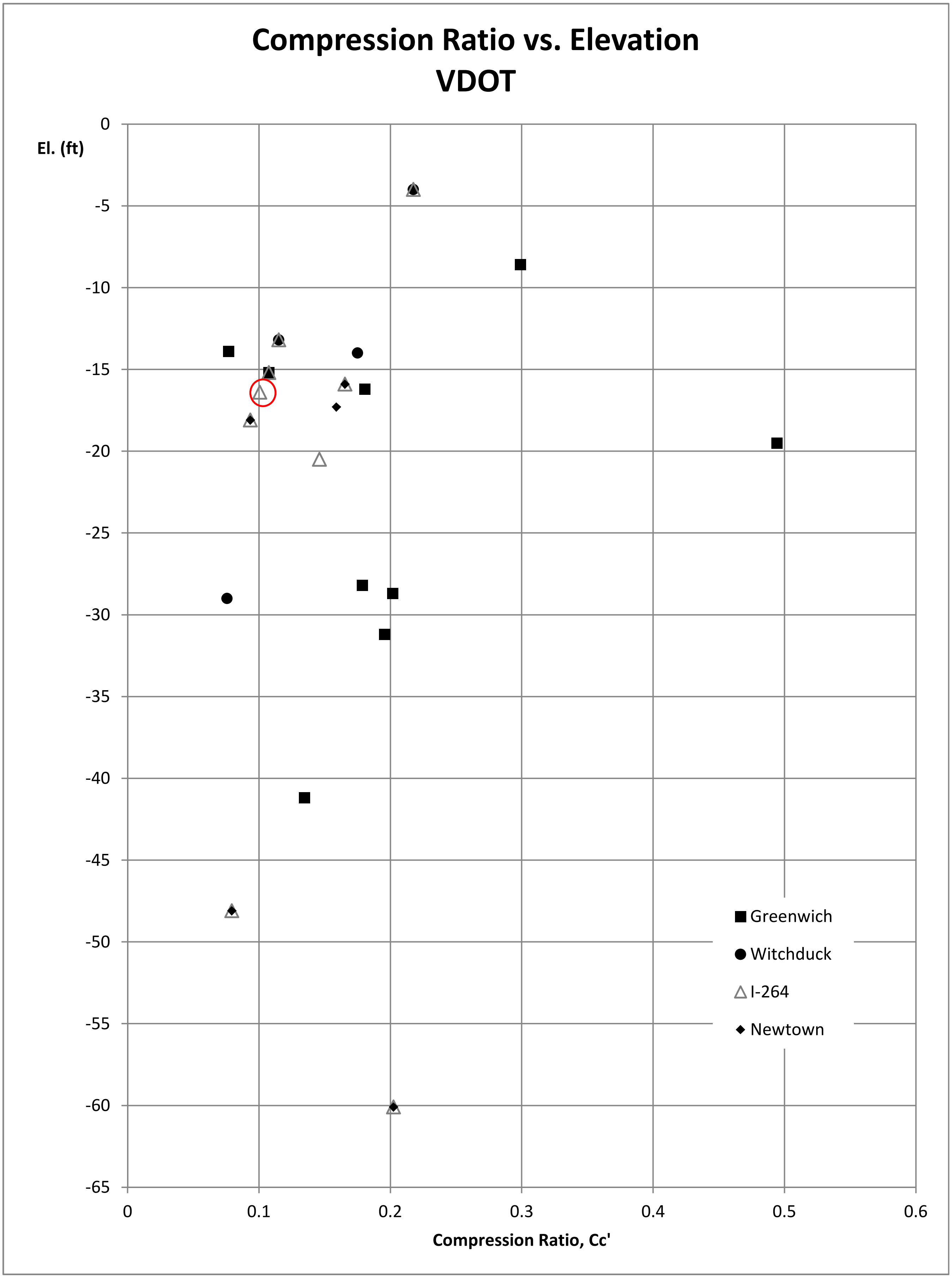
Project 0264-122-108
City of Norfolk

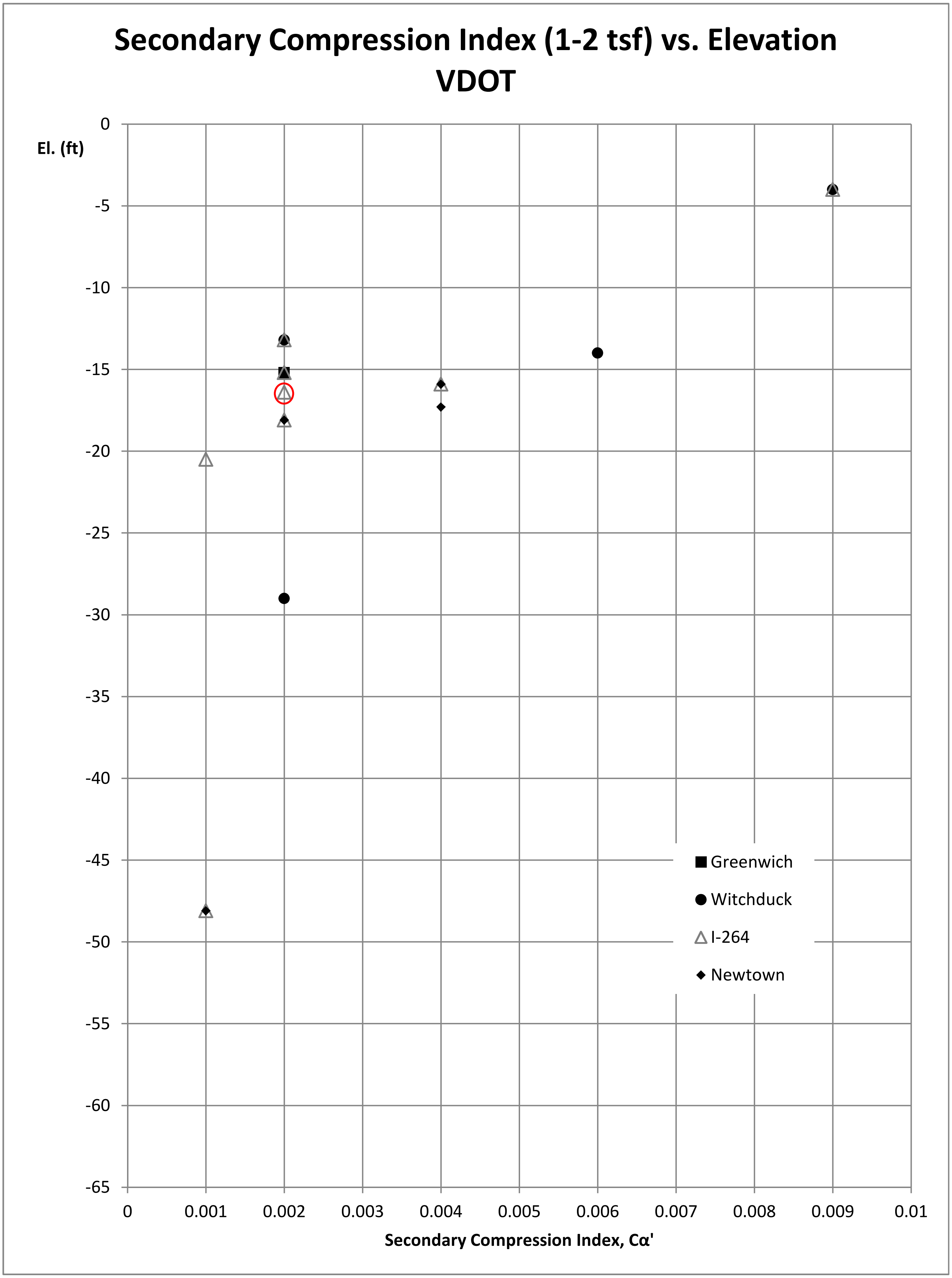
Project 0264-134-102
City of Virginia Beach

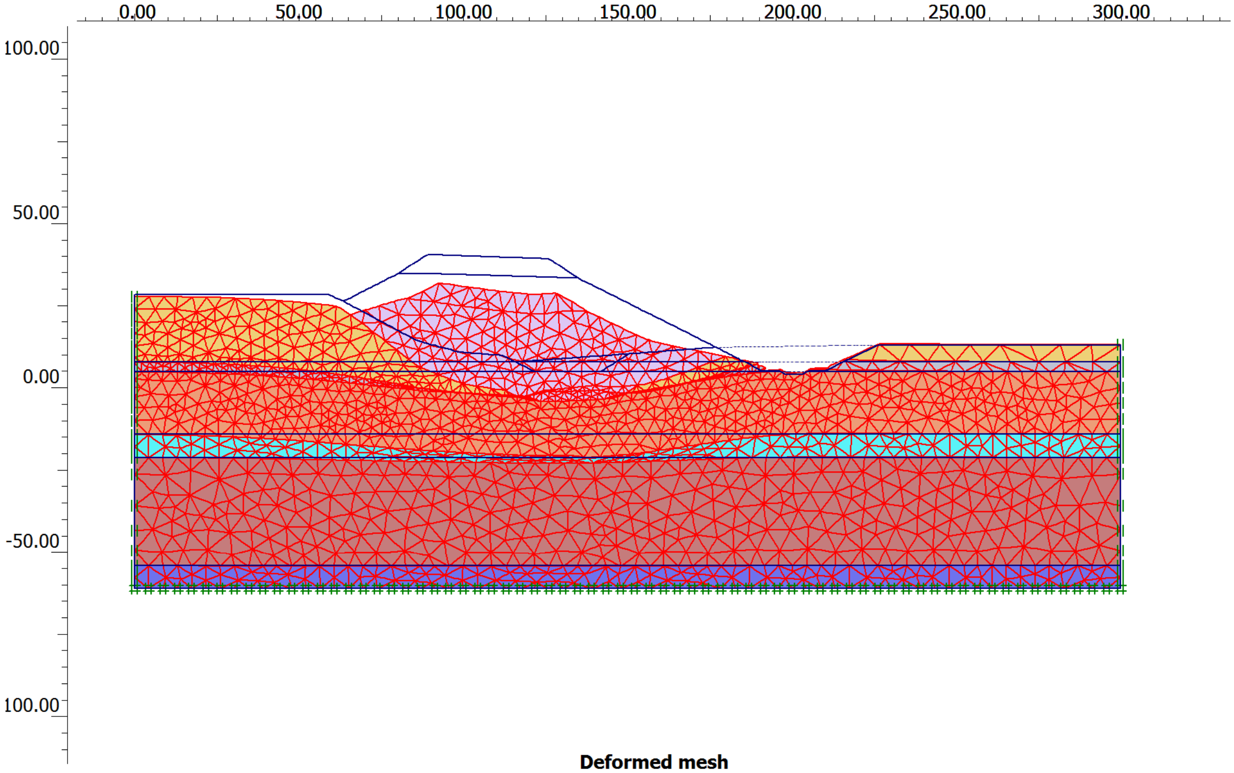
Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan


Recompression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.005
0.01
0.015
0.02
0.025
0.03
Recompression Ratio, Cr'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown


Compression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.1
0.2
0.3
0.4
0.5
0.6
Compression Ratio, Cc'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown


Secondary Compression Index (1-2 tsf) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
Secondary Compression Index, Cα'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown



Deformed mesh

Extreme total displacement 1.17 ft

(displacements scaled up 10.00 times)

Figure 4 STA 53+00 with Surcharge, Deformed Mesh

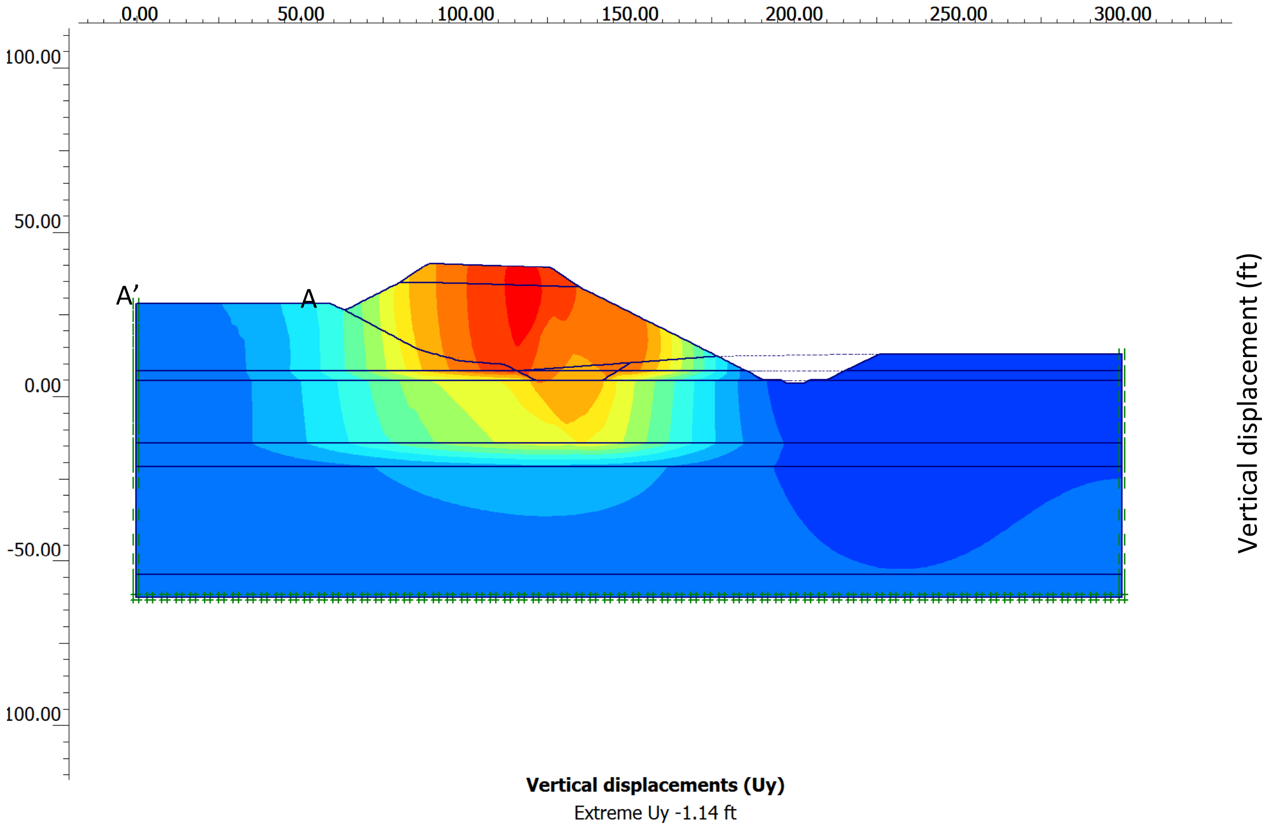


Figure 5 STA 53+00 with Surcharge, Vertical Displacements

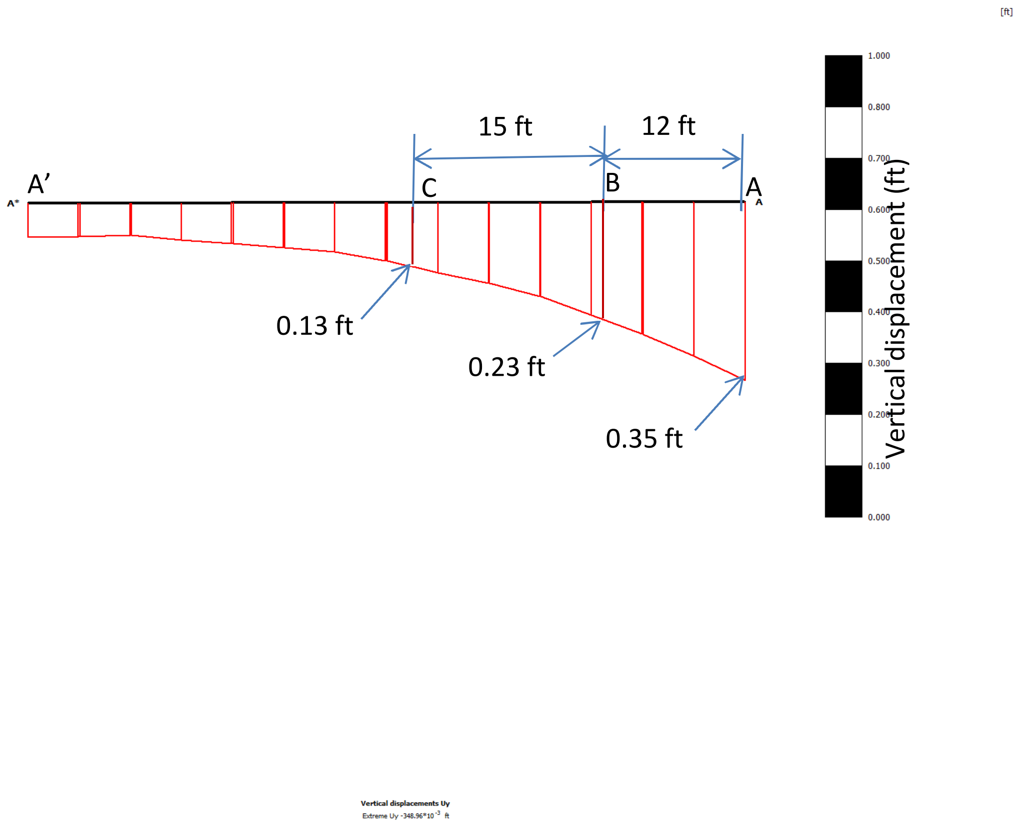


Figure 6 STA 53+00 with Surcharge, Vertical Displacements along the Existing Road Surface (A-A')

Attachment

Plaxis Modelling Report
for the I-264 Expansion at STA 53+00

01/10/2017

User: URS Corporation

Title: STA5300

Table of Contents

1. General Information

Table [1] units

Type	Unit
Length	ft
Force	lb
Time	s

Table [2] Model dimensions

	min.	max.
X	0.000	300.000
Y	-61.000	40.800

Table [3] Model

Model	Plane Strain
Element	15-Noded

2. Geometry

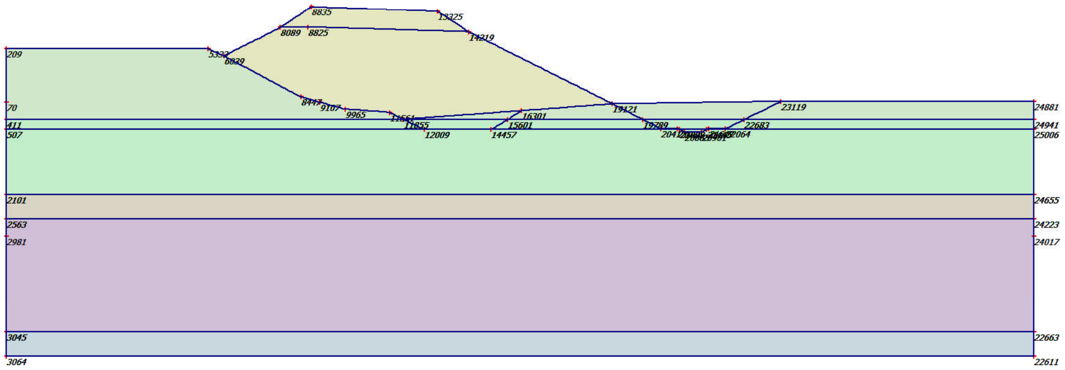


Fig. 1 Plot of geometry model with significant nodes

Table [4] Table of significant nodes

Node no.	x-coord.	y-coord.	Node no.	x-coord.	y-coord.
209	0.000	28.500	11855	116.000	8.000
5333	59.000	28.500	70	0.000	13.000
6039	63.500	26.500	2101	0.000	-14.000
8089	80.000	34.800	24655	300.000	-14.000
8825	88.000	34.900	2981	0.000	-26.000
14219	135.000	33.500	24017	300.000	-26.000
19121	177.000	12.500	3045	0.000	-54.000

Node no.	x-coord.	y-coord.	Node no.	x-coord.	y-coord.
20417	191.000	5.300	22663	300.000	-54.000
21086	196.000	5.300	3064	0.000	-61.000
20885	198.000	4.300	22611	300.000	-61.000
20901	203.000	4.300	8835	89.000	40.800
21617	205.000	5.300	13325	126.000	39.500
22064	210.000	5.300	507	0.000	5.000
23119	226.000	13.200	25006	300.000	5.000
24881	300.000	13.200	21093	196.600	5.000
8447	86.000	14.500	21415	204.400	5.000
9107	91.570	13.000	24941	300.000	8.000
9965	99.000	11.000	19789	185.750	8.000
11561	112.000	10.000	22683	215.468	8.000
12009	122.000	5.000	15601	146.409	8.000
14457	141.500	5.000	2563	0.000	-21.000
16301	150.500	10.500	24223	300.000	-21.000
411	0.000	8.000			

2.1. Clusters

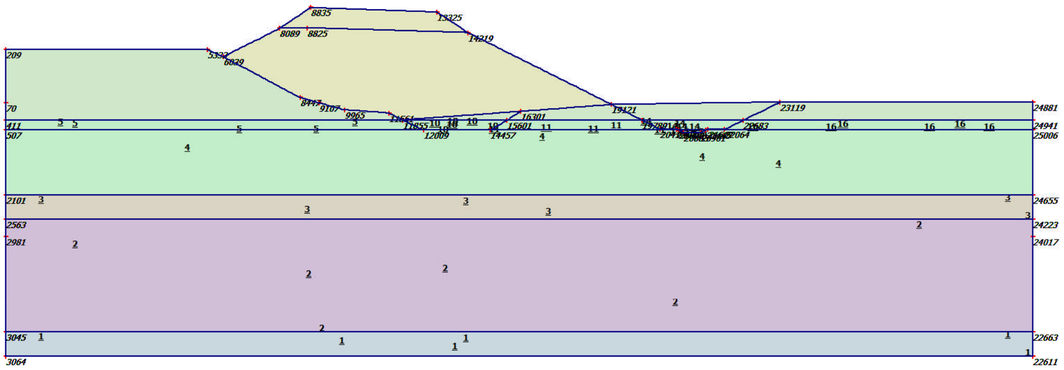


Fig. 2 Plot of geometry model with cluster numbers

Table [5] Table of clusters

Cluster no.	**Nodes**
1	3045, 22663, 3064, 22611.
2	2981, 24017, 3045, 22663, 2563, 24223.
3	2101, 24655, 2563, 24223.
4	20885, 20901, 12009, 14457, 2101, 24655, 507, 25006, 21093, 21415.
5	12009, 411, 11855, 507.
6	209, 5333, 6039, 8447, 9107, 9965, 11561, 411, 11855, 70.
7	6039, 8089, 8825, 14219, 19121, 8447, 9107, 9965, 11561, 16301, 11855.
8	8089, 8825, 14219, 8835, 13325.

Cluster no.	Nodes
9	16301, 11855, 15601.
10	12009, 14457, 11855, 15601.
11	20417, 21086, 14457, 21093, 19789, 15601.
12	19121, 16301, 19789, 15601.
13	19121, 23119, 19789, 22683.
14	20417, 21086, 21617, 22064, 21093, 21415, 19789, 22683.
15	20885, 20901, 21093, 21415.
16	21617, 22064, 25006, 21415, 24941, 22683.
17	23119, 24881, 24941, 22683.

3. Mesh data

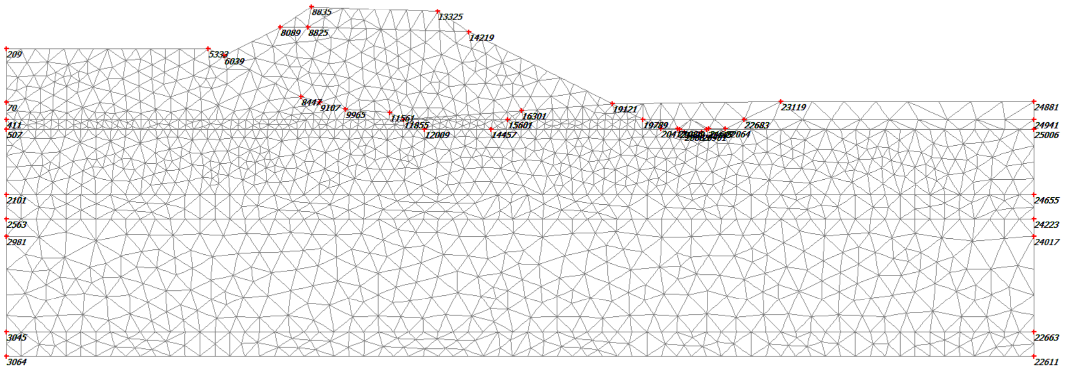


Fig. 3 Plot of the mesh with significant nodes

Table [6] Numbers, type of elements, integrations

Type	**Type of element**	**Type of integration**	**Total no.**
Soil	15-Noded	12-point Gauss	3088

4. Material data

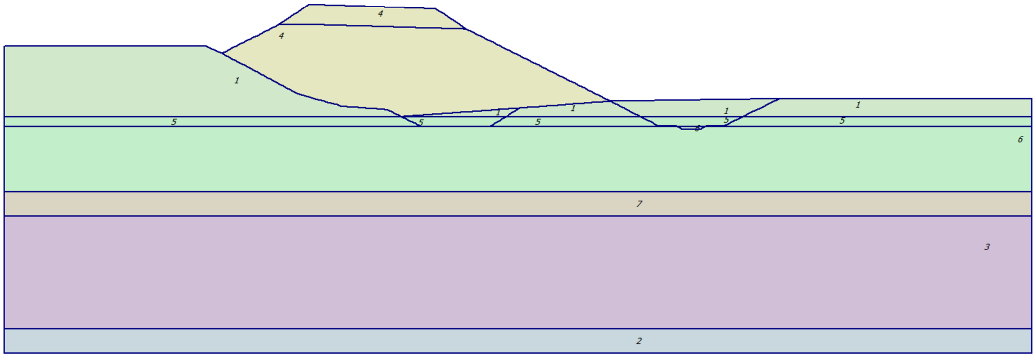


Fig. 4 Plot of geometry with material data sets

Table [7] Soil data sets parameters

Mohr-Coulomb		**1** **Existing Fill**	**3** **Lower Sand**	**4** **Proposed Fill**	**6** **Upper Sand**
Type		Drained	Drained	Drained	Drained
γ_{unsat}	[lb/ft^3]	115.00	125.00	130.00	115.00
γ_{sat}	[lb/ft^3]	115.00	125.00	130.00	115.00
k_x	[ft/s]	0.000	0.000	0.000	0.000
k_y	[ft/s]	0.000	0.000	0.000	0.000
e_{init}	[-]	0.500	0.500	0.500	0.500

Mohr-Coulomb		1 Existing Fill	3 Lower Sand	4 Proposed Fill	6 Upper Sand
c_k	[-]	1E15	1E15	1E15	1E15
E_{ref}	[lb/ft²]	750000.000	500000.000	1000000.000	500000.000
ν	[-]	0.300	0.300	0.300	0.300
G_{ref}	[lb/ft²]	288461.538	192307.692	384615.385	192307.692
E_{oed}	[lb/ft²]	1009615.385	673076.923	1346153.846	673076.923
c_{ref}	[lb/ft²]	25.00	25.00	25.00	25.00
φ	[°]	32.00	32.00	34.00	30.00
ψ	[°]	0.00	0.00	0.00	0.00
E_{inc}	[lb/ft²/ft]	0.00	0.00	0.00	0.00
y_{ref}	[ft]	0.000	0.000	0.000	0.000
$c_{increment}$	[lb/ft²/ft]	0.00	0.00	0.00	0.00
$T_{str.}$	[lb/ft²]	0.00	0.00	0.00	0.00
$R_{inter.}$	[-]	1.00	1.00	1.00	1.00
Interface permeability		Neutral	Neutral	Neutral	Neutral

Soft-Soil		2 Lower Clay	5 Upper Clay1	7 Upper Clay2
Type		Drained	Drained	Drained
γ_{unsat}	[lb/ft³]	118.00	120.00	112.00
γ_{sat}	[lb/ft³]	118.00	120.00	112.00
k_x	[ft/s]	0.000	0.000	0.000
k_y	[ft/s]	0.000	0.000	0.000
e_{init}	[-]	1.20	0.97	0.97

Soft-Soil		**2** **Lower Clay**	**5** **Upper Clay1**	**7** **Upper Clay2**
c_k	[-]	1E15	1E15	1E15
$\lambda*$	[-]	0.043	0.052	0.074
$\kappa*$	[-]	0.010	0.010	0.012
c	[lb/ft²]	25.00	25.00	25.00
φ	[°]	25.00	23.00	23.00
ψ	[°]	0.00	0.00	0.00
ν_{ur}	[-]	0.150	0.150	0.150
K_0^{nc}	[-]	0.58	0.61	0.61
R_{inter}	[-]	1.00	1.00	1.00
Interface permeability		Neutral	Neutral	Neutral

5. Calculation phases

Table [8] List of phases

Phase	Ph-No.	Start phase	Calculation type	Load input	First step	Last step
Initial phase	0	-1		-	0	0
<Phase 1>	1	0	Plastic analysis	Staged construction	1	30
<Phase 2>	2	1	Plastic analysis	Staged construction	31	104

Table [9] Staged construction info

Ph-No.	Active clusters	Inactive clusters	Active beams	Active geotextiles	Active anchors
0	1, 2, 3, 4, 5, 10, 11, 14, 15, 16.	6, 7, 8, 9, 12, 13, 17.			
1	1, 2, 3, 4, 5, 6, 11, 12, 13, 14, 15, 16, 17.	7, 8, 9, 10.			
2	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 16, 17.	13, 14, 15.			

Table [10] Control parameters 1

Ph-No.	Additional steps	Reset displacements to zero	Ignore undrained behaviour	Delete intermediate steps
1	250	Yes	No	Yes
2	250	Yes	No	Yes

Table [11] Control parameters 2

Ph-No.	Iterative procedure	Tolerated error	Over relaxation	Max. iterations	Desired min.	Desired max.	Arc-length control

Ph-No.	Iterative procedure	Tolerated error	Over relaxation	Max. iterations	Desired min.	Desired max.	Arc-length control
1	Standard	0.010	1.200	60	6	15	Yes
2	Standard	0.010	1.200	60	6	15	Yes

Table [12] Incremental multipliers (input values)

Ph-No.	Displ.	Load A	Load B	Weight	Accel	Time	s-f
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

5.2. Total multipliers

Table [13] Total multipliers - input values

Ph-No.	Displ.	Load A	Load B	Weight	Accel	Time	s-f
0	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000

Table [14] Total multipliers - reached values

Ph-No.	Displ.	Load A	Load B	Weight	Accel	Time	s-f
0	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000

6. Results for phase

6.3. Calculation information

Table [15] Step Info phase no: 0

Step no:	0
Calculation type	INITIAL
Extrapolation factor	0.994
Relative stiffness	0.139

Table [16] Reached multipliers phase no: 0

Multipliers	Incremental value	Total value
Prescribed displacements	0.0000	1.0000
Load system A	0.0000	1.0000
Load system B	0.0000	1.0000
Soil weight	0.0000	1.0000
Acceleration	0.0000	0.0000
Strength reduction factor	0.0000	1.0000
Time	0.0000	0.0000

Table [17] Staged construction info phase no: 0

Staged construction	Incremental value	Total value
Active proportion of total area	0.000	0.817
Active proportion of stage	0.000	0.000

6.4. Deformations

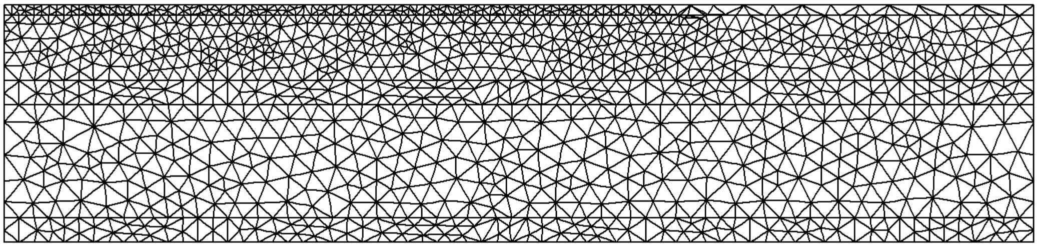


Fig. 5 Plot of deformed mesh

- Step no: 0 -

6.4.1. Plot of total displacements

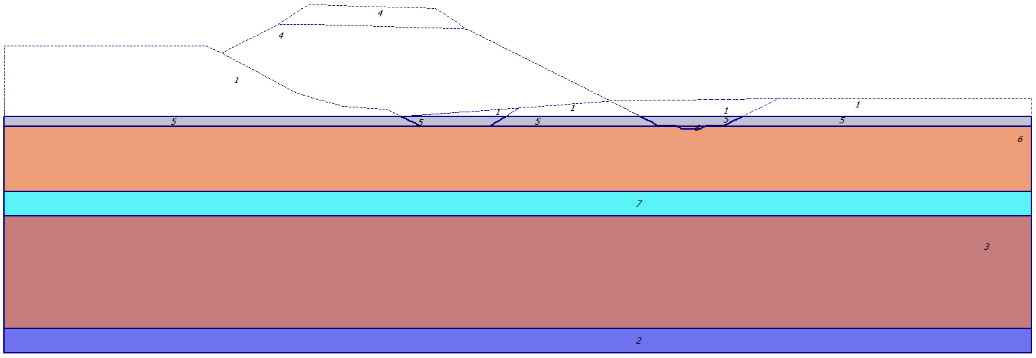


Fig. 6 Plot of total displacements (arrows)

- Step no: 0 -

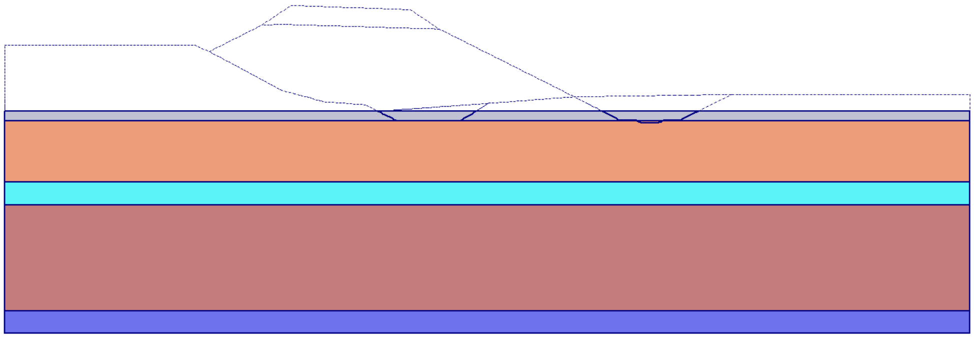


Fig. 7 Plot of total displacements (shadings)

- Step no: 0 -

6.4.2. Plot of horizontal displacements

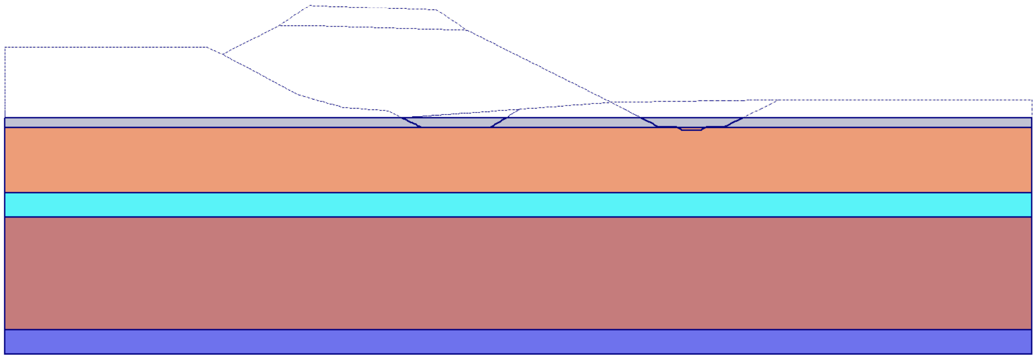


Fig. 8 Plot of horizontal displacements (arrows)

- Step no: 0 -

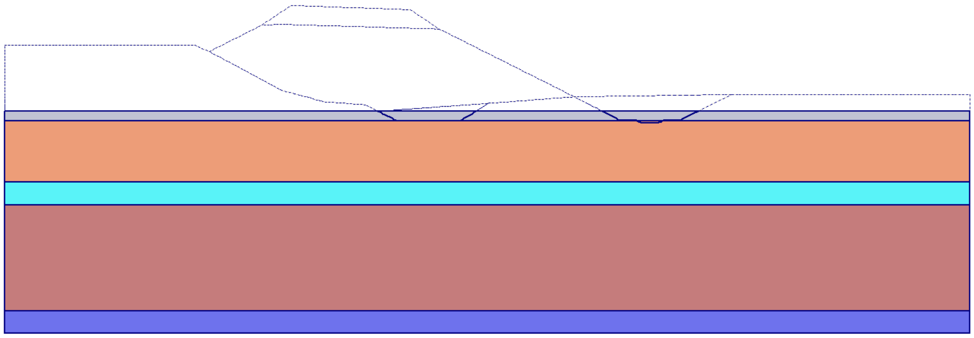


Fig. 9 Plot of horizontal displacements (shadings)

- Step no: 0 -

6.4.3. Plot of vertical displacements

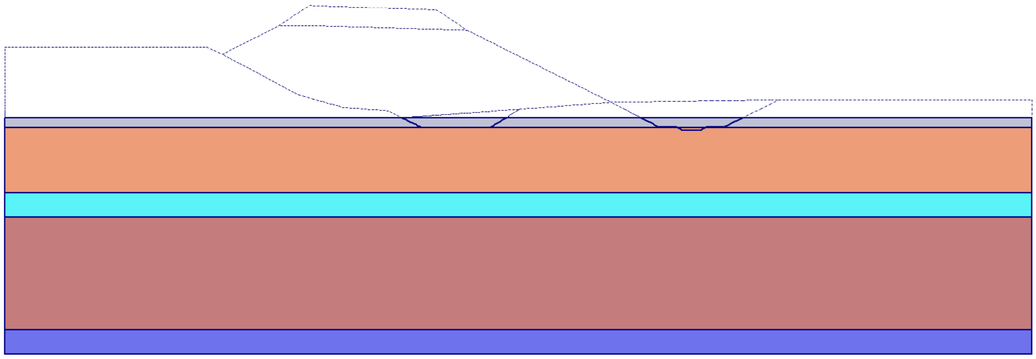


Fig. 10 Plot of vertical displacements (arrows)

- Step no: 0 -

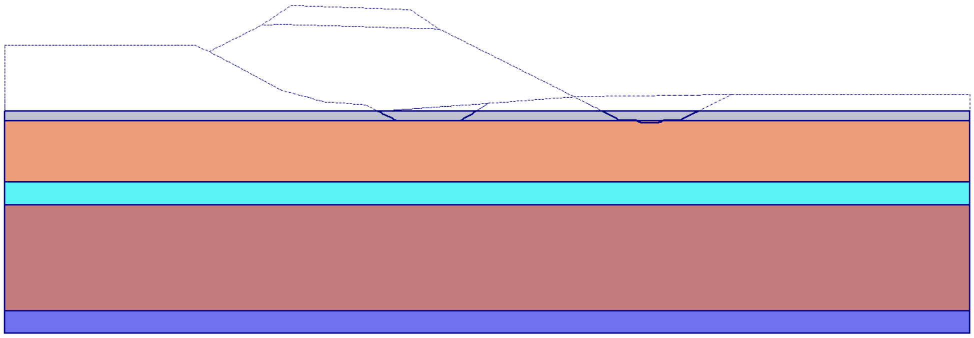


Fig. 11 Plot of vertical displacements (shadings)

- Step no: 0 -

6.4.4. Plot of incremental strains

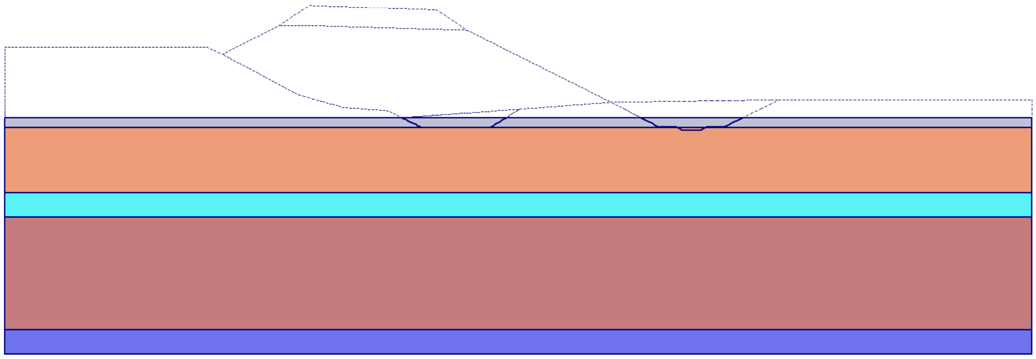


Fig. 12 Plot of total incremental strains (principal directions)

- Step no: 0 -

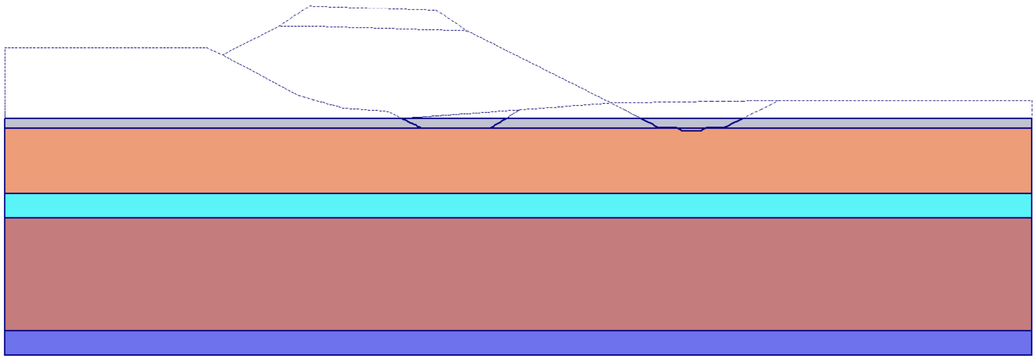


Fig. 13 Plot of total incremental strains (shear shadings)

- Step no: 0 -

6.5. Stresses

6.5.5. Plot of effective stresses

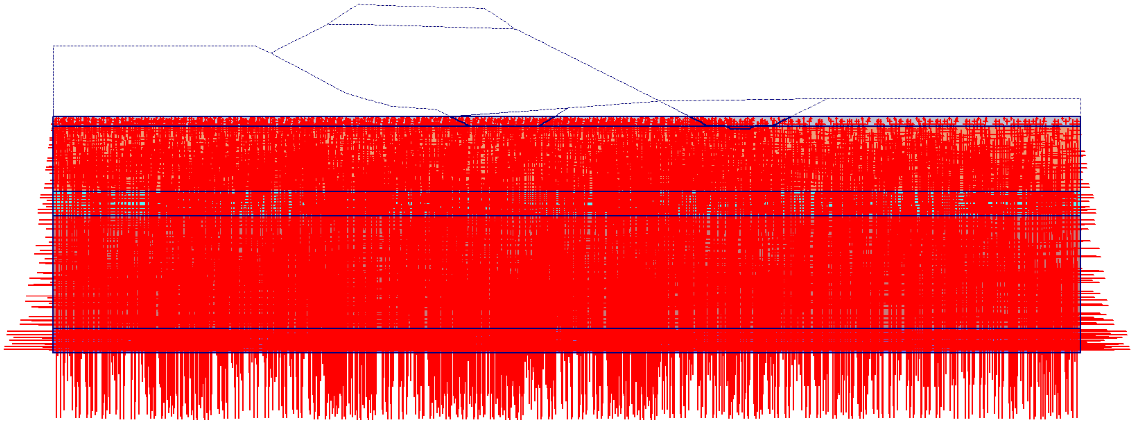


Fig. 14 Plot of effective stresses (principal directions)

- Step no: 0 -

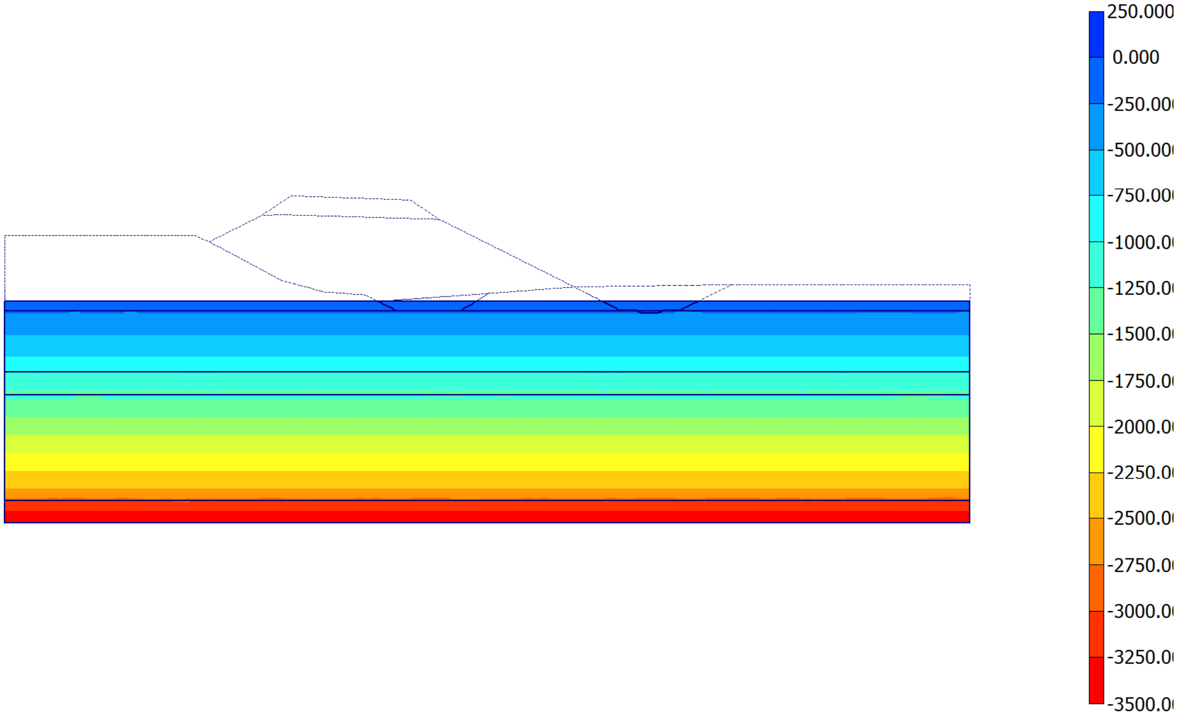


Fig. 15 Plot of effective stresses (mean shadings)

- Step no: 0 -

6.5.6. Plot of total stresses

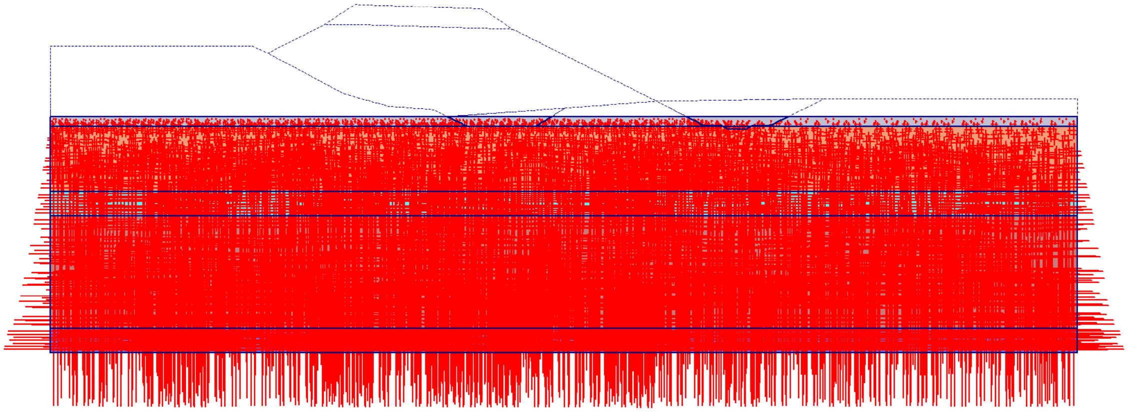


Fig. 16 Plot of total stresses (principal directions)

- Step no: 0 -

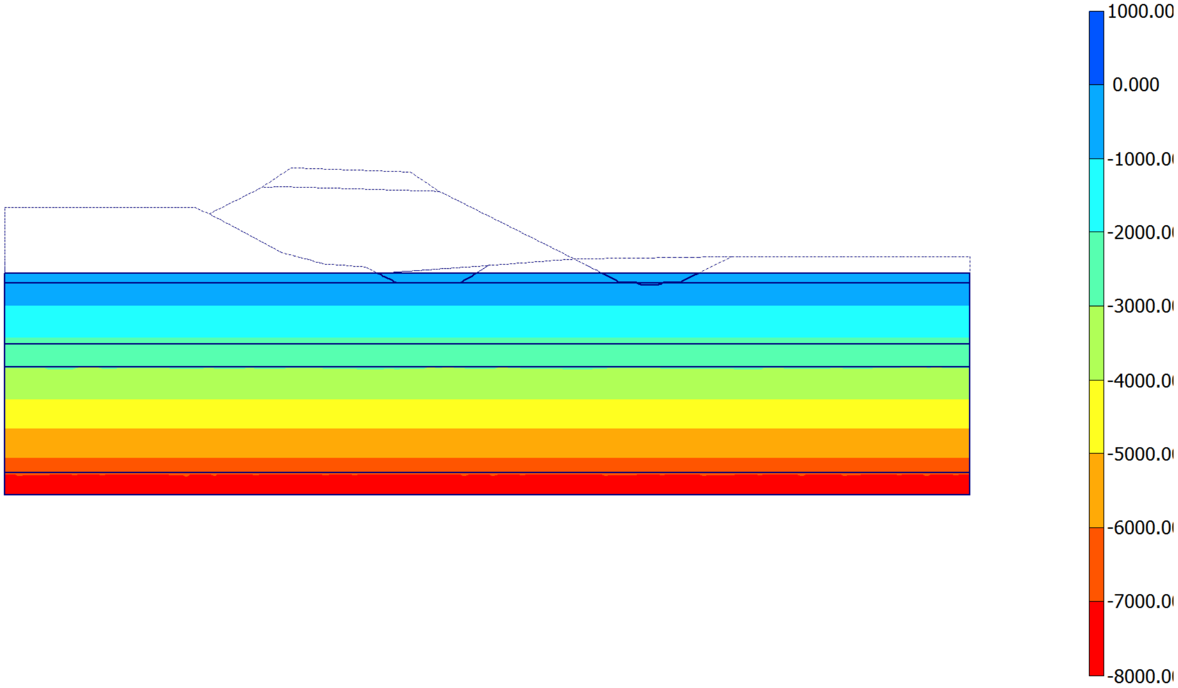


Fig. 17 Plot of total stresses (mean shadings)

- Step no: 0 -

7. Results for phase 1

7.6. Calculation information

Table [19] Step Info phase no: 1

Step no:	30
Calculation type **Extrapolation factor** **Relative stiffness**	PLASTIC 0.355 0.200

Table [20] Reached multipliers phase no: 1

Multipliers	**Incremental value**	**Total value**
Prescribed displacements	0.0000	1.0000
Load system A	0.0000	1.0000
Load system B	0.0000	1.0000
Soil weight	0.0000	1.0000
Acceleration	0.0000	0.0000
Strength reduction factor	0.0000	1.0000
Time	0.0000	0.0000

Table [21] Staged construction info phase no: 1

Staged construction	**Incremental value**	**Total value**
Active proportion of total area	0.000	0.909
Active proportion of stage	0.051	1.000

Table [22] Iteration info phase no: 1

Iter. no.	Global error	Plastic points	Plastic Cap + Hard. points	Inacc. Pl. pts.	Plastic Intf. pts.	Inacc. Intf. pts.	Apex & Tension	Inacc. Apx. pts.
1	0.010	7313	4699	6519	0	0	109	109
2	0.008	7270	4697	211	0	0	105	41

7.7. Deformations

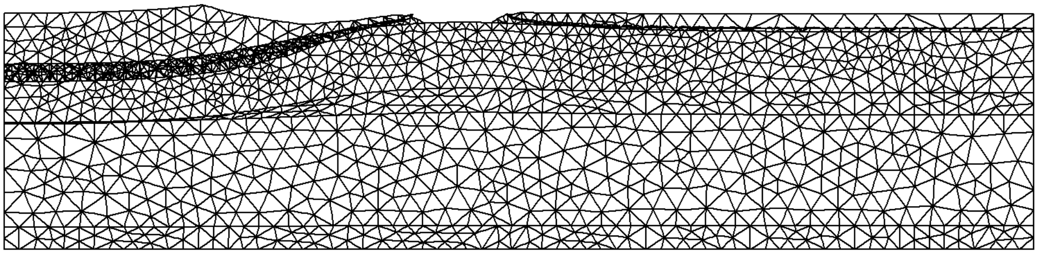


Fig. 18 Plot of deformed mesh

- Step no: 30 - (Phase: 1)

7.7.7. Plot of total displacements

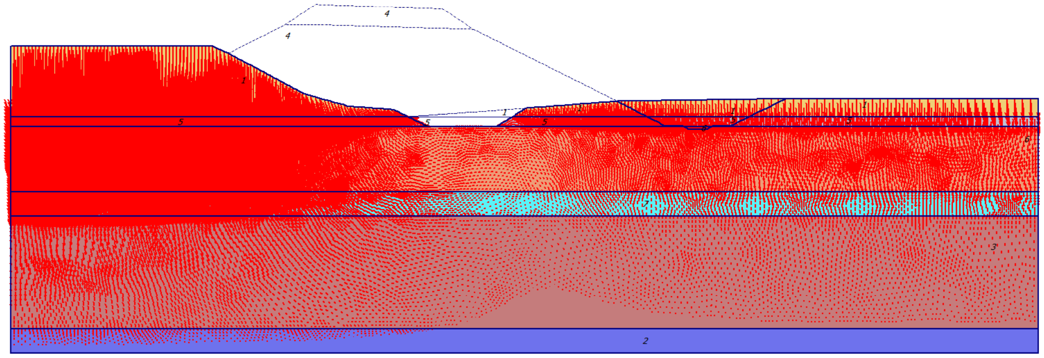


Fig. 19 Plot of total displacements (arrows)

- Step no: 30 - (Phase: 1)

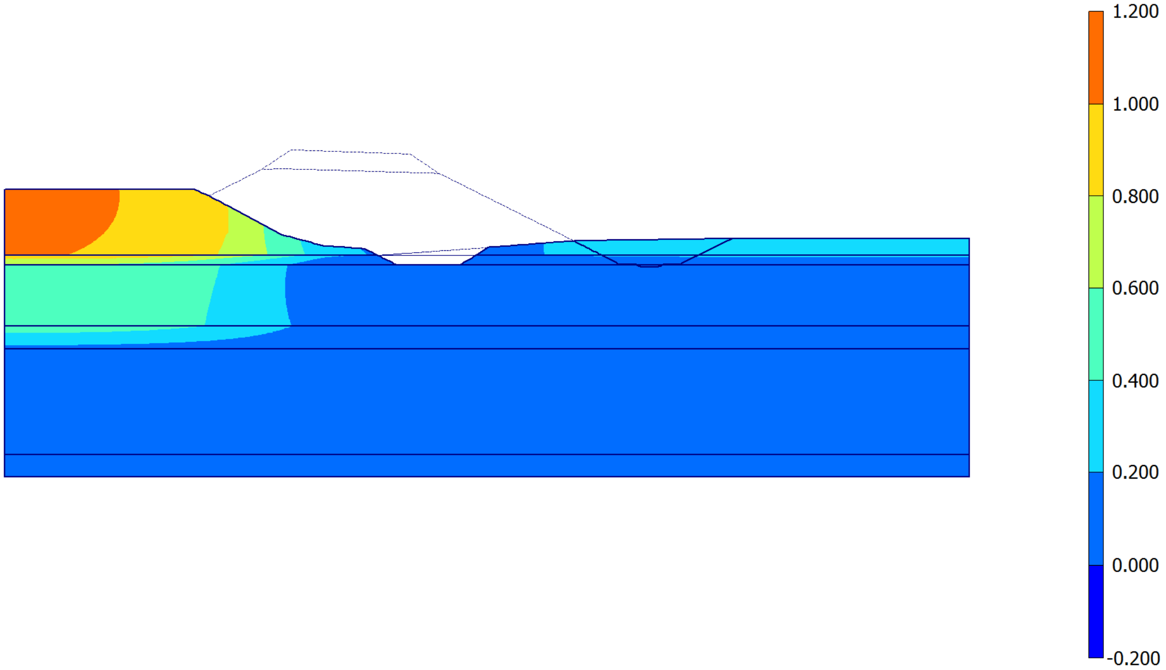


Fig. 20 Plot of total displacements (shadings)

- Step no: 30 - (Phase: 1)

7.7.8. Plot of horizontal displacements

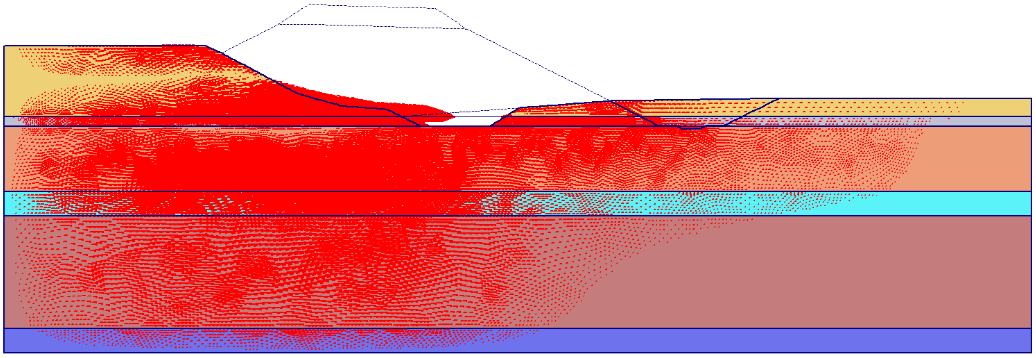


Fig. 21 Plot of horizontal displacements (arrows)

- Step no: 30 - (Phase: 1)

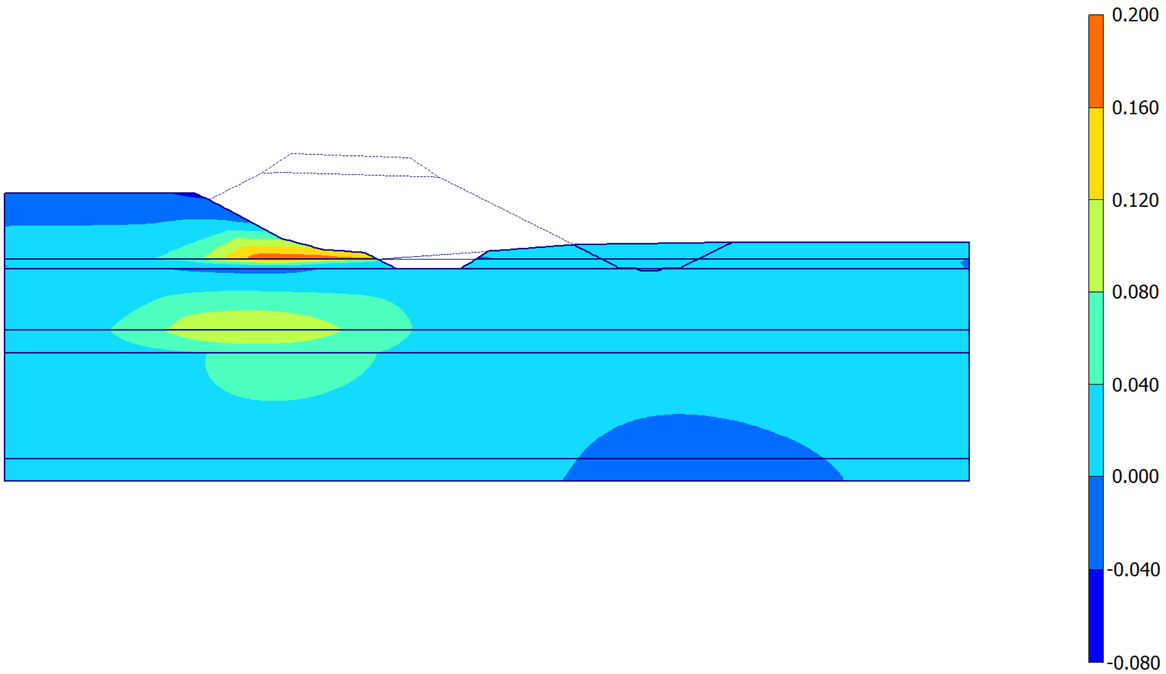


Fig. 22 Plot of horizontal displacements (shadings)

- Step no: 30 - (Phase: 1)

7.7.9. Plot of vertical displacements

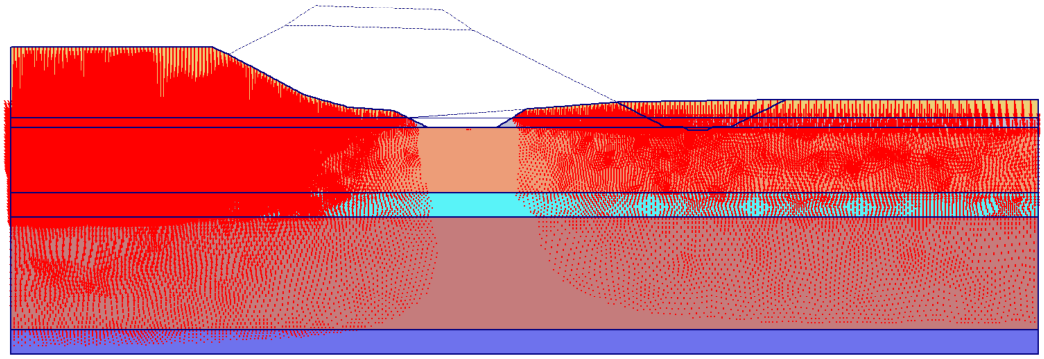


Fig. 23 Plot of vertical displacements (arrows)

- Step no: 30 - (Phase: 1)

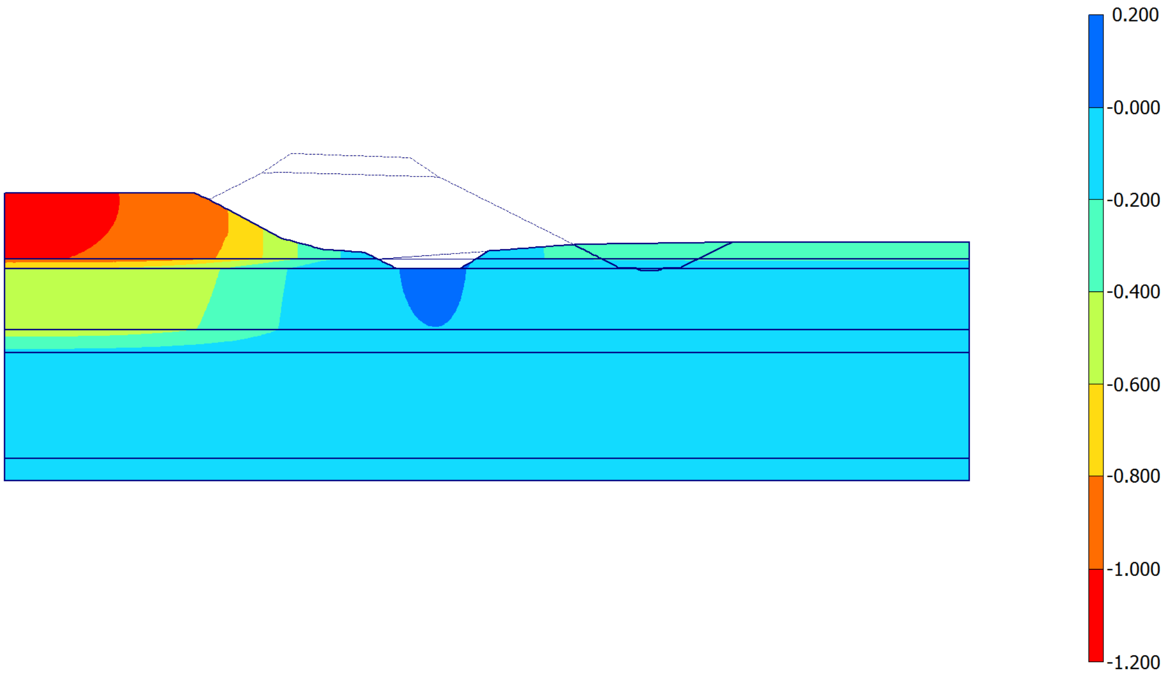


Fig. 24 Plot of vertical displacements (shadings)

- Step no: 30 - (Phase: 1)

7.7.10. Plot of incremental strains

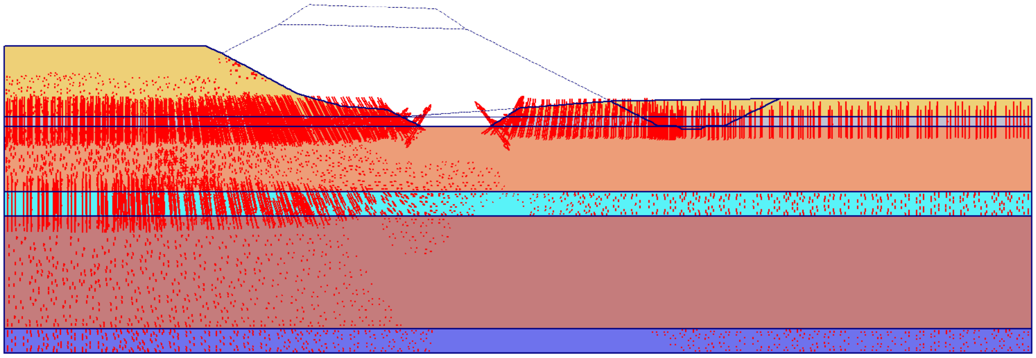


Fig. 25 Plot of total incremental strains (principal directions)

- Step no: 30 - (Phase: 1)

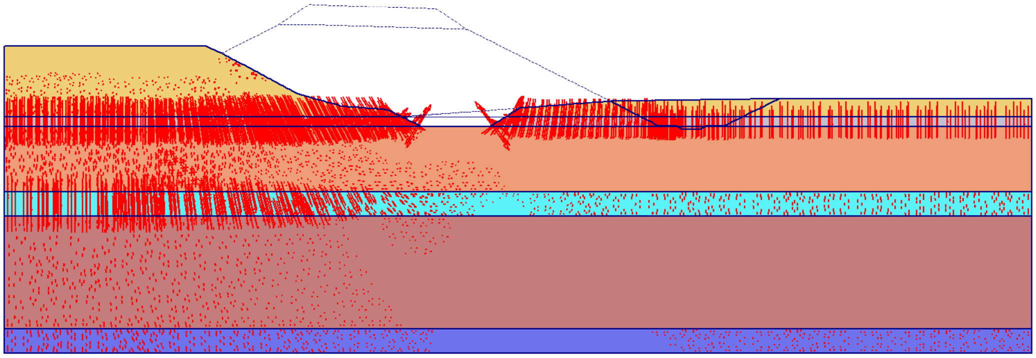


Fig. 26 Plot of total incremental strains (shear shadings)

- Step no: 30 - (Phase: 1)

7.8. Stresses

7.8.11. Plot of effective stresses

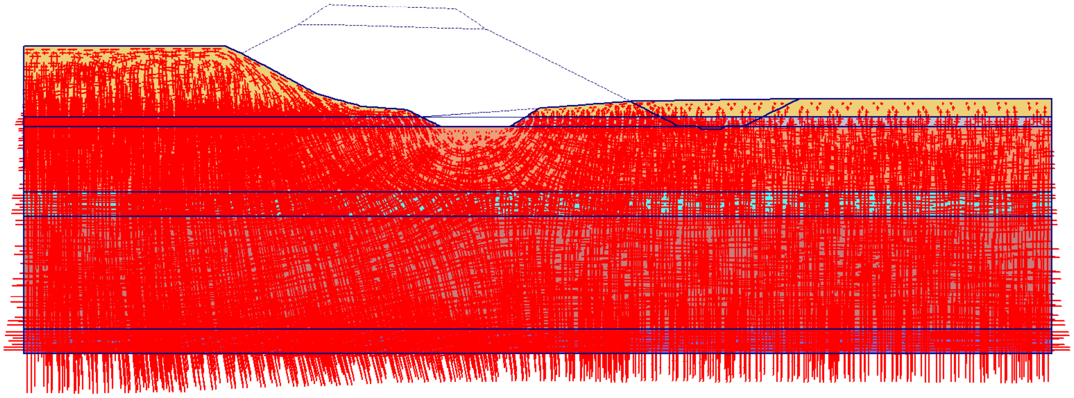


Fig. 27 Plot of effective stresses (principal directions)

- Step no: 30 - (Phase: 1)

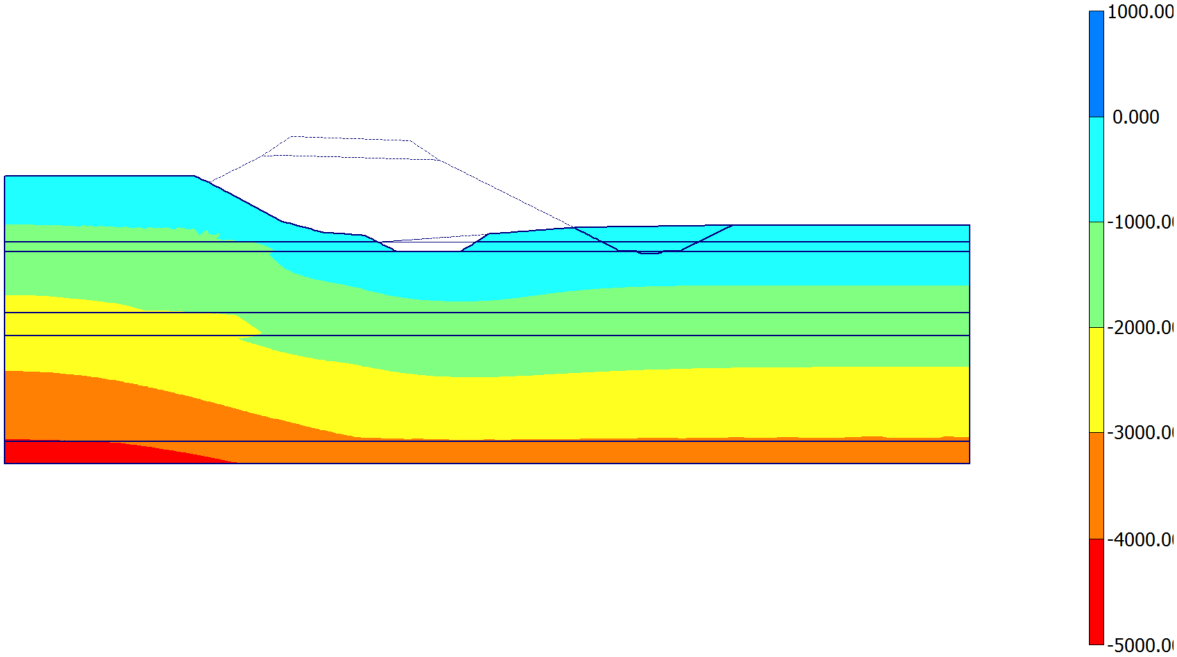


Fig. 28 Plot of effective stresses (mean shadings)

- Step no: 30 - (Phase: 1)

7.8.12. Plot of total stresses

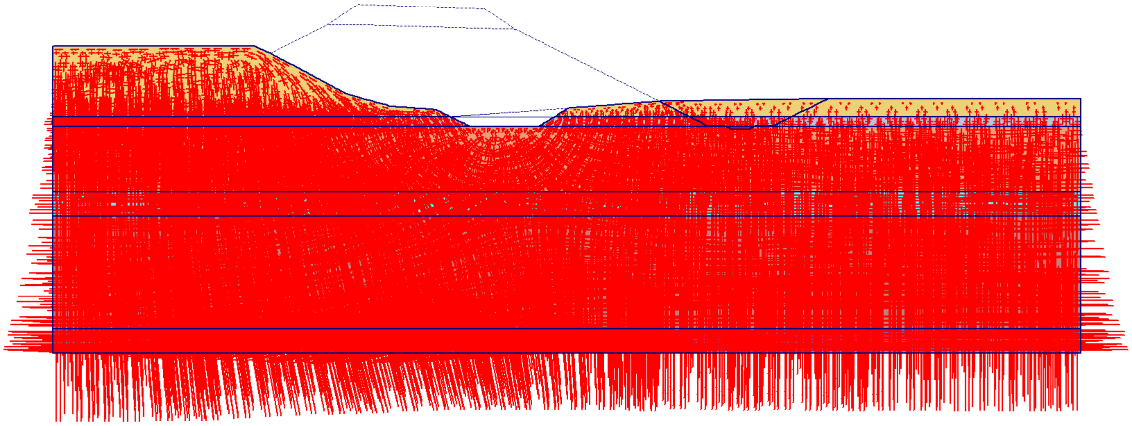


Fig. 29 Plot of total stresses (principal directions)

- Step no: 30 - (Phase: 1)

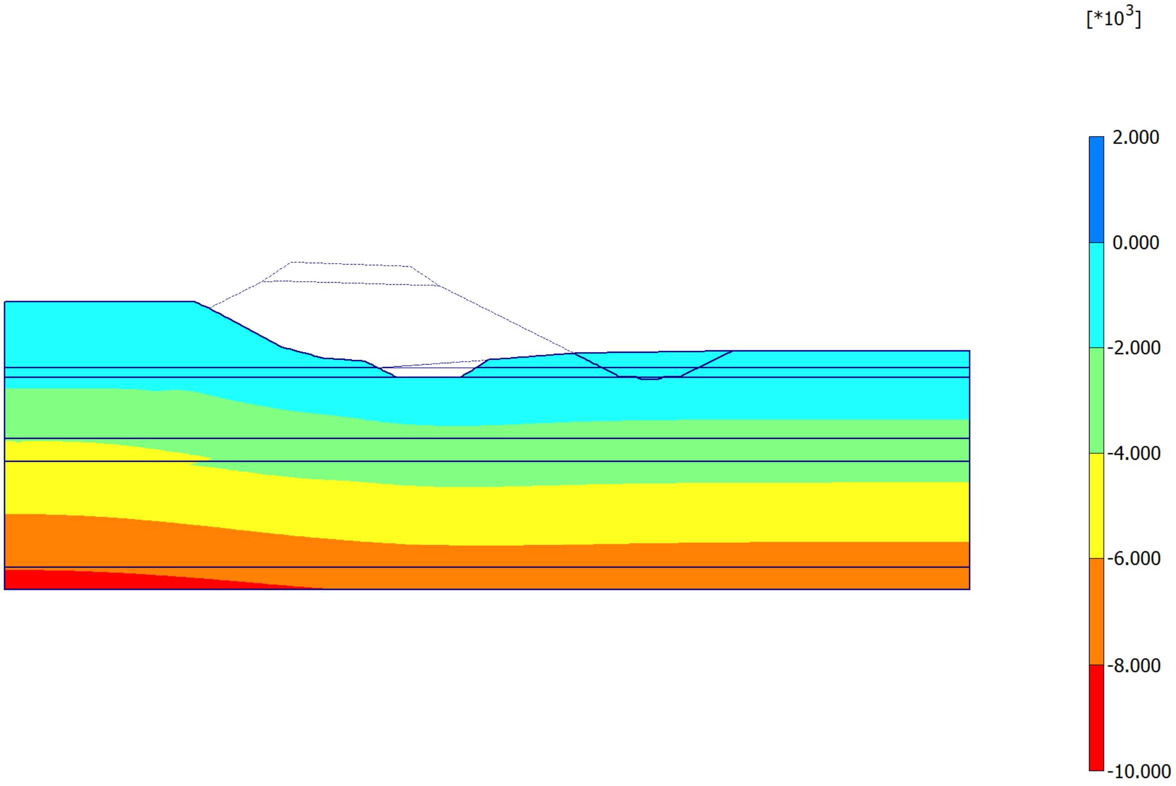


Fig. 30 Plot of total stresses (mean shadings)

- Step no: 30 - (Phase: 1)

8. Results for phase 2

8.9. Calculation information

Table [23] Step Info phase no: 2

Step no:	104
Calculation type	PLASTIC
Extrapolation factor	0.994
Relative stiffness	0.139

Table [24] Reached multipliers phase no: 2

Multipliers	Incremental value	Total value
Prescribed displacements	0.0000	1.0000
Load system A	0.0000	1.0000
Load system B	0.0000	1.0000
Soil weight	0.0000	1.0000
Acceleration	0.0000	0.0000
Strength reduction factor	0.0000	1.0000
Time	0.0000	0.0000

Table [25] Staged construction info phase no: 2

Staged construction	Incremental value	Total value
Active proportion of total area	0.000	0.990
Active proportion of stage	0.014	1.000

Table [26] Iteration info phase no: 2

Iter. no.	Global error	Plastic points	Plastic Cap + Hard. points	Inacc. Pl. pts.	Plastic Intf. pts.	Inacc. Intf. pts.	Apex & Tension	Inacc. Apx. pts.
1	0.010	9085	4691	59	0	0	151	47
2	0.010	9069	4691	146	0	0	150	85

8.10. Deformations

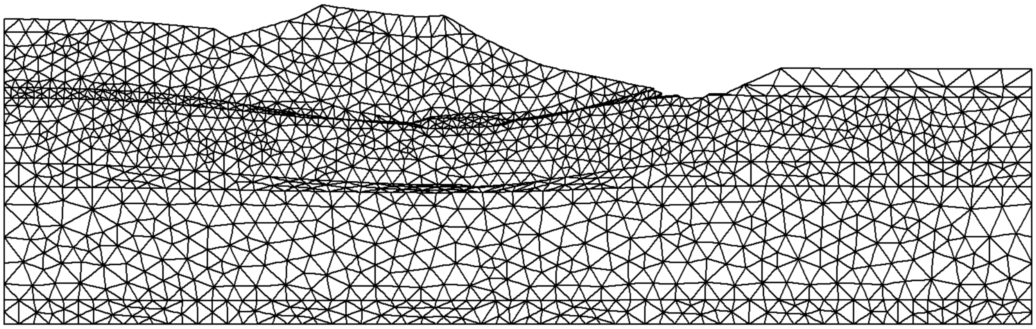


Fig. 31 Plot of deformed mesh

- Step no: 104 - (Phase: 2)

8.10.13. Plot of total displacements

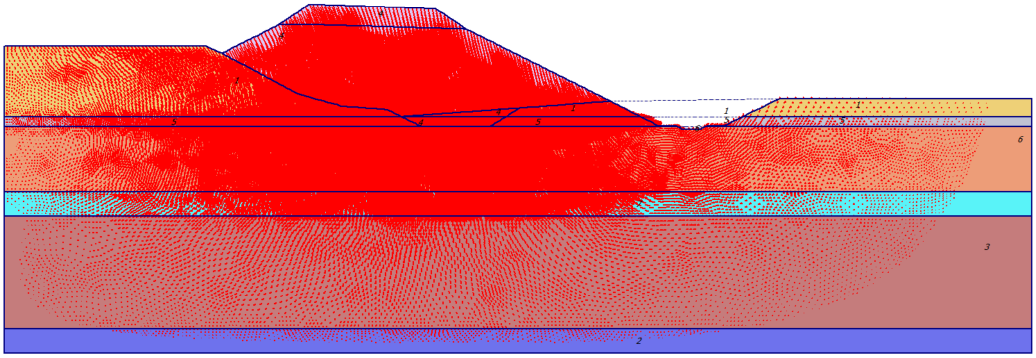


Fig. 32 Plot of total displacements (arrows)

- Step no: 104 - (Phase: 2)

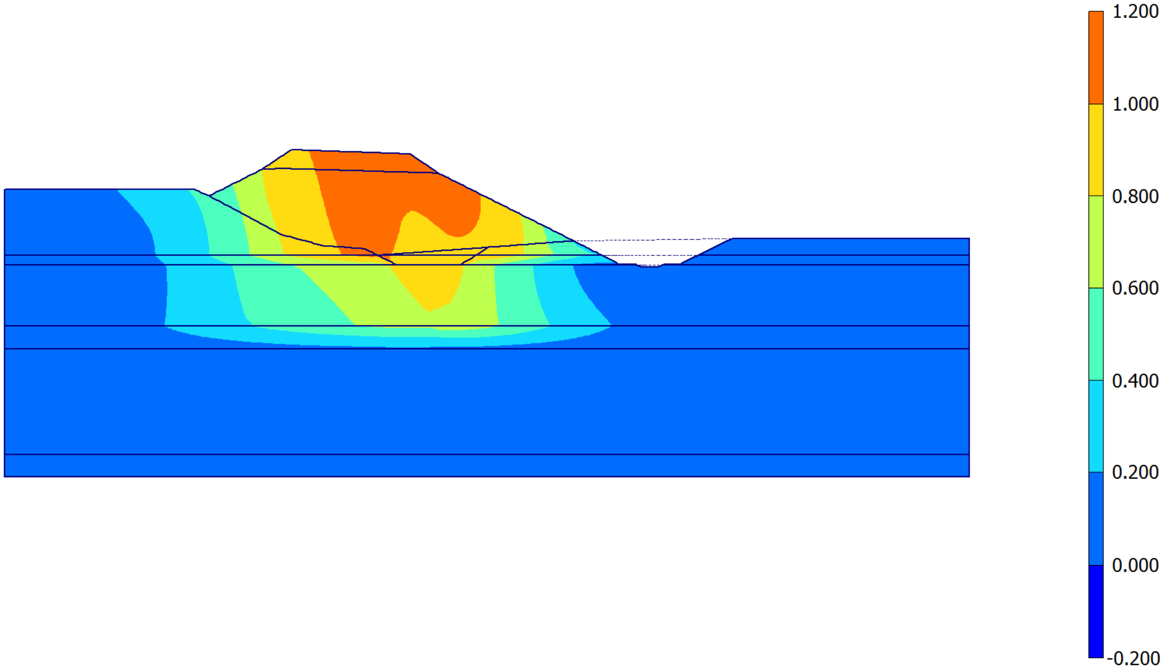


Fig. 33 Plot of total displacements (shadings)

- Step no: 104 - (Phase: 2)

8.10.14. Plot of horizontal displacements

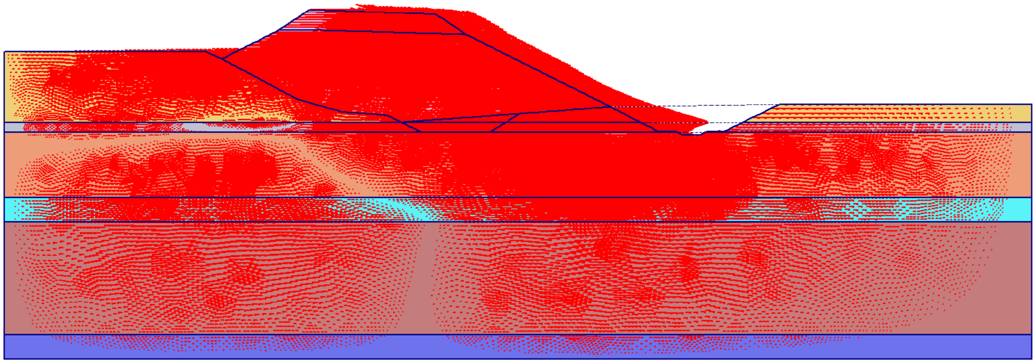


Fig. 34 Plot of horizontal displacements (arrows)

- Step no: 104 - (Phase: 2)

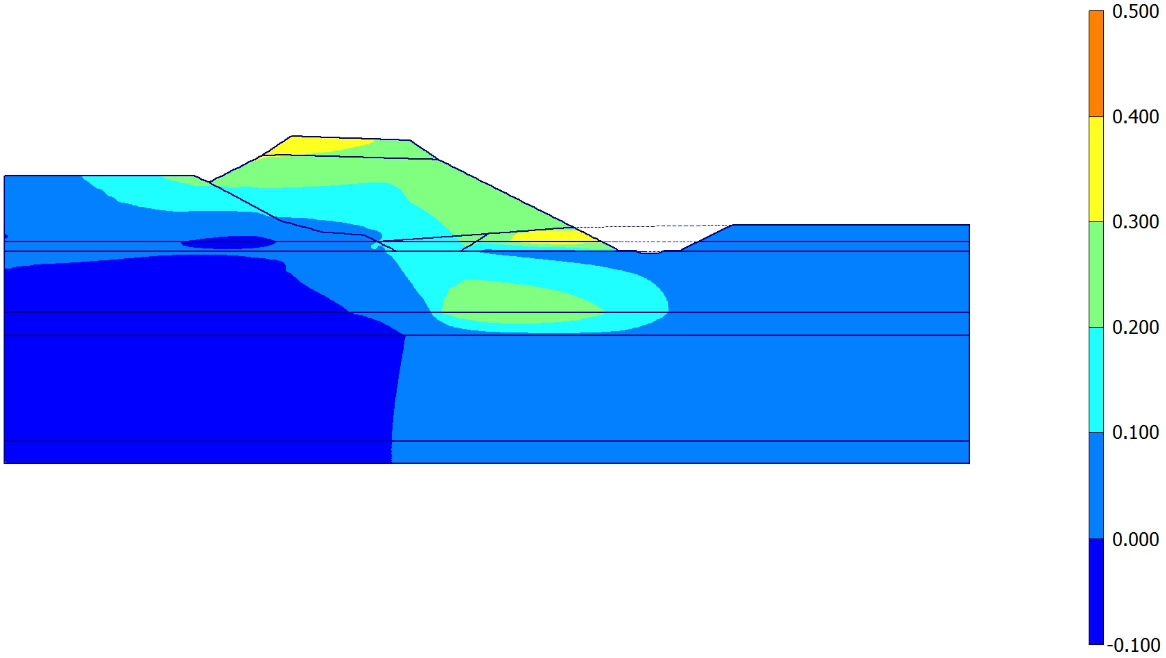


Fig. 35 Plot of horizontal displacements (shadings)

- Step no: 104 - (Phase: 2)

8.10.15. Plot of vertical displacements

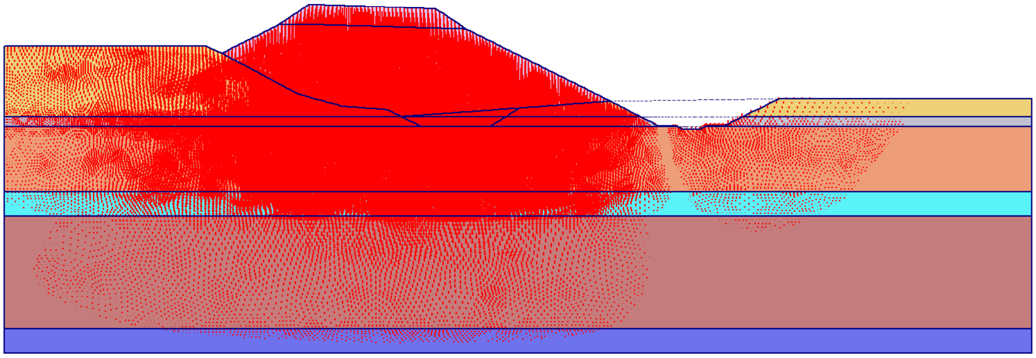


Fig. 36 Plot of vertical displacements (arrows)

- Step no: 104 - (Phase: 2)

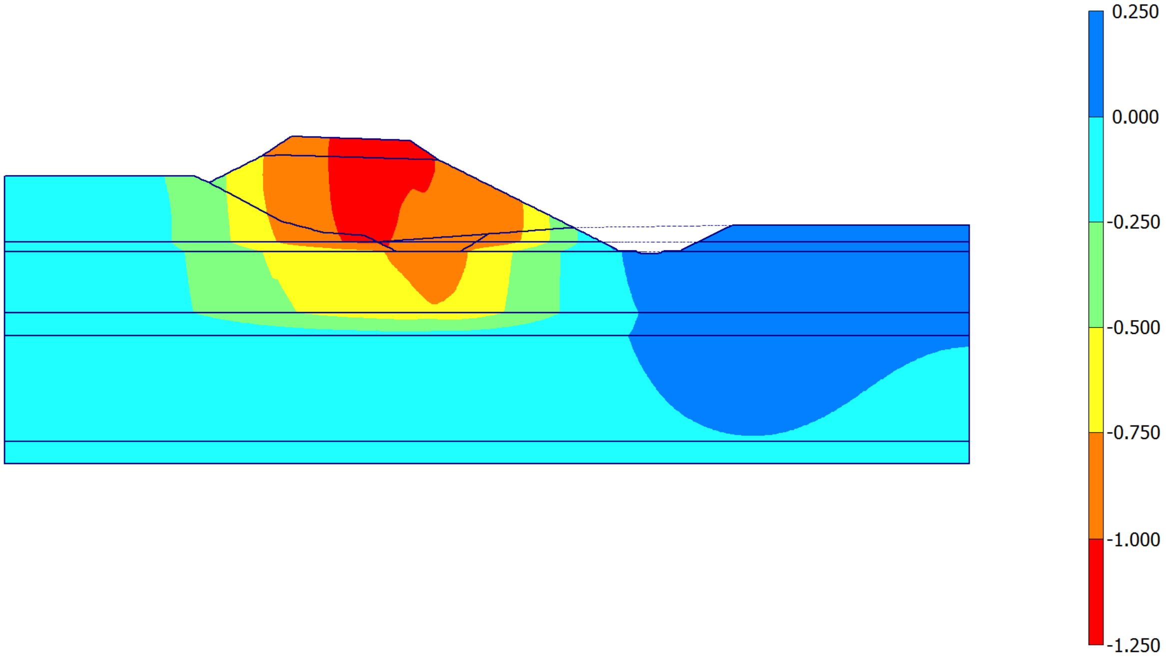


Fig. 37 Plot of vertical displacements (shadings)

- Step no: 104 - (Phase: 2)

8.10.16. Plot of incremental strains

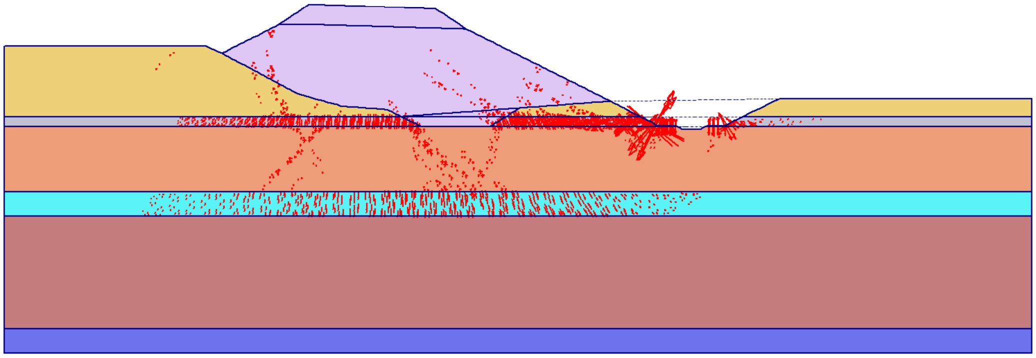


Fig. 38 Plot of total incremental strains (principal directions)

- Step no: 104 - (Phase: 2)

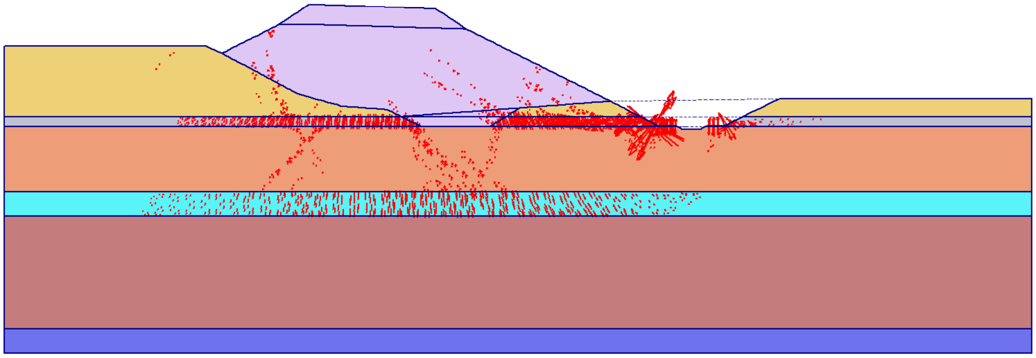


Fig. 39 Plot of total incremental strains (shear shadings)

- Step no: 104 - (Phase: 2)

8.11. Stresses

8.11.17. Plot of effective stresses

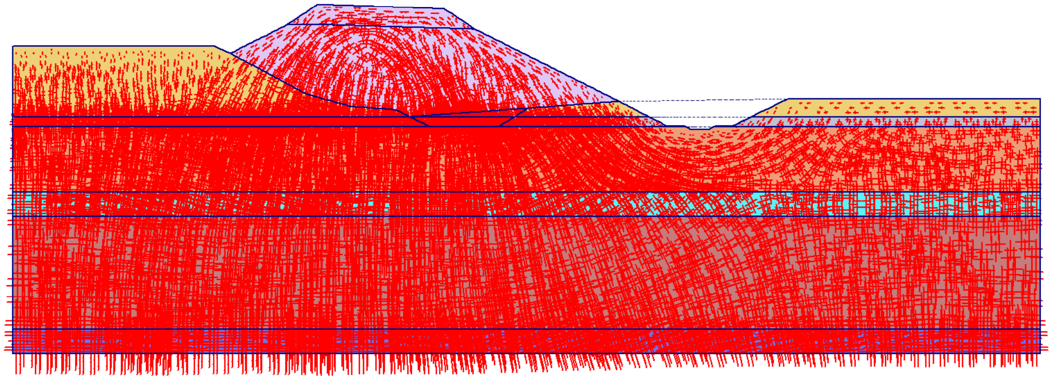


Fig. 40 Plot of effective stresses (principal directions)

- Step no: 104 - (Phase: 2)

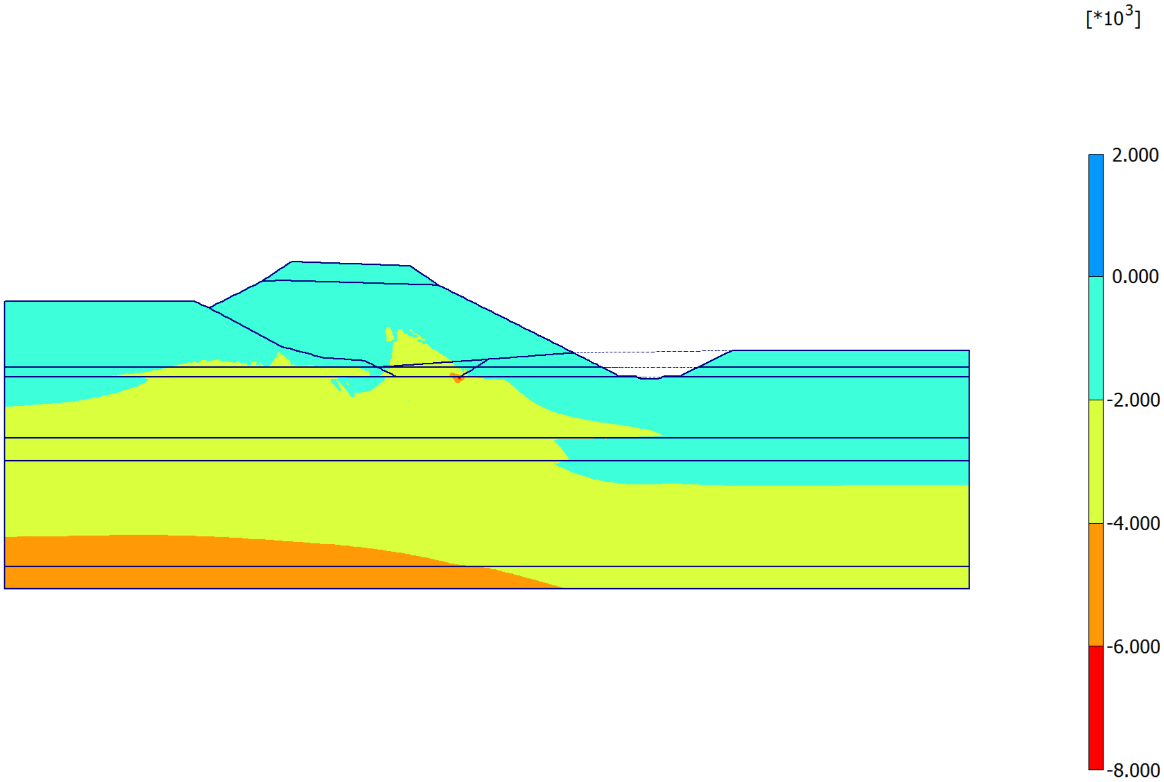


Fig. 41 Plot of effective stresses (mean shadings)

- Step no: 104 - (Phase: 2)

8.11.18. Plot of total stresses

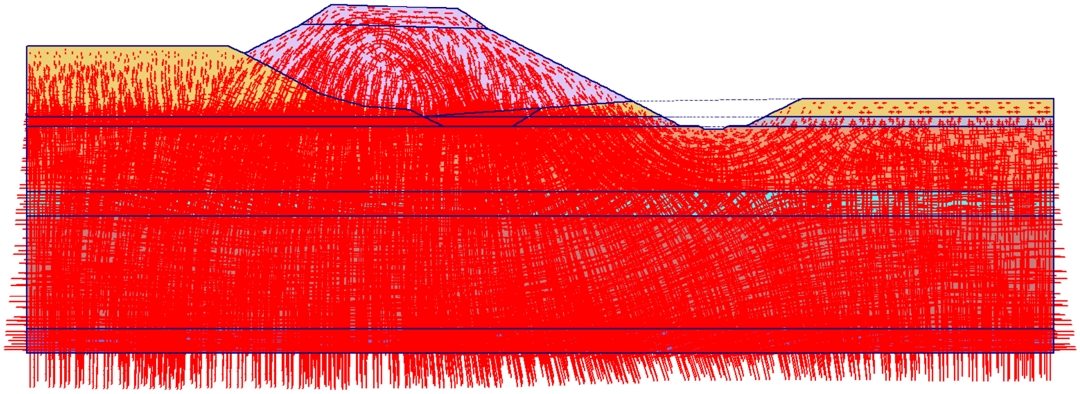


Fig. 42 Plot of total stresses (principal directions)

- Step no: 104 - (Phase: 2)

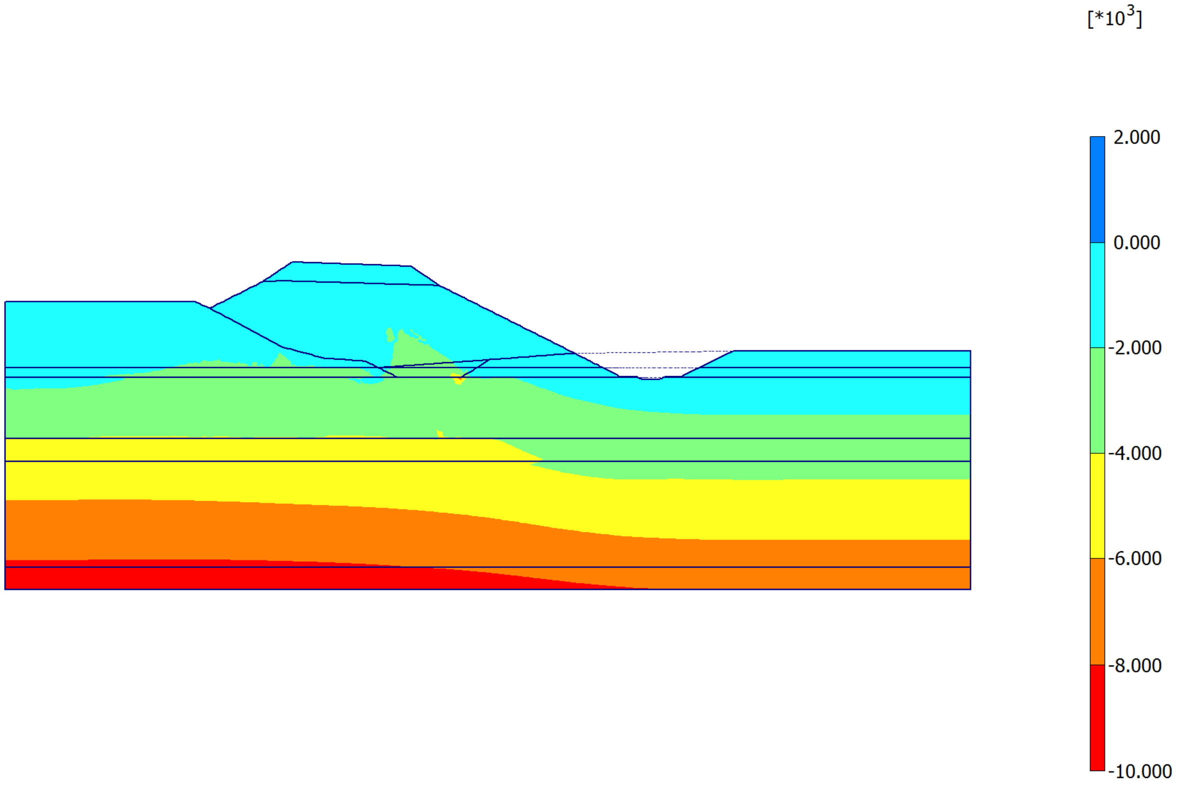


Fig. 43 Plot of total stresses (mean shadings)

- Step no: 104 - (Phase: 2)

Appendix C-2

Plaxis Modelling Results for the I-264 Expansion at STA 182+50

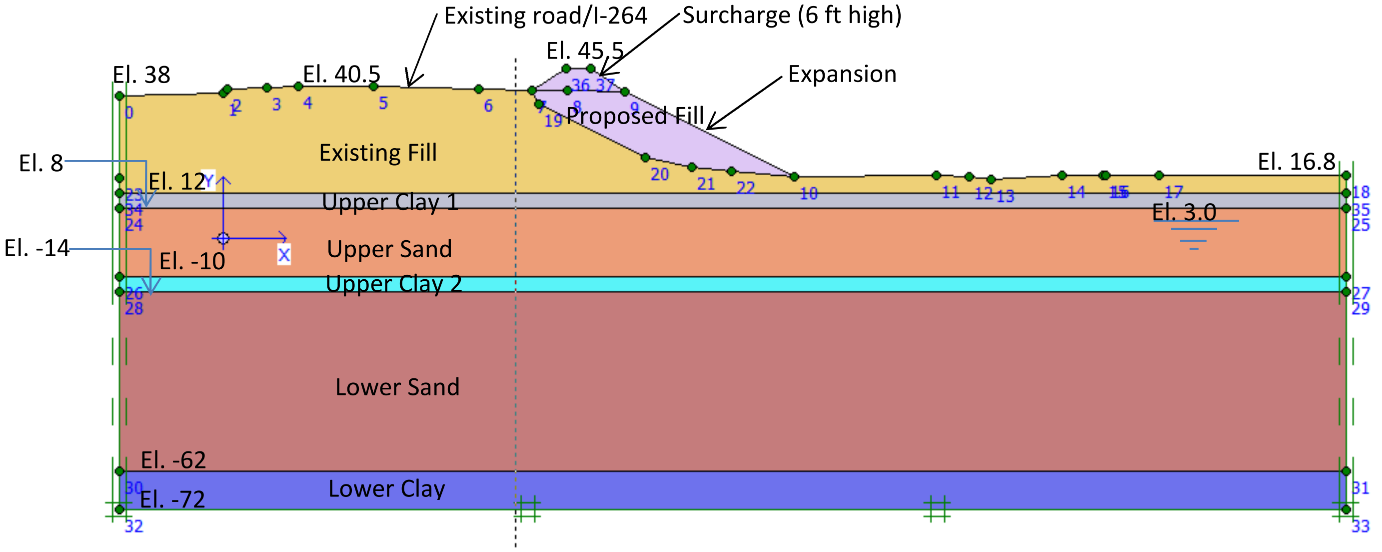
1. Introduction

This document summarizes the results of the numerical analyses to model the expansion of I-264 at STA 182+50 for the WitchDuck Project. Plaxis 8.5 was used to analyze the deformation of the existing roadway and the expansion.

The global stability of the existing road and the expansion was not analyzed and is not included in this report.

2. Geometry

The cross section of the existing road and the expansion is shown in Figure 1. A 6-foot high surcharge is added on top of the expansion to accelerate the consolidation of the soft soils below the expansion. The subsurface ground conditions consist of (from top bottom) upper clay 1, upper and sand, upper clay 2, lower sand, and lower clay.



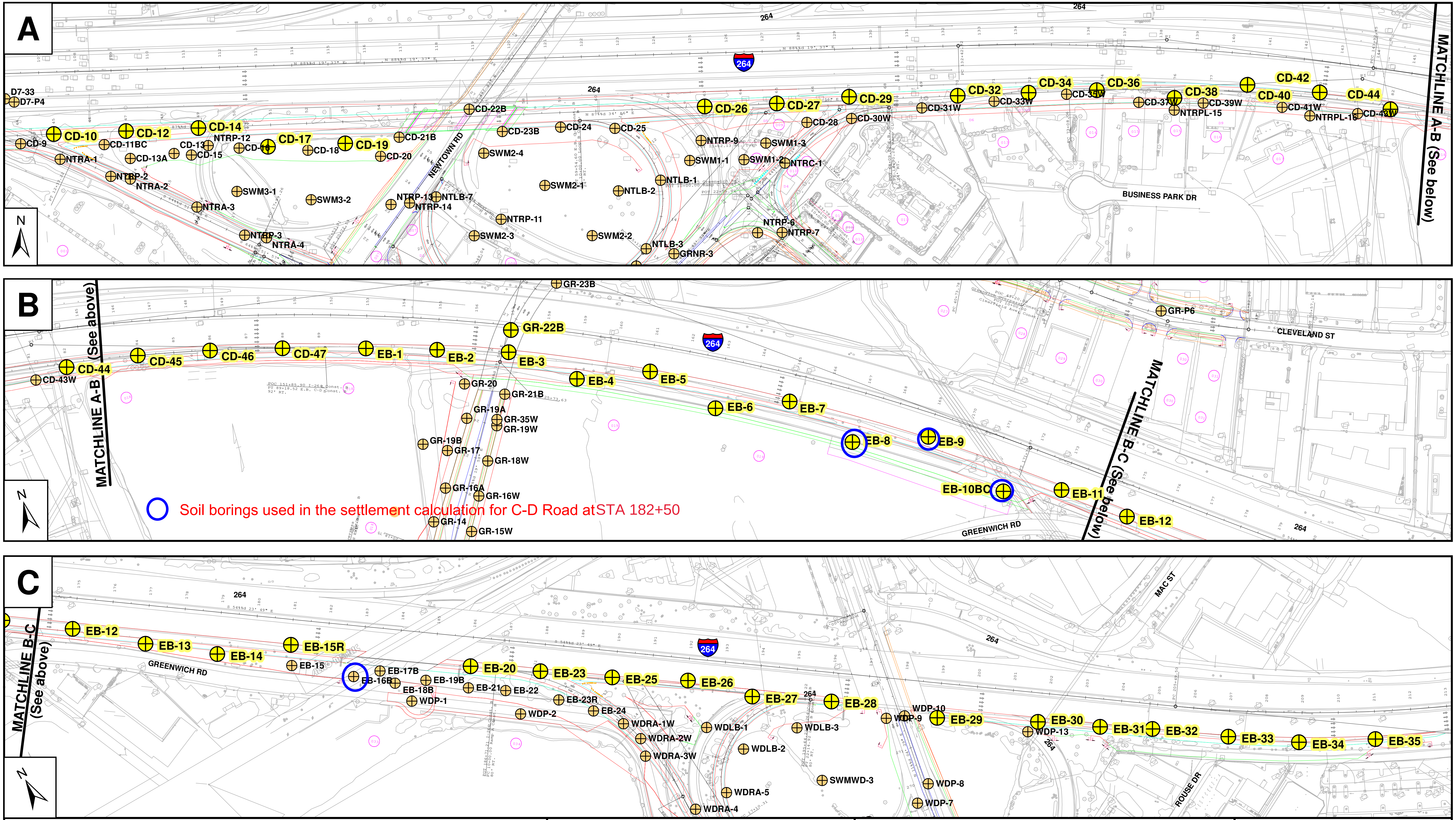
Unit: ft

Figure 1 Cross Section at STA 182+50

3. Plaxis Model

The deformation of the existing road and the expansion was considered as a two-dimensional plain strain problem. Figure 2 shows the finite element mesh of the Plaxis model. Plain strain, 15-noded elements were used. Detailed model information is included in the attachment.

The following 3 construction stages/phases were modelled:



0 125 250 Feet

SPT Exploration Locations

Borings in other PSAs

Prepared by: HDR

Date: November 2011

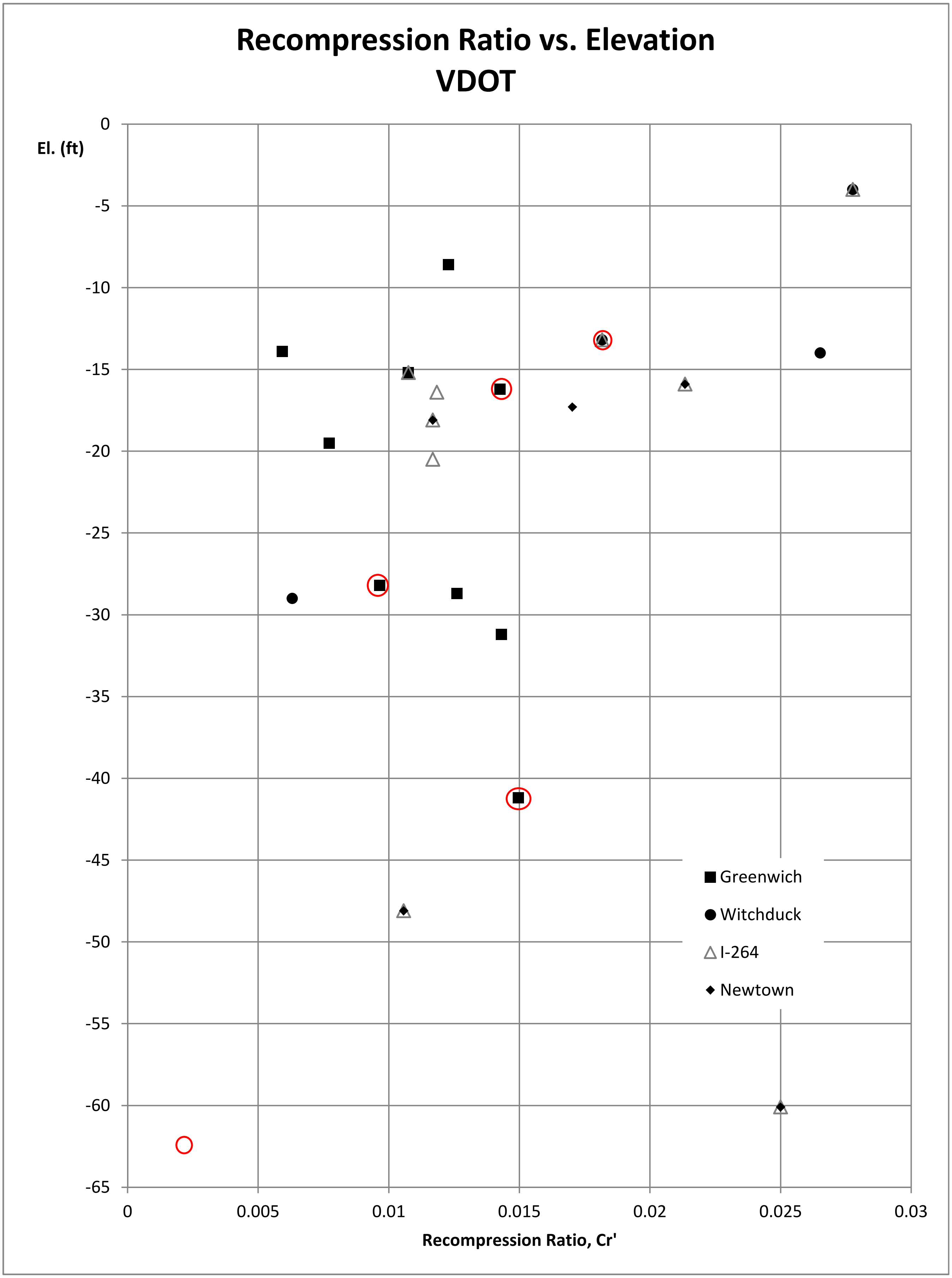
VDOT Virginia Department of Transportation

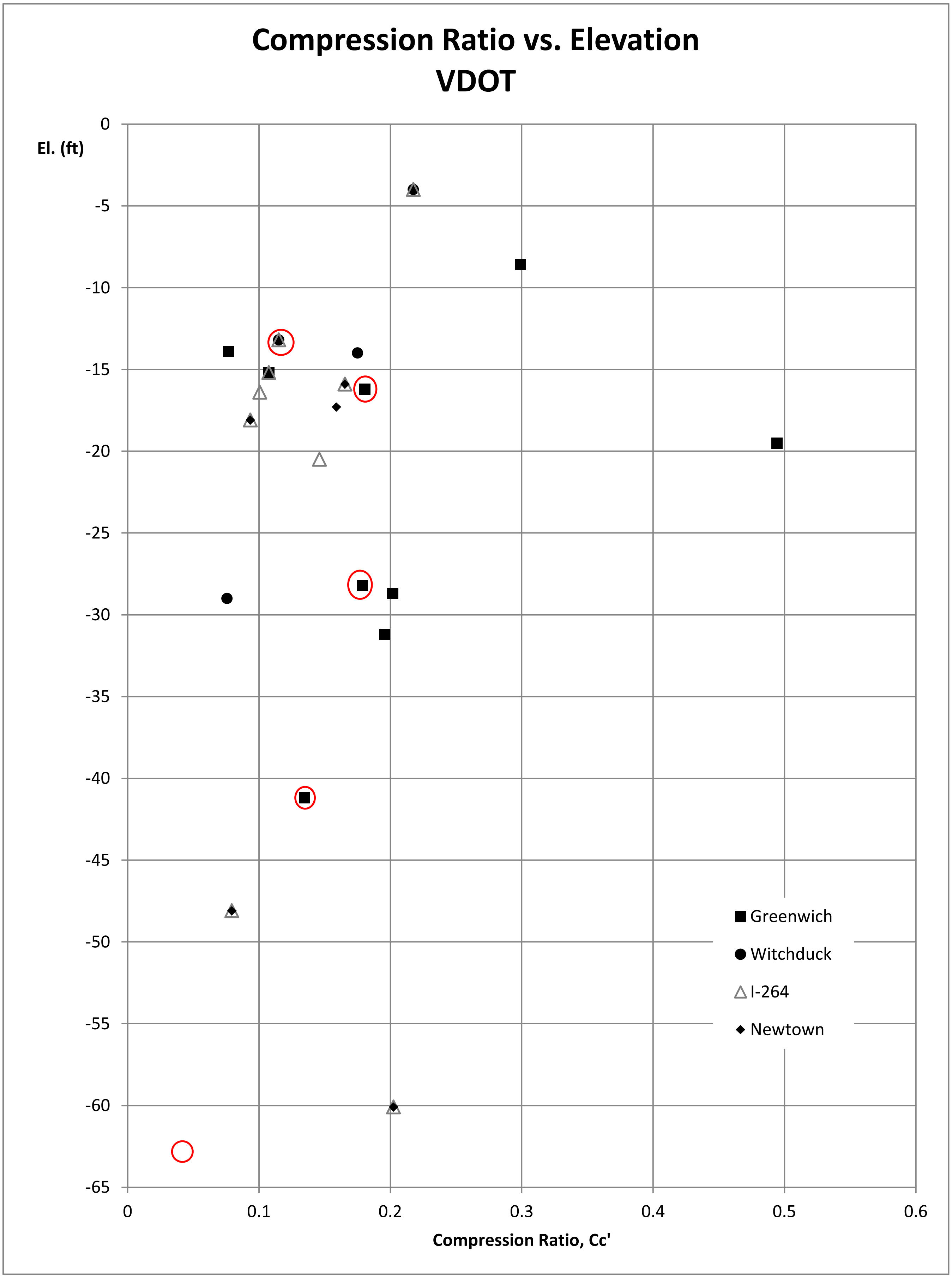
Project 0264-122-108
City of Norfolk

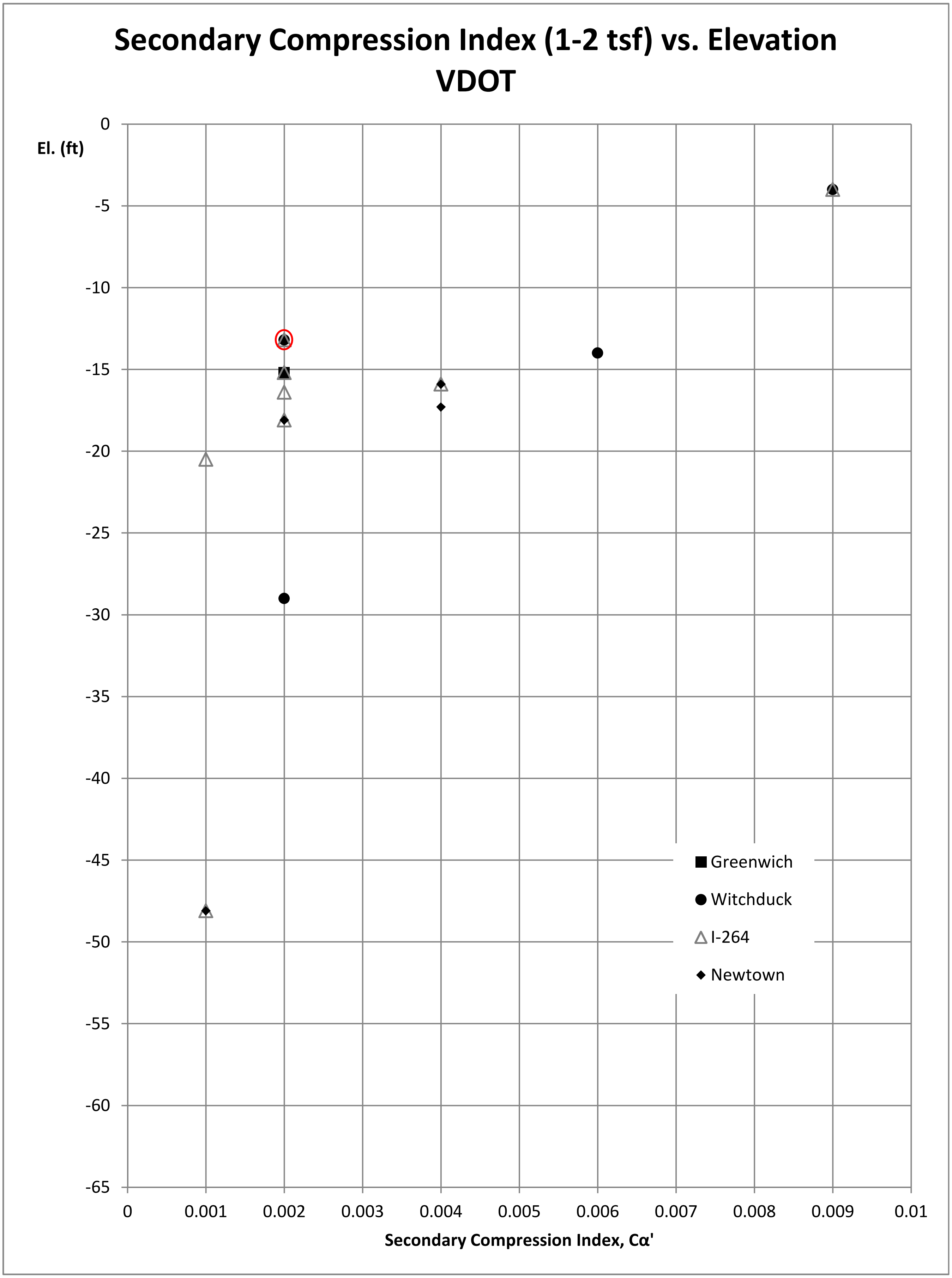
Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan


Recompression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.005
0.01
0.015
0.02
0.025
0.03
Recompression Ratio, Cr'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown


Compression Ratio vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.1
0.2
0.3
0.4
0.5
0.6
Compression Ratio, Cc'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown


Secondary Compression Index (1-2 tsf) vs. Elevation
VDOT
El. (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
Secondary Compression Index, Cα'
■ Greenwich
● Witchduck
△ I-264
◆ Newtown

- Initial Phase: establishment of the initial stress conditions before the construction of the existing roadway
- Phase 1: construction of the existing roadway and placement of the existing fill
- Phase 2: construction of the proposed expansion and surcharge

Below are the assumptions and limitations of the model:

- No secondary compression was modeled
- Model assumed the surcharge will be on long enough for full primary consolidation to occur
- Any settlement resulting from the original embankment construction has completed

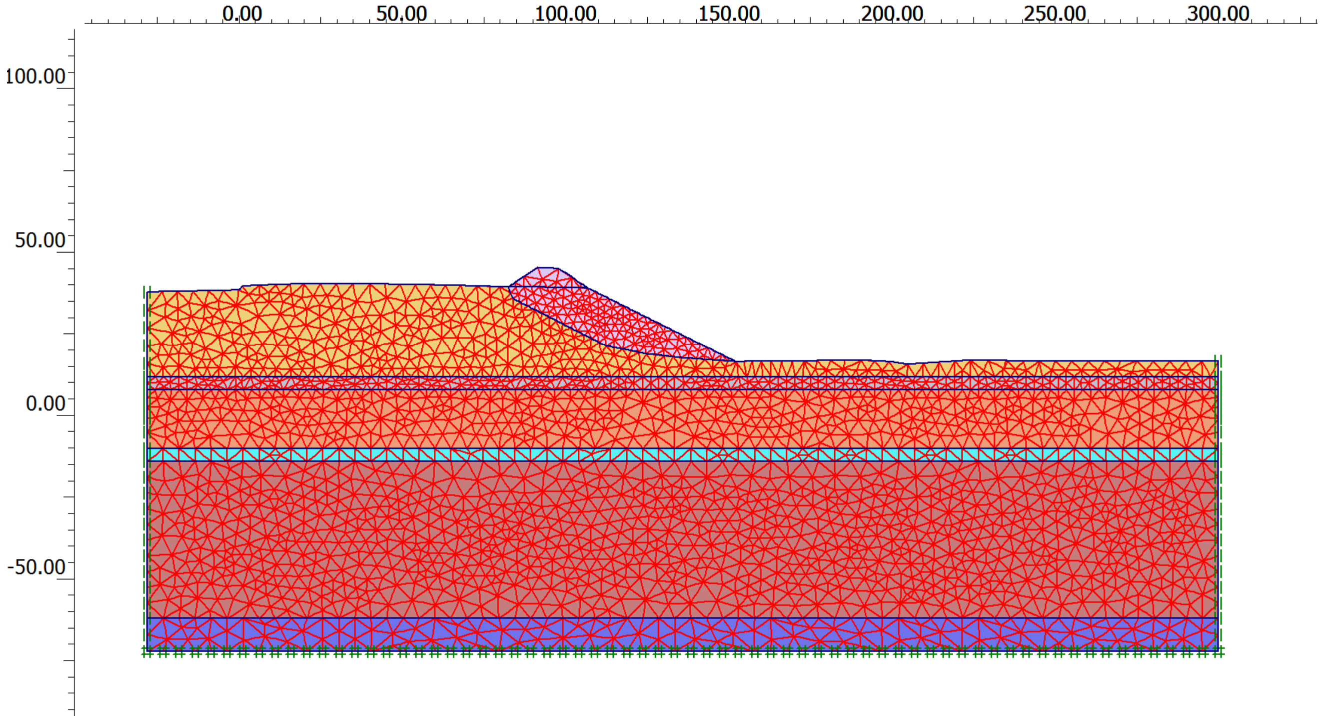


Figure 2 Finite Element Mesh

4. Soil Parameters

The parameters for the soils in Figure 1 are included in Table 1. The Mohr-Coulomb model was used for the existing Fill, proposed Fill, upper sand, and lower sand. The soft soil model was used for the long term consolidation analysis of the upper clay 1, upper clay 2, and lower clay. All soils were modelled for the drained conditions to calculate the long-term deformation of the roadway and the expansion.

Table 1 Soil Parameters

Layer	Total Unit Weight (pcf)	C’ (psf)	ϕ’ (degrees)	μ	K_0^{NC}	K_0^{OC}	C_c'	C_r'	e_0	OCR	E (psf)
Proposed Fill	130	25	34	0.3	0.44	NA	NA	NA	NA	NA	1,000,000
Existing Fill	115	25	32	0.3	0.47	NA	NA	NA	NA	NA	750,000
Upper Clay 1	120	25	23	NA	0.61	0.8	0.12	0.012	0.97	2	NA
Upper Clay 2	112	25	23	NA	0.61	0.71	0.17	0.014	0.97	1.5	NA
Upper Sand	118	25	30	0.3	0.50	0.6	NA	NA	NA	1.5	500,000
Lower Clay	115	25	25	NA	0.58	0.78	0.1	0.012	1.2	2	NA
Lower Sand	125	25	32	0.3	0.47	0.6	NA	NA	NA	1.5	500,000

Notes:

1. $C_c' = C_c/(1+e_0)$.
2. $C_r' = C_r/(1+e_0)$
3. $K_0^{OC} = K_0^{NC}\ OCR^{\sin\phi'}$, where K_0^{NC} is the coefficient of earth pressure at rest for normally consoliadted soils and K_0^{OC} is the coefficient of earth pressure at rest for over-consoliadted soils.
4. A samll C’ value (i.e., 25 psf) was used for all soils to improve the peformance of modelling.
5. The OCR values for the Upper Sand and the Lower Sand was assumed the same as that of the Upper Clay 2.

5. Analysis Results

Figures 3, 4, and 5 show the deformed mesh, the vertical displacements, and the settlements along the existing roadway. Detailed analysis results are included in the attachment.

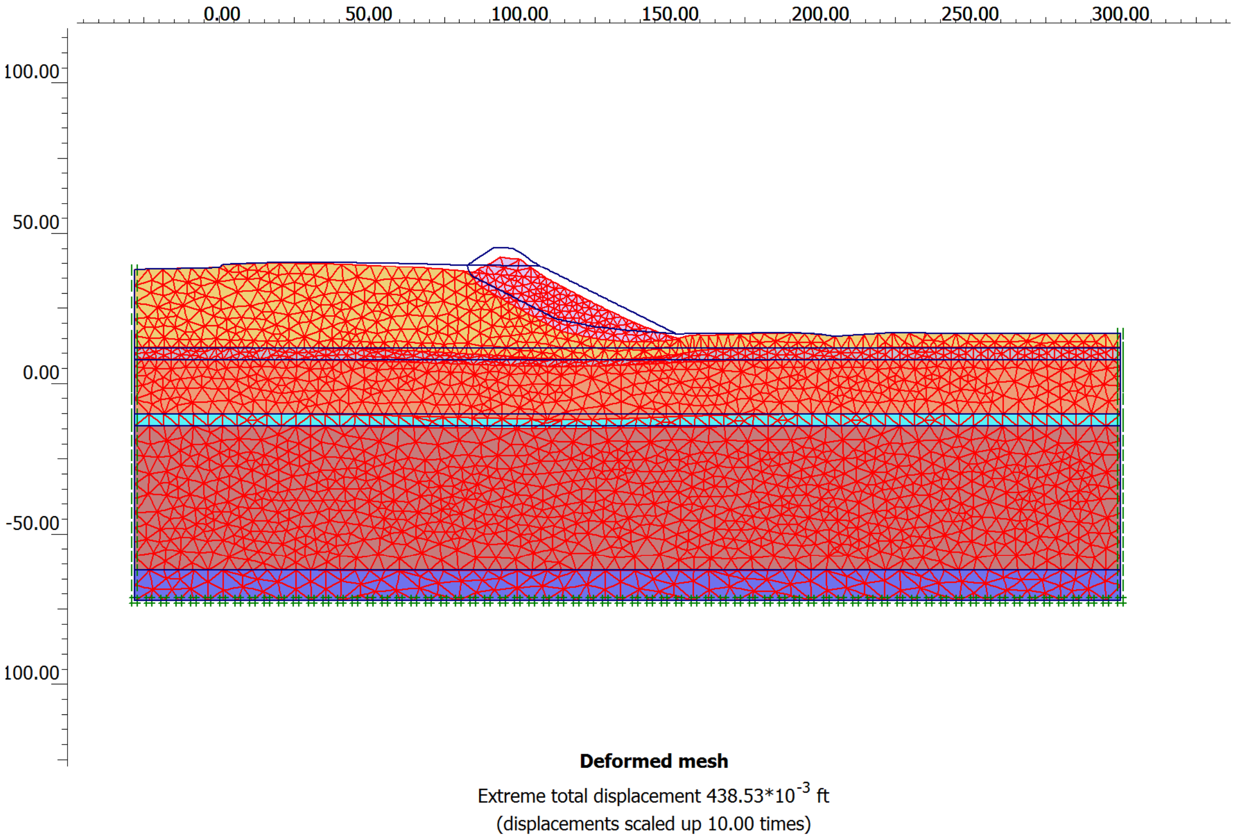


Figure 4 182+50 with Surcharge, Deformed Mesh

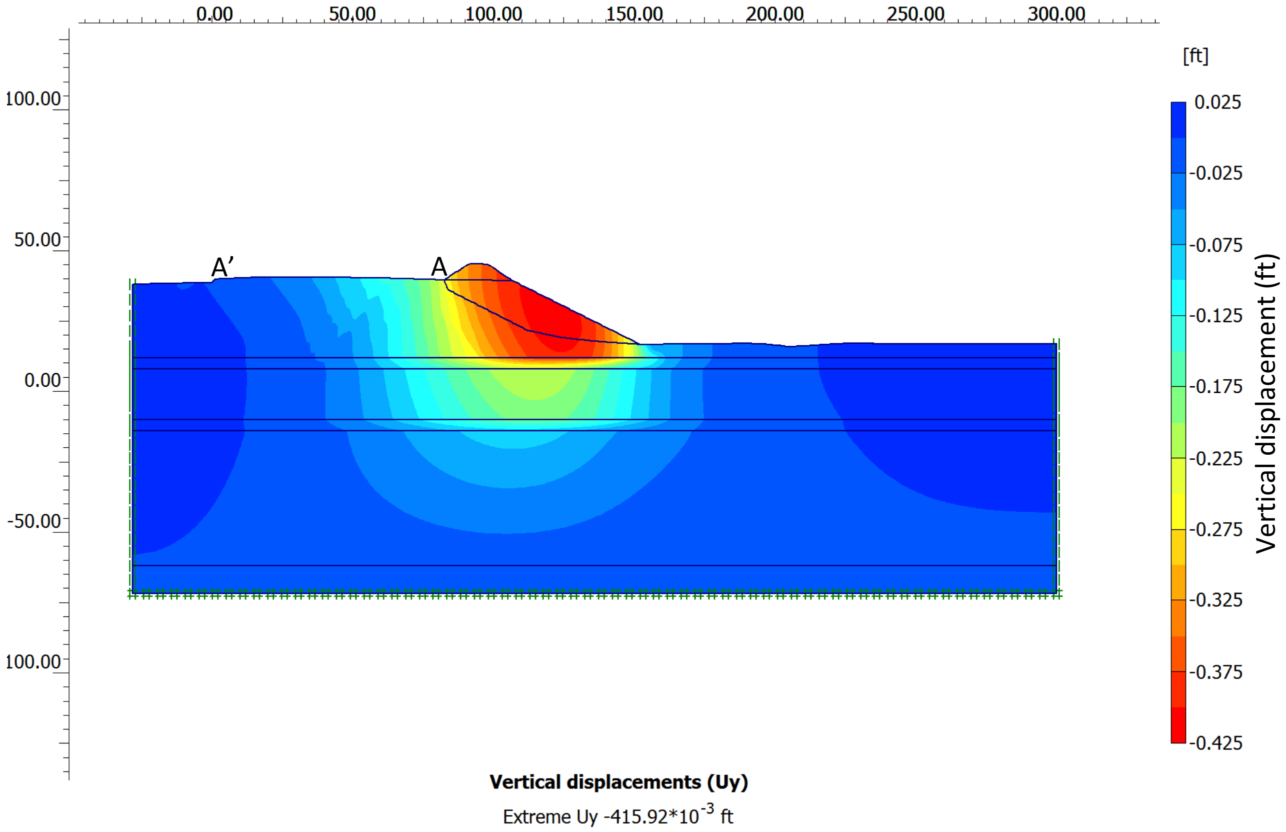


Figure 5 182+50 with Surcharge, Vertical Displacements

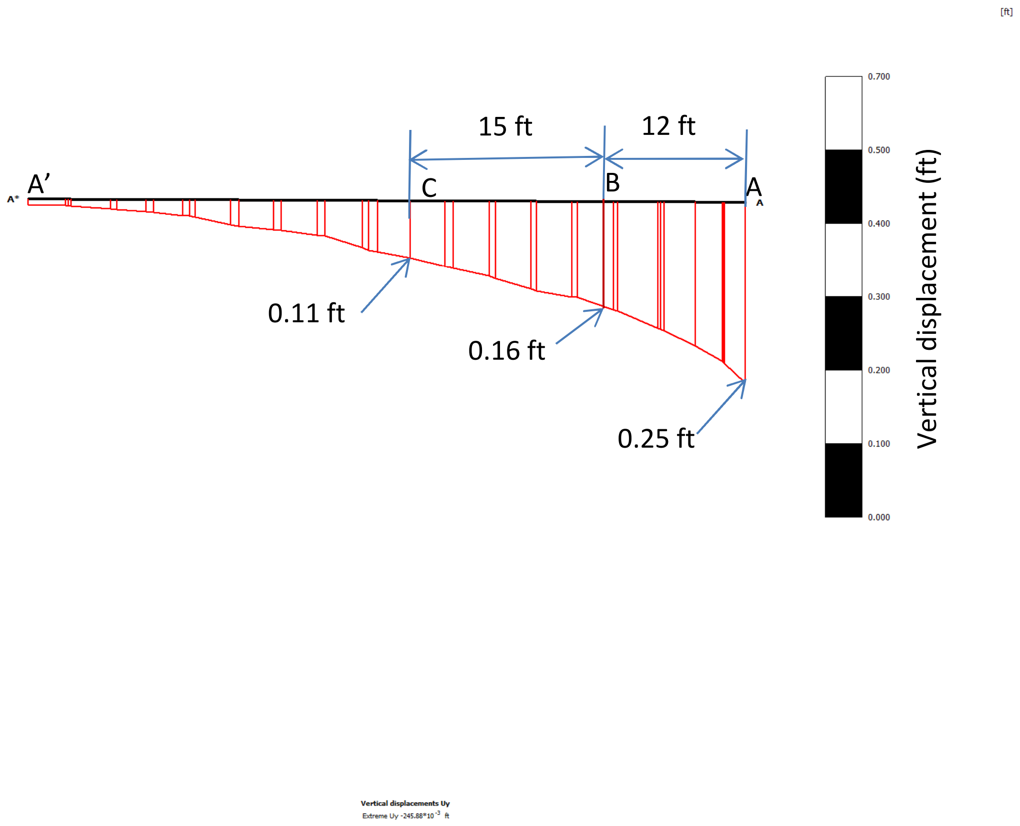


Figure 6 182+50 with Surcharge, Vertical Displacements along the Existing Road Surface (A-A')

Attachment

Plaxis Modelling Report

for the I-264 Expansion at STA 182+50

01/10/2017

User: URS Corporation

Title: STA18250

Table of Contents

1. General Information

Table [1] units

Type	Unit
Length	ft
Force	lb
Time	s

Table [2] Model dimensions

	min.	max.
X	-28.000	300.000
Y	-72.000	45.500

Table [3] Model

Model	Plane Strain
Element	15-Noded

2. Geometry

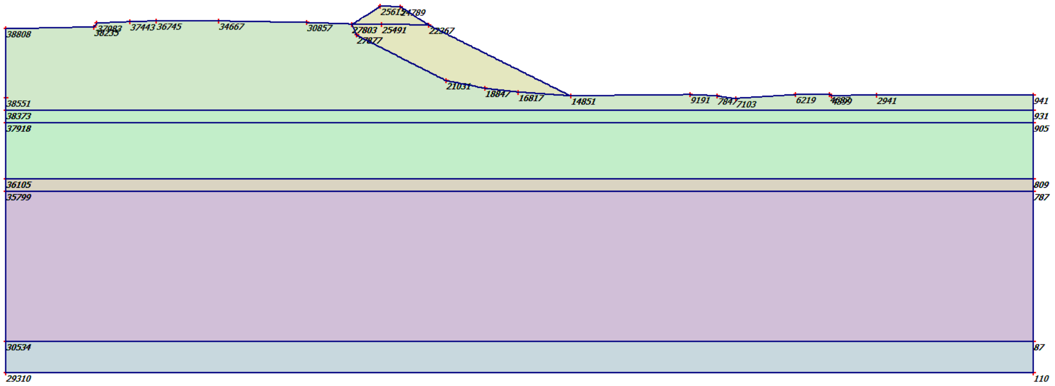


Fig. 1 Plot of geometry model with significant nodes

Table [4] Table of significant nodes

Node no.	x-coord.	y-coord.	Node no.	x-coord.	y-coord.
38808	-28.000	38.000	27877	84.000	36.000
38235	0.000	38.600	21031	112.500	21.500
37983	1.000	39.800	18847	125.000	19.000
37443	11.500	40.300	16817	135.500	17.800
36745	20.000	40.500	38551	-28.000	16.000
34667	40.000	40.500	37918	-28.000	8.000
30857	68.000	40.000	905	300.000	8.000

Node no.	x-coord.	y-coord.	Node no.	x-coord.	y-coord.
27803	82.500	39.500	36105	-28.000	-10.000
25491	92.000	39.500	809	300.000	-10.000
22367	107.000	39.200	35799	-28.000	-14.000
14851	152.300	16.600	787	300.000	-14.000
9191	190.500	17.000	30534	-28.000	-62.000
7847	199.000	16.600	87	300.000	-62.000
7103	205.000	15.800	29310	-28.000	-72.000
6219	224.000	17.000	110	300.000	-72.000
4687	235.000	17.000	38373	-28.000	12.000
4399	235.500	16.700	931	300.000	12.000
2941	250.000	16.800	25615	91.500	45.500
941	300.000	16.800	24789	98.000	45.200

2.1. Clusters

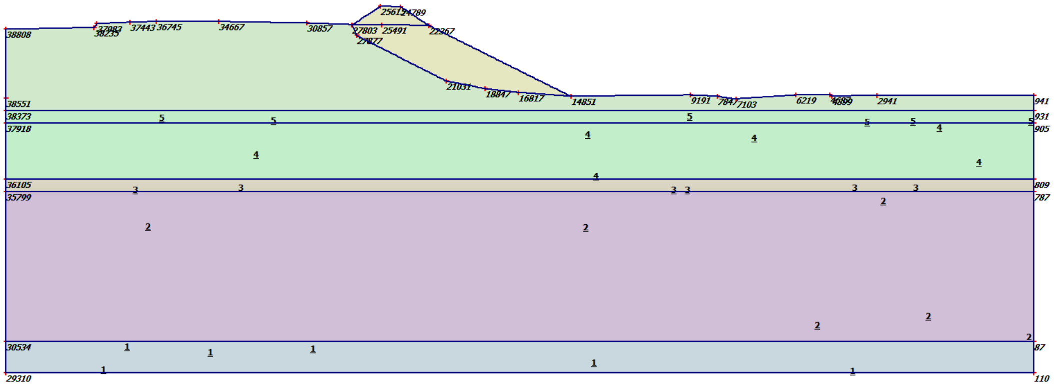


Fig. 2 Plot of geometry model with cluster numbers

Table [5] Table of clusters

Cluster no.	Nodes
1	30534, 87, 29310, 110.
2	35799, 787, 30534, 87.
3	36105, 809, 35799, 787.
4	37918, 905, 36105, 809.
5	37918, 905, 38373, 931.
6	38808, 38235, 37983, 37443, 36745, 34667, 30857, 27803, 14851, 9191, 7847, 7103, 6219, 4687, 4399, 2941, 941, 27877, 21031, 18847, 16817, 38551, 38373, 931.
7	27803, 25491, 22367, 14851, 27877, 21031, 18847, 16817.
8	27803, 25491, 22367, 25615, 24789.

3. Mesh data

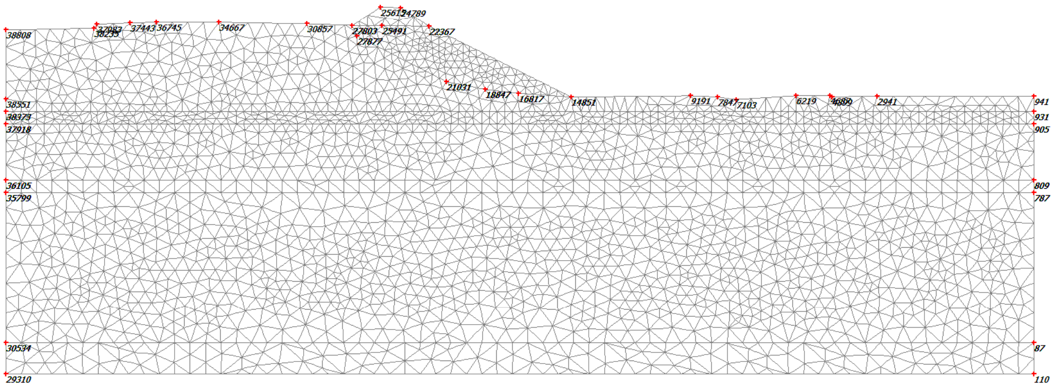


Fig. 3 Plot of the mesh with significant nodes

Table [6] Numbers, type of elements, integrations

Type	**Type of element**	**Type of integration**	**Total no.**
Soil	15-Noded	12-point Gauss	4802

4. Material data

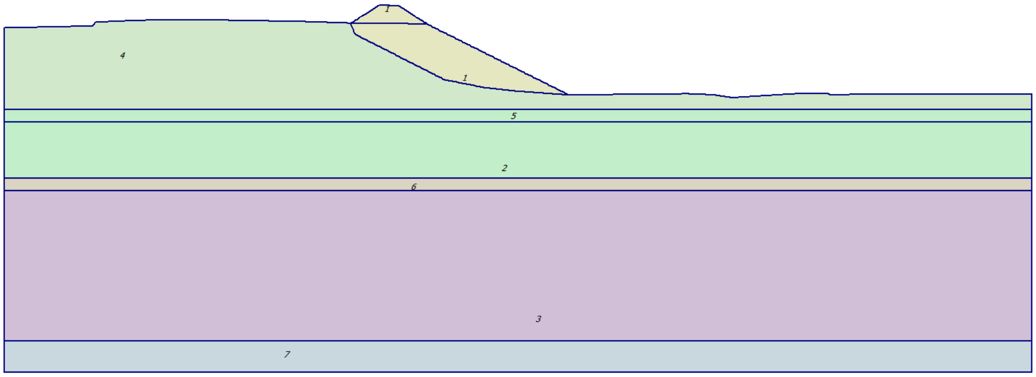


Fig. 4 Plot of geometry with material data sets

Table [7] Soil data sets parameters

Mohr-Coulomb		**1** **Proposed Fill**	**2** **Upper Sand**	**3** **Lower Sand**	**4** **Existing Fill**
Type		Drained	Drained	Drained	Drained
γ_{unsat}	[lb/ft³]	130.00	115.00	125.00	115.00
γ_{sat}	[lb/ft³]	130.00	115.00	125.00	115.00
k_x	[ft/s]	0.000	0.000	0.000	0.000
k_y	[ft/s]	0.000	0.000	0.000	0.000
e_{init}	[-]	0.500	0.500	0.500	0.500

Mohr-Coulomb		**1 Proposed Fill**	**2 Upper Sand**	**3 Lower Sand**	**4 Existing Fill**
c_k	[-]	1E15	1E15	1E15	1E15
E_{ref}	[lb/ft^2]	1000000.000	500000.000	500000.000	750000.000
ν	[-]	0.300	0.300	0.300	0.300
G_{ref}	[lb/ft^2]	384615.385	192307.692	192307.692	288461.538
E_{oed}	[lb/ft^2]	1346153.846	673076.923	673076.923	1009615.385
c_{ref}	[lb/ft^2]	25.00	25.00	25.00	25.00
φ	[°]	34.00	30.00	32.00	32.00
ψ	[°]	0.00	0.00	0.00	0.00
E_{inc}	[lb/ft^2/ft]	0.00	0.00	0.00	0.00
y_{ref}	[ft]	0.000	0.000	0.000	0.000
$c_{increment}$	[lb/ft^2/ft]	0.00	0.00	0.00	0.00
$T_{str.}$	[lb/ft^2]	0.00	0.00	0.00	0.00
$R_{inter.}$	[-]	1.00	1.00	1.00	1.00
Interface permeability		Neutral	Neutral	Neutral	Neutral

Soft-Soil		**5 Upper Clay1**	**6 Upper Clay2**	**7 Lower Clay**
Type		Drained	Drained	Drained
γ_{unsat}	[lb/ft^3]	120.00	112.00	118.00
γ_{sat}	[lb/ft^3]	120.00	112.00	118.00
k_x	[ft/s]	0.000	0.000	0.000
k_y	[ft/s]	0.000	0.000	0.000
e_{init}	[-]	0.97	0.97	1.20

Soft-Soil		**5** **Upper Clay1**	**6** **Upper Clay2**	**7** **Lower Clay**
c_k	[-]	1E15	1E15	1E15
$\lambda*$	[-]	0.052	0.074	0.043
$\kappa*$	[-]	0.010	0.012	0.010
c	[lb/ft²]	25.00	25.00	25.00
φ	[°]	23.00	23.00	25.00
ψ	[°]	0.00	0.00	0.00
ν_{ur}	[-]	0.150	0.150	0.150
K_0^{nc}	[-]	0.61	0.61	0.58
R_{inter}	[-]	1.00	1.00	1.00
Interface permeability		Neutral	Neutral	Neutral

5. Calculation phases

Table [8] List of phases

Phase	Ph-No.	Start phase	Calculation type	Load input	First step	Last step
Initial phase	0	0		-	0	0
<Phase 1>	1	0	Plastic analysis	Staged construction	1	31
<Phase 2>	2	1	Plastic analysis	Staged construction	32	45

Table [9] Staged construction info

Ph-No.	Active clusters	Inactive clusters	Active beams	Active geotextiles	Active anchors
0	1, 2, 3, 4, 5.	6, 7, 8.			
1	1, 2, 3, 4, 5, 6.	7, 8.			
2	1, 2, 3, 4, 5, 6, 7, 8.				

Table [10] Control parameters 1

Ph-No.	Additional steps	Reset displacements to zero	Ignore undrained behaviour	Delete intermediate steps
1	250	Yes	No	Yes
2	250	Yes	No	Yes

Table [11] Control parameters 2

Ph-No.	Iterative procedure	Tolerated error	Over relaxation	Max. iterations	Desired min.	Desired max.	Arc-length control
1	Standard	0.010	1.200	60	6	15	Yes
2	Standard	0.010	1.200	60	6	15	Yes

Table [12] Incremental multipliers (input values)

Ph-No.	Displ.	Load A	Load B	Weight	Accel	Time	s-f
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

5.2. Total multipliers

Table [13] Total multipliers - input values

Ph-No.	Displ.	Load A	Load B	Weight	Accel	Time	s-f
0	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000

Table [14] Total multipliers - reached values

Ph-No.	Displ.	Load A	Load B	Weight	Accel	Time	s-f
0	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000

6. Results for phase

6.3. Calculation information

Table [15] Step Info phase no: 0

Step no:	0
Calculation type	INITIAL
Extrapolation factor	0.928
Relative stiffness	0.131

Table [16] Reached multipliers phase no: 0

Multipliers	Incremental value	Total value
Prescribed displacements	0.0000	1.0000
Load system A	0.0000	1.0000
Load system B	0.0000	1.0000
Soil weight	0.0000	1.0000
Acceleration	0.0000	0.0000
Strength reduction factor	0.0000	1.0000
Time	0.0000	0.0000

Table [17] Staged construction info phase no: 0

Staged construction	Incremental value	Total value
Active proportion of total area	0.000	0.840
Active proportion of stage	0.000	0.000

6.4. Deformations

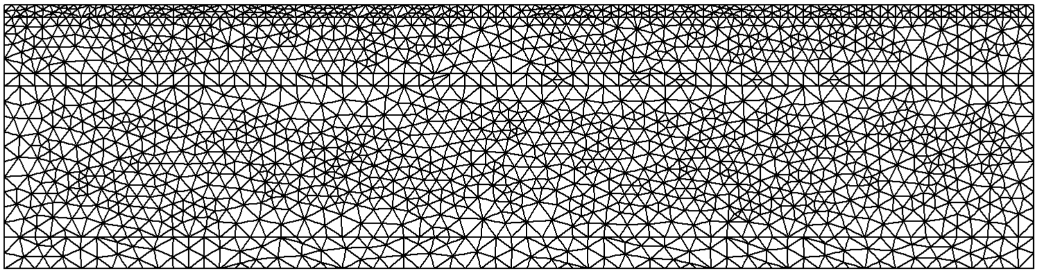


Fig. 5 Plot of deformed mesh

- Step no: 0 -

6.4.1. Plot of total displacements

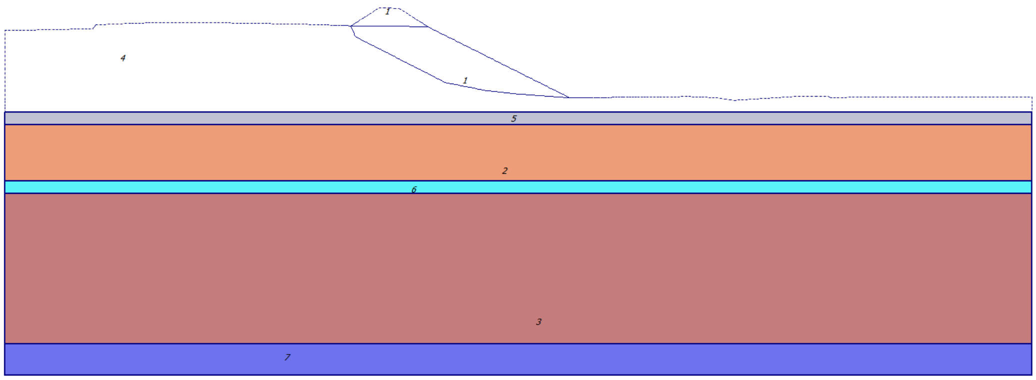


Fig. 6 Plot of total displacements (arrows)

- Step no: 0 -

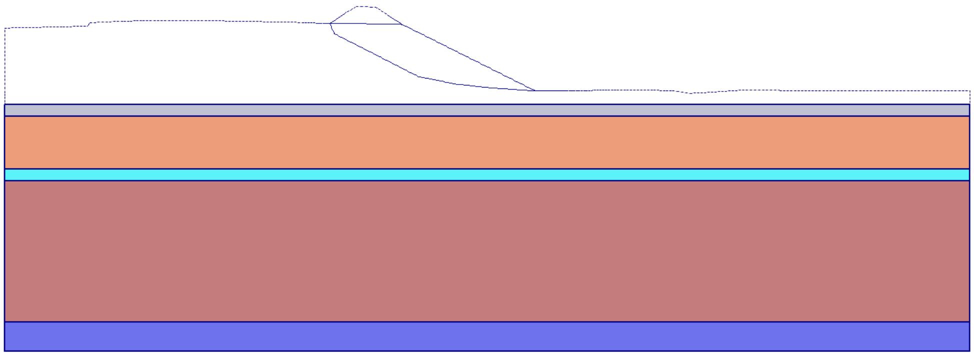


Fig. 7 Plot of total displacements (shadings)

- Step no: 0 -

6.4.2. Plot of horizontal displacements

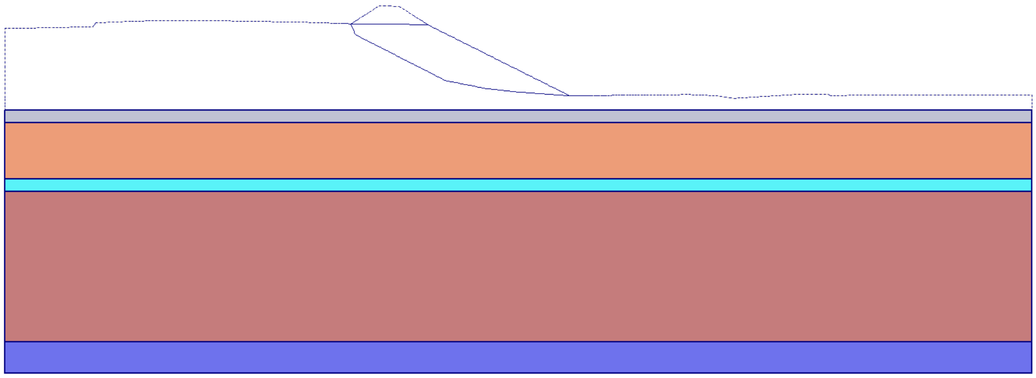


Fig. 8 Plot of horizontal displacements (arrows)

- Step no: 0 -

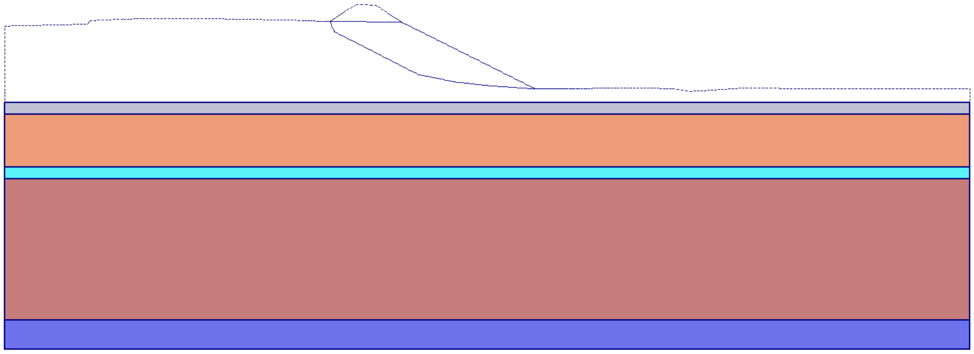


Fig. 9 Plot of horizontal displacements (shadings)

- Step no: 0 -

6.4.3. Plot of vertical displacements

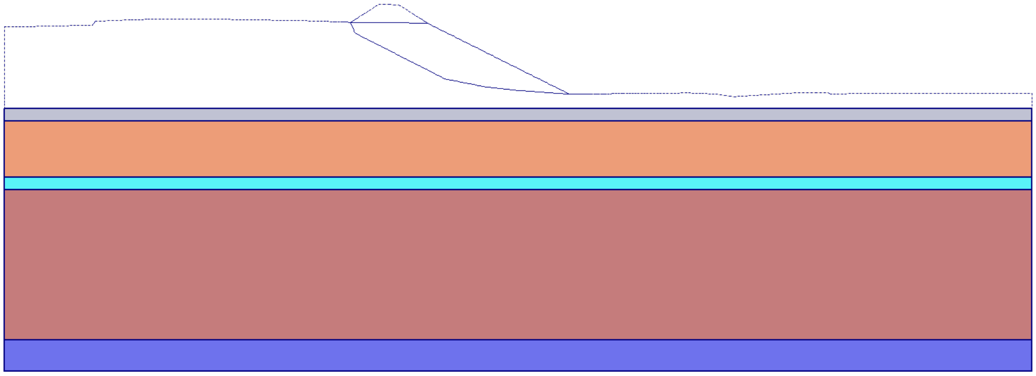


Fig. 10 Plot of vertical displacements (arrows)

- Step no: 0 -

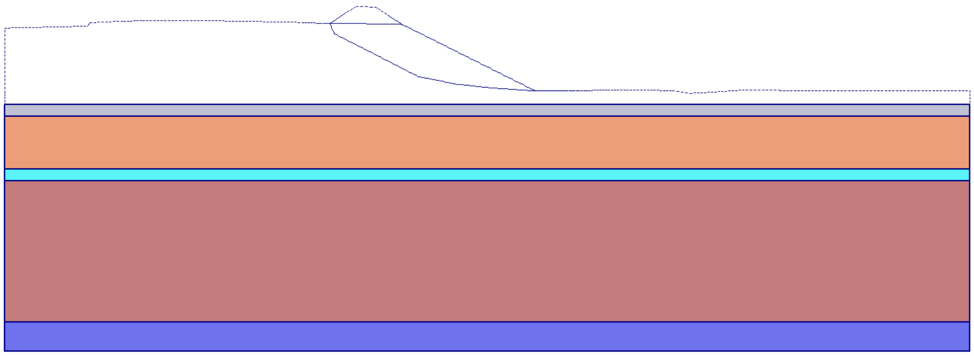


Fig. 11 Plot of vertical displacements (shadings)

- Step no: 0 -

6.4.4. Plot of total strains

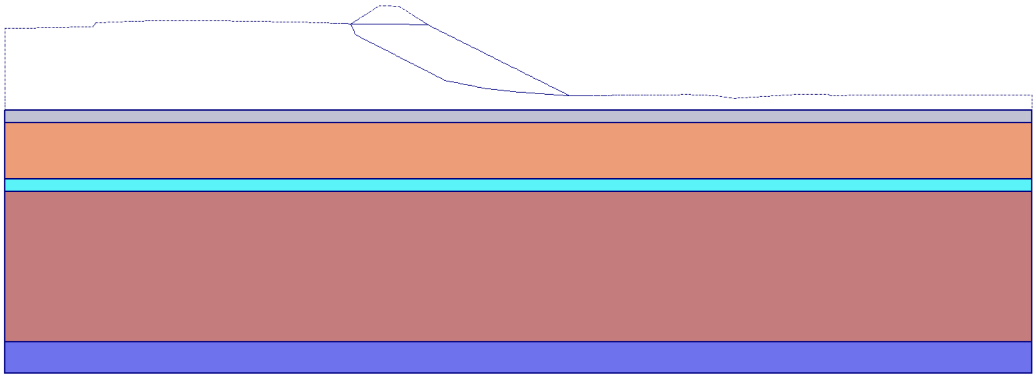


Fig. 12 Plot of total strains (principal directions)

- Step no: 0 -

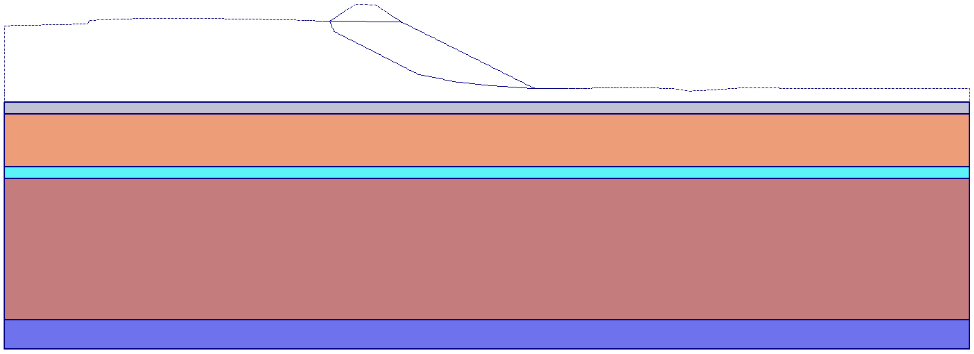


Fig. 13 Plot of total strains (shear shadings)

- Step no: 0 -

6.5. Stresses

6.5.5. Plot of effective stresses

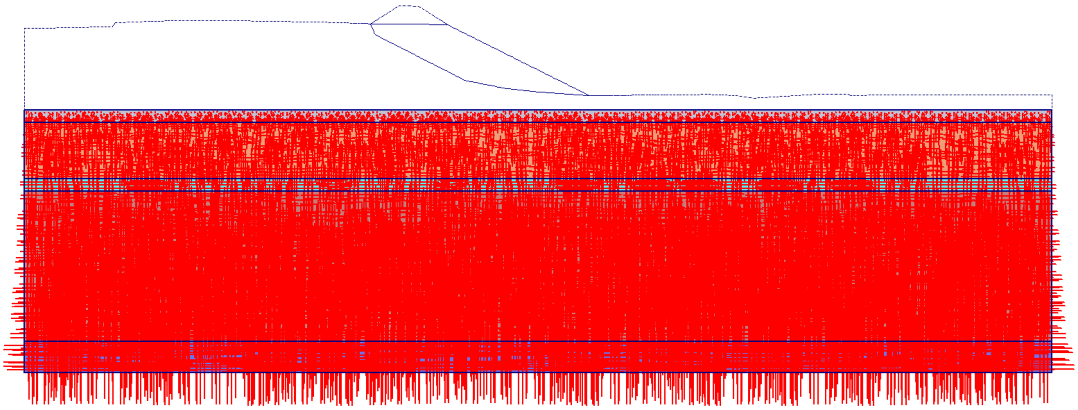


Fig. 14 Plot of effective stresses (principal directions)

- Step no: 0 -

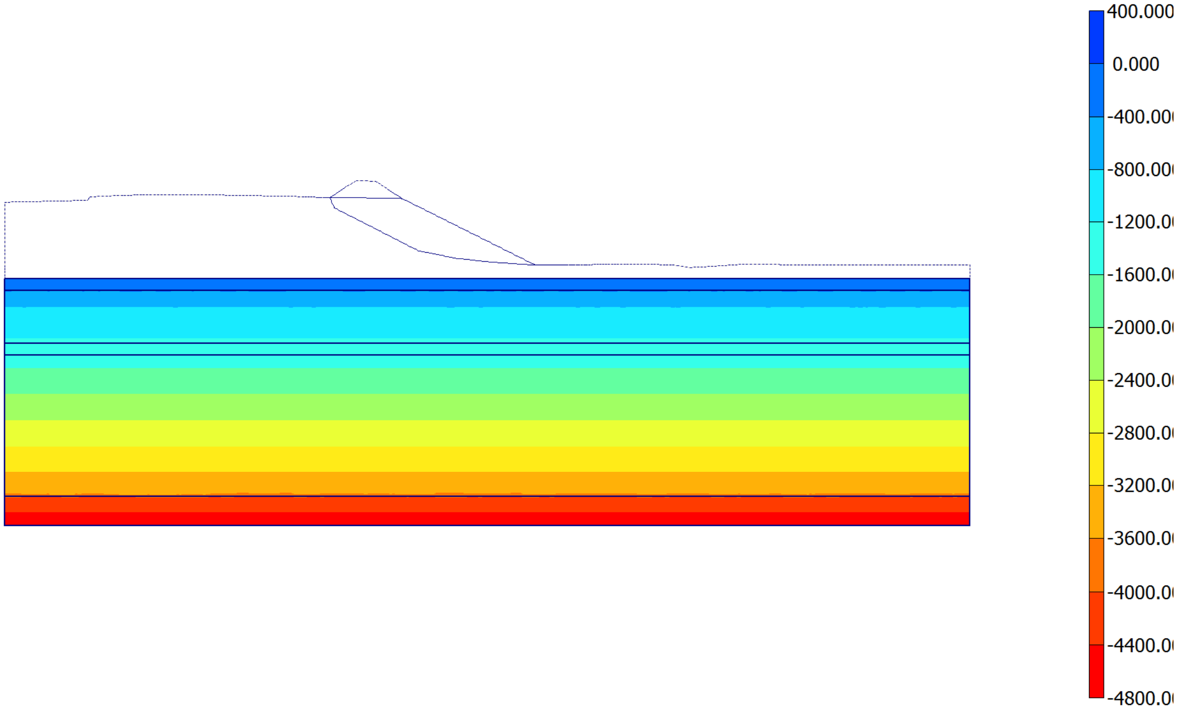


Fig. 15 Plot of effective stresses (mean shadings)

- Step no: 0 -

6.5.6. Plot of total stresses

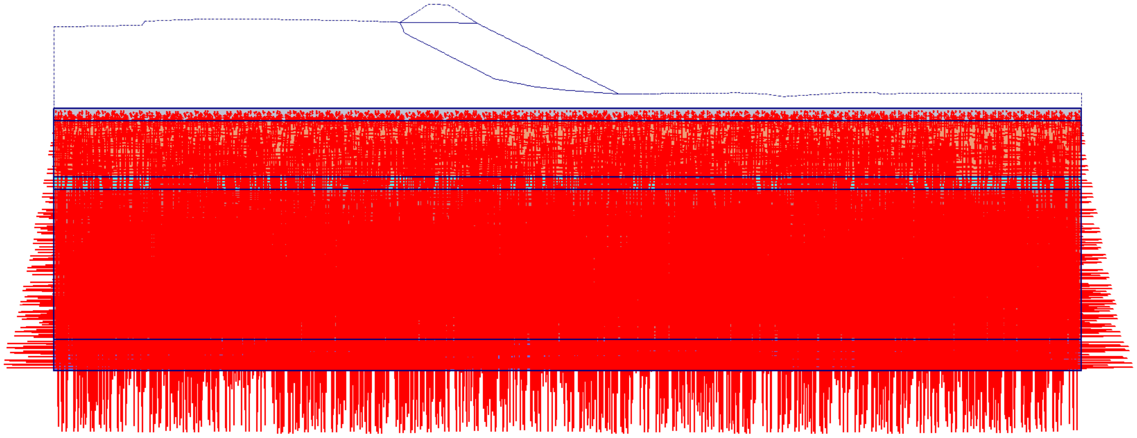


Fig. 16 Plot of total stresses (principal directions)

- Step no: 0 -

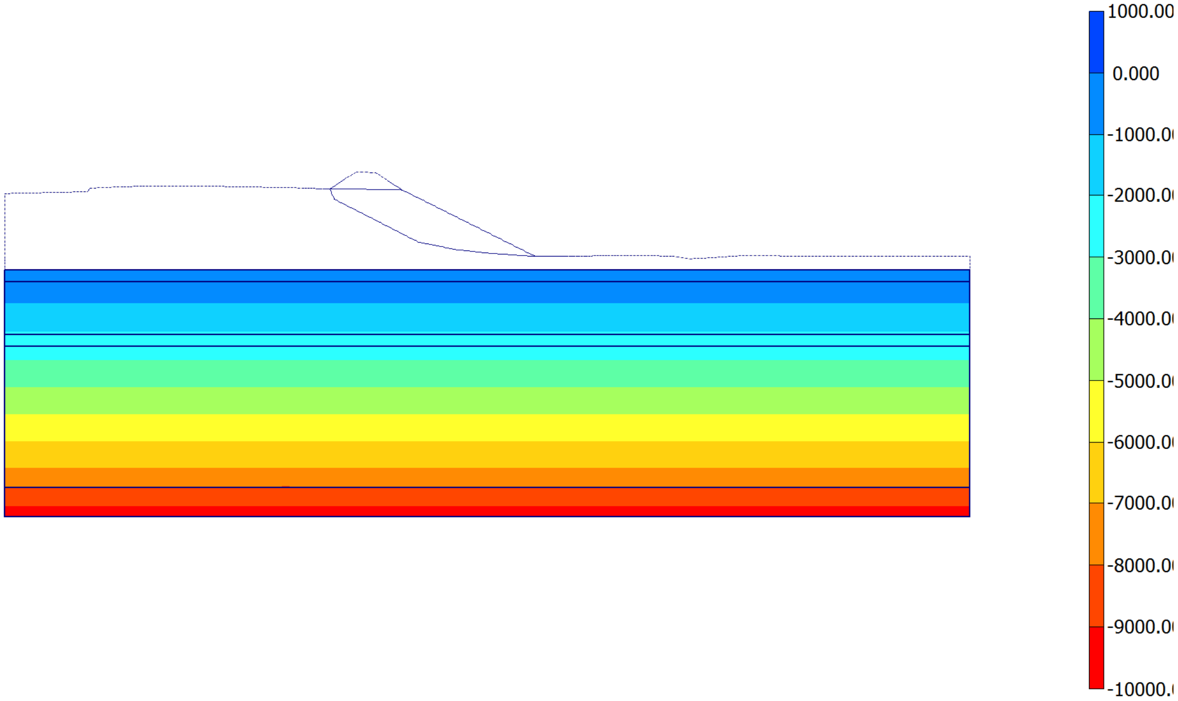


Fig. 17 Plot of total stresses (mean shadings)

- Step no: 0 -

7. Results for phase 1

7.6. Calculation information

Table [19] Step Info phase no: 1

Step no:	31
Calculation type	PLASTIC
Extrapolation factor	0.753
Relative stiffness	0.250

Table [20] Reached multipliers phase no: 1

Multipliers	**Incremental value**	**Total value**
Prescribed displacements	0.0000	1.0000
Load system A	0.0000	1.0000
Load system B	0.0000	1.0000
Soil weight	0.0000	1.0000
Acceleration	0.0000	0.0000
Strength reduction factor	0.0000	1.0000
Time	0.0000	0.0000

Table [21] Staged construction info phase no: 1

Staged construction	**Incremental value**	**Total value**
Active proportion of total area	0.000	0.978
Active proportion of stage	0.057	1.000

Table [22] Iteration info phase no: 1

Iter. no.	Global error	Plastic points	Plastic Cap + Hard. points	Inacc. Pl. pts.	Plastic Intf. pts.	Inacc. Intf. pts.	Apex & Tension	Inacc. Apx. pts.
1	0.009	9804	7480	6240	0	0	31	31
2	0.008	9779	7480	166	0	0	32	22

7.7. Deformations

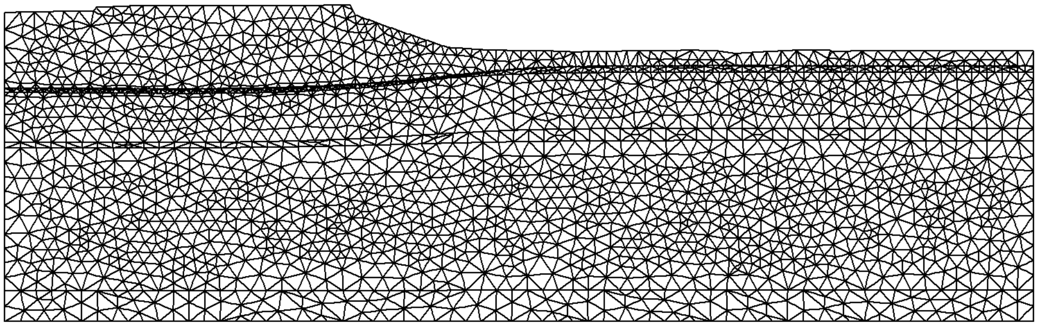


Fig. 18 Plot of deformed mesh

- Step no: 31 - (Phase: 1)

7.7.7. Plot of total displacements

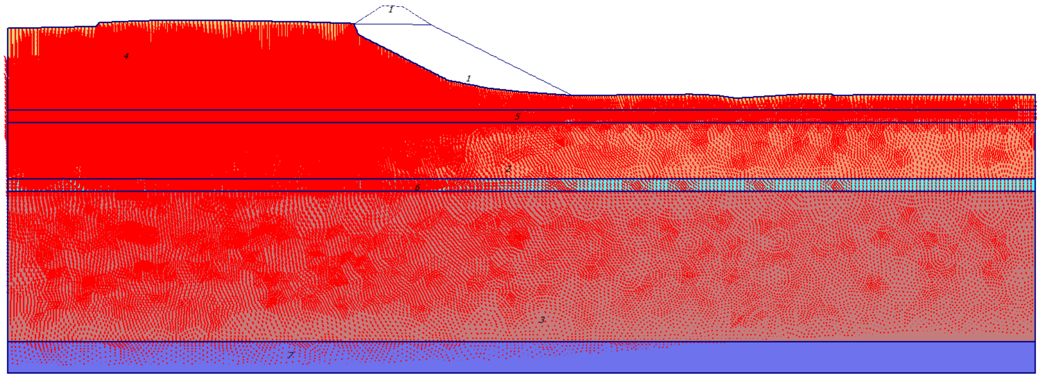


Fig. 19 Plot of total displacements (arrows)

- Step no: 31 - (Phase: 1)

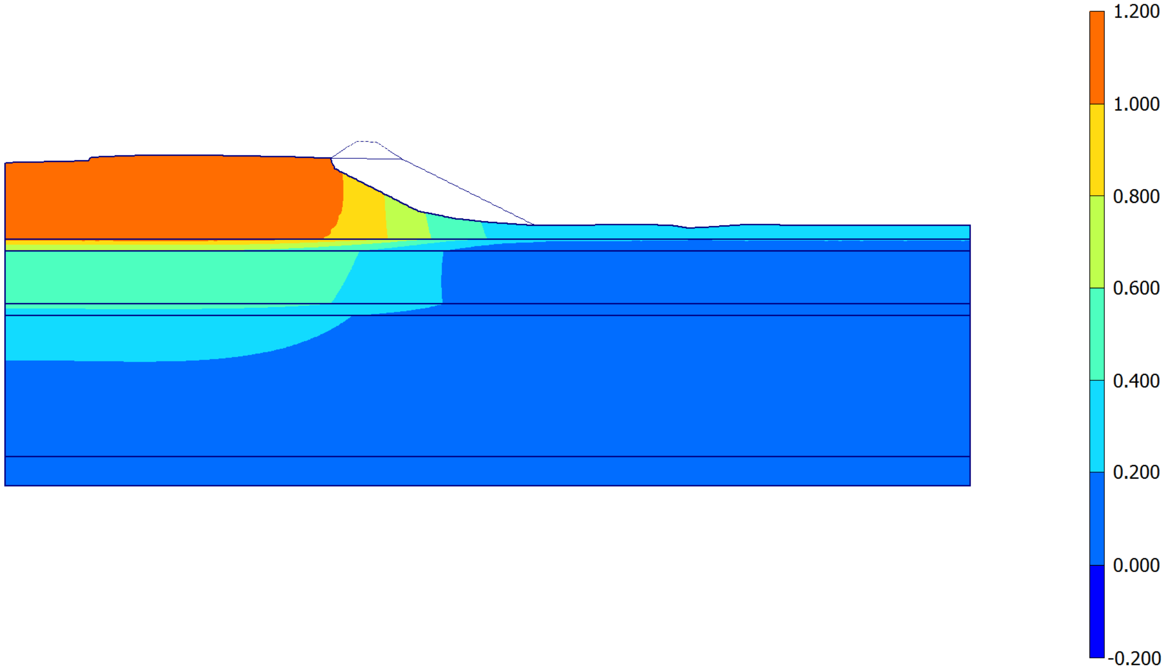


Fig. 20 Plot of total displacements (shadings)

- Step no: 31 - (Phase: 1)

7.7.8. Plot of horizontal displacements

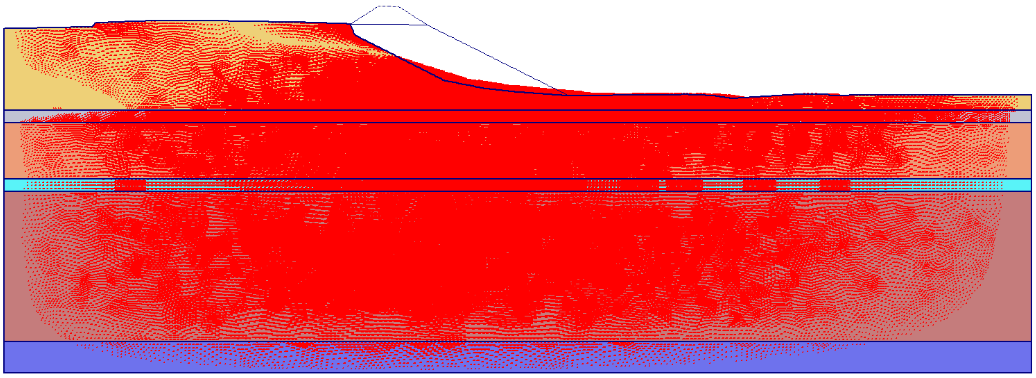


Fig. 21 Plot of horizontal displacements (arrows)

- Step no: 31 - (Phase: 1)

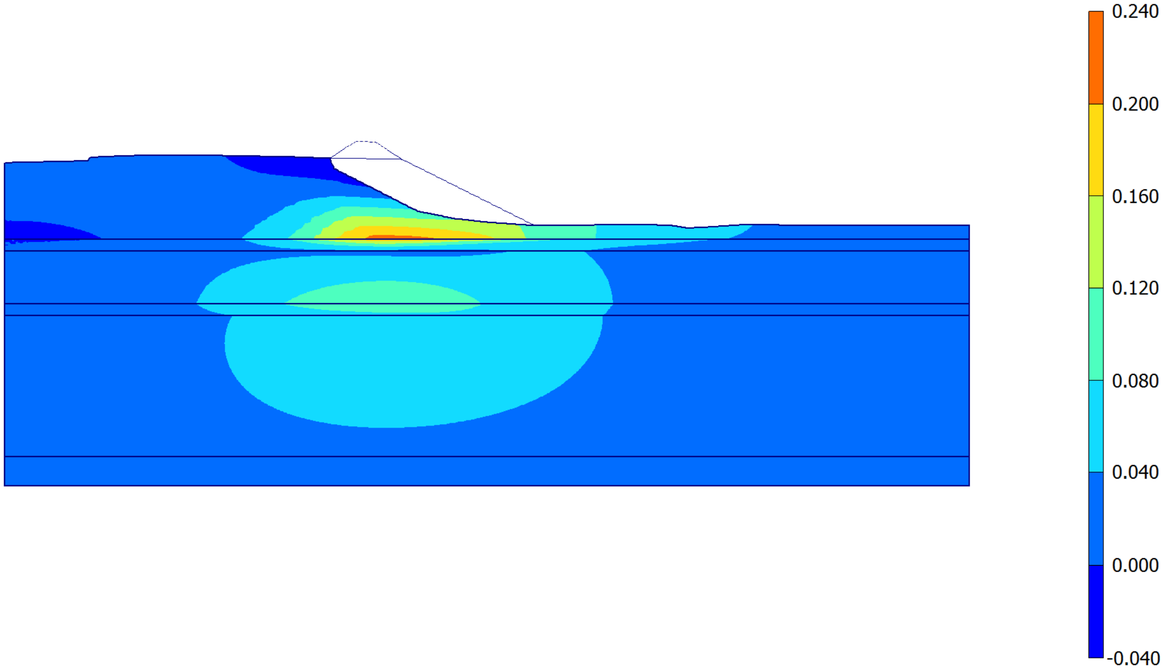


Fig. 22 Plot of horizontal displacements (shadings)

- Step no: 31 - (Phase: 1)

7.7.9. Plot of vertical displacements

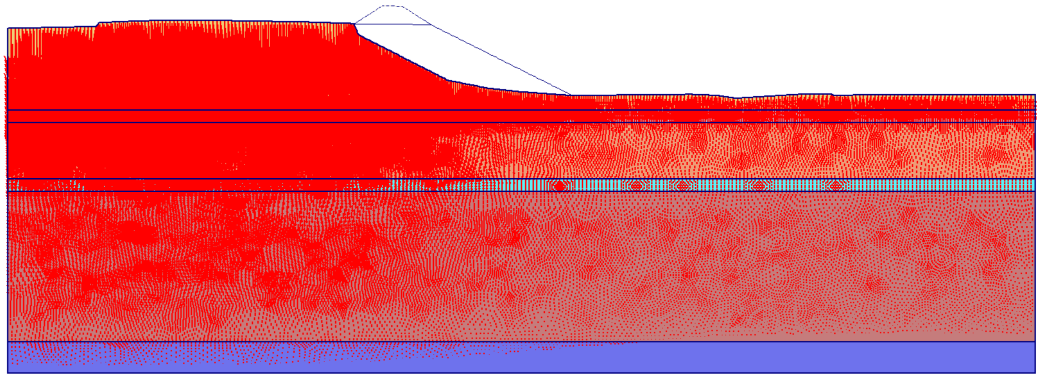


Fig. 23 Plot of vertical displacements (arrows)

- Step no: 31 - (Phase: 1)

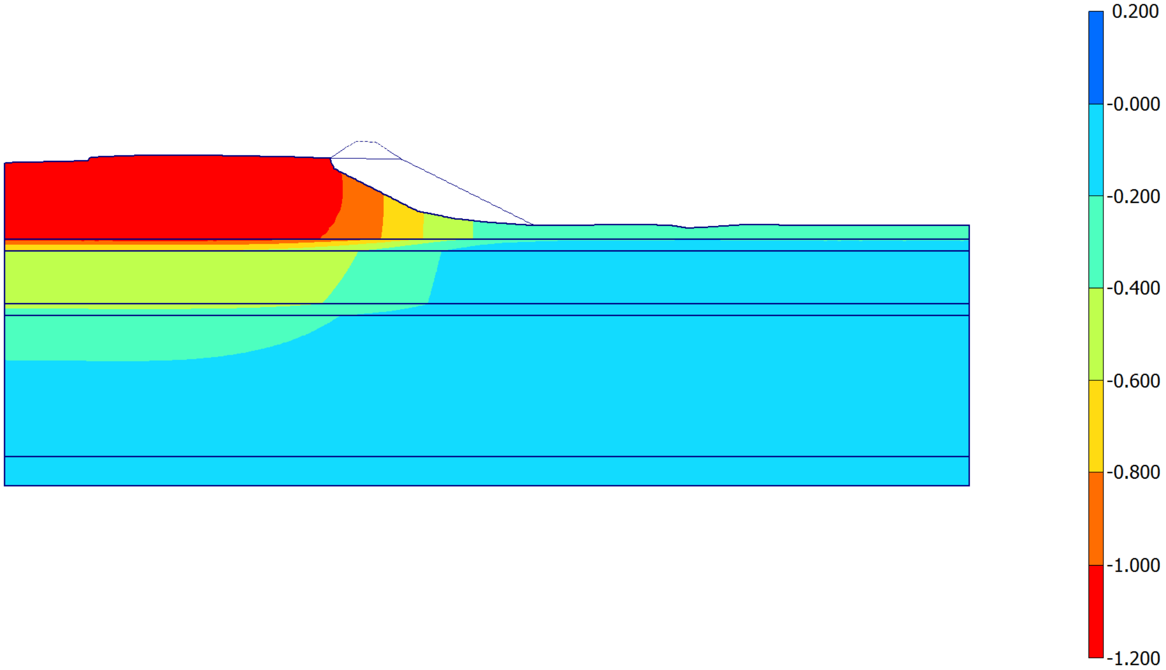


Fig. 24 Plot of vertical displacements (shadings)

- Step no: 31 - (Phase: 1)

7.7.10. Plot of total strains

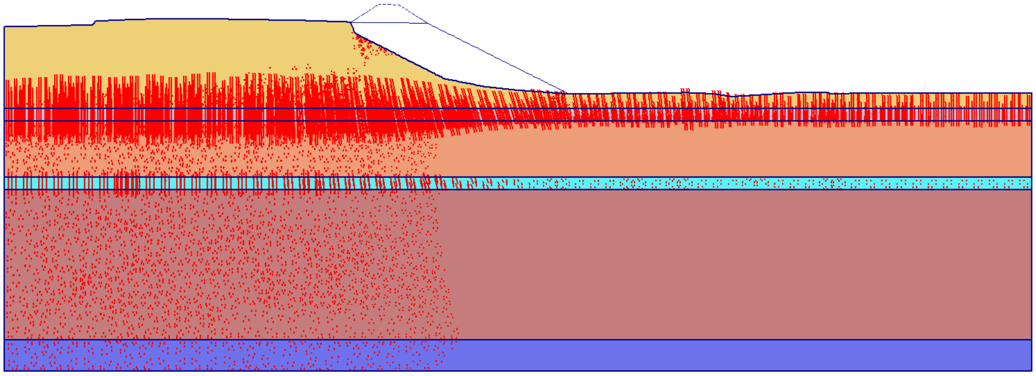


Fig. 25 Plot of total strains (principal directions)

- Step no: 31 - (Phase: 1)

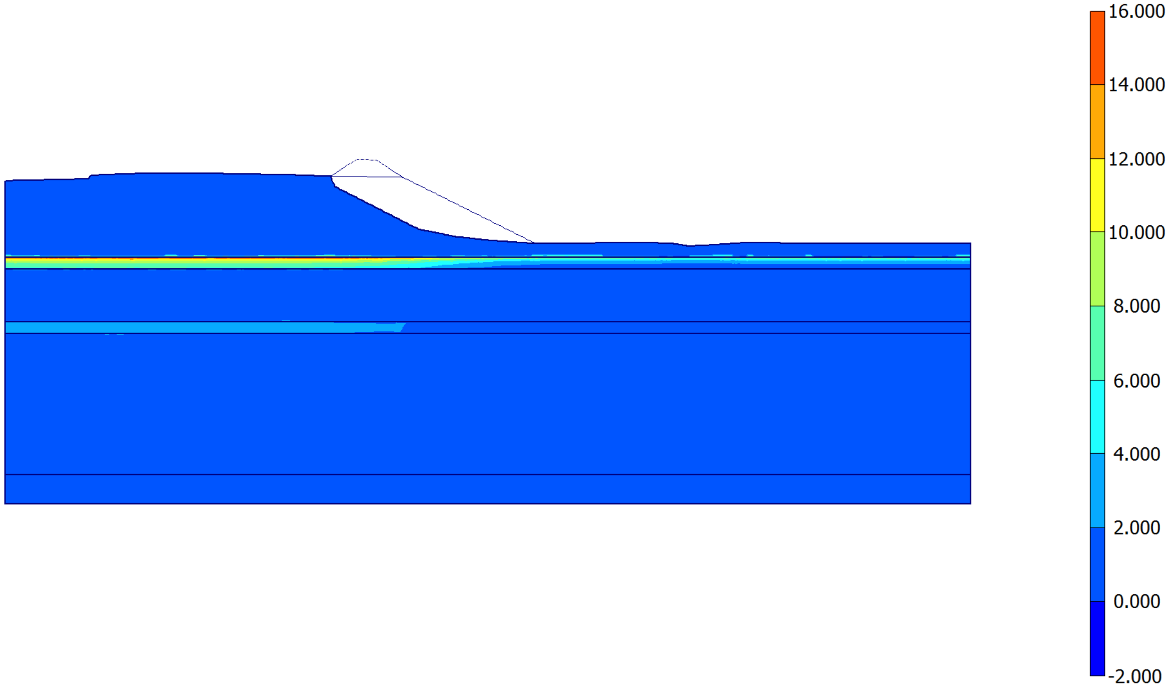


Fig. 26 Plot of total strains (shear shadings)

- Step no: 31 - (Phase: 1)

7.8. Stresses

7.8.11. Plot of effective stresses

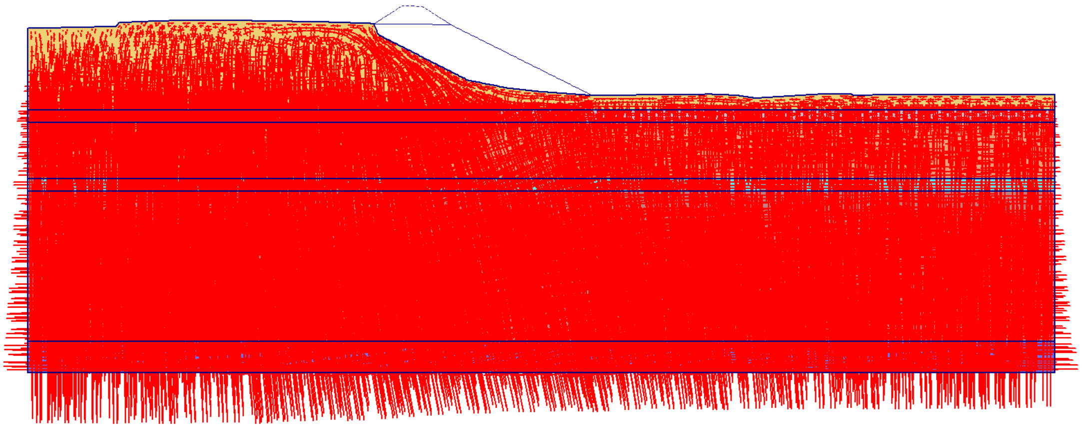


Fig. 27 Plot of effective stresses (principal directions)

- Step no: 31 - (Phase: 1)

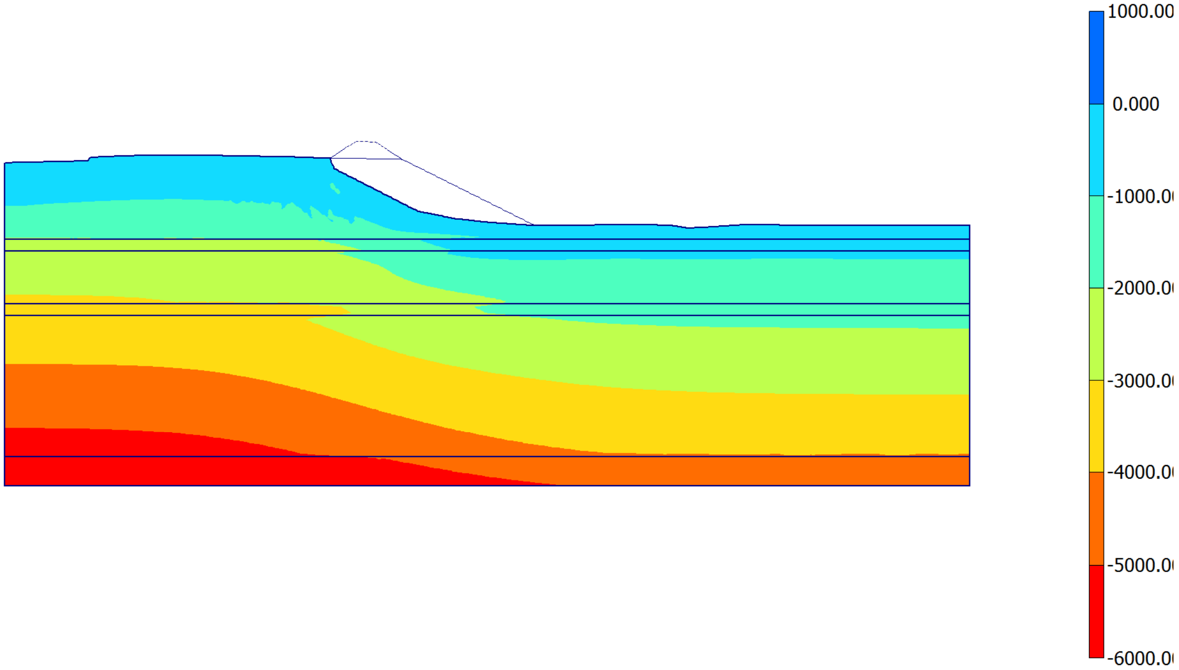


Fig. 28 Plot of effective stresses (mean shadings)

- Step no: 31 - (Phase: 1)

7.8.12. Plot of total stresses

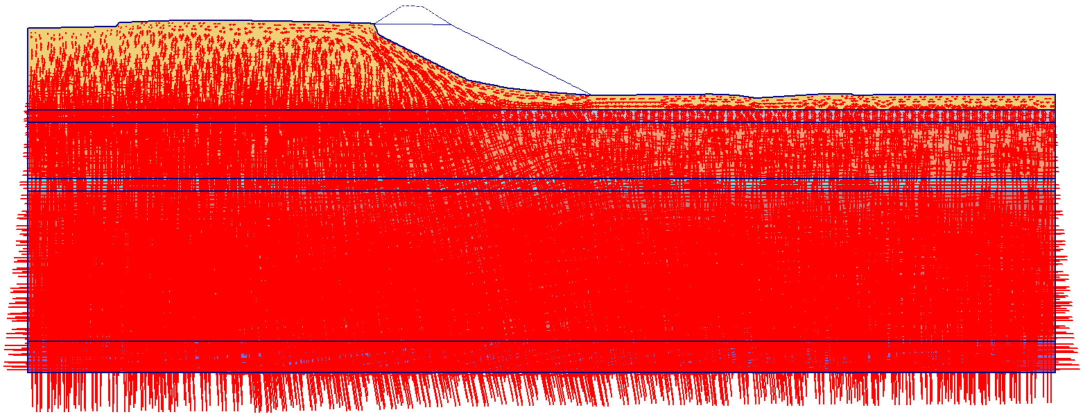


Fig. 29 Plot of total stresses (principal directions)

- Step no: 31 - (Phase: 1)

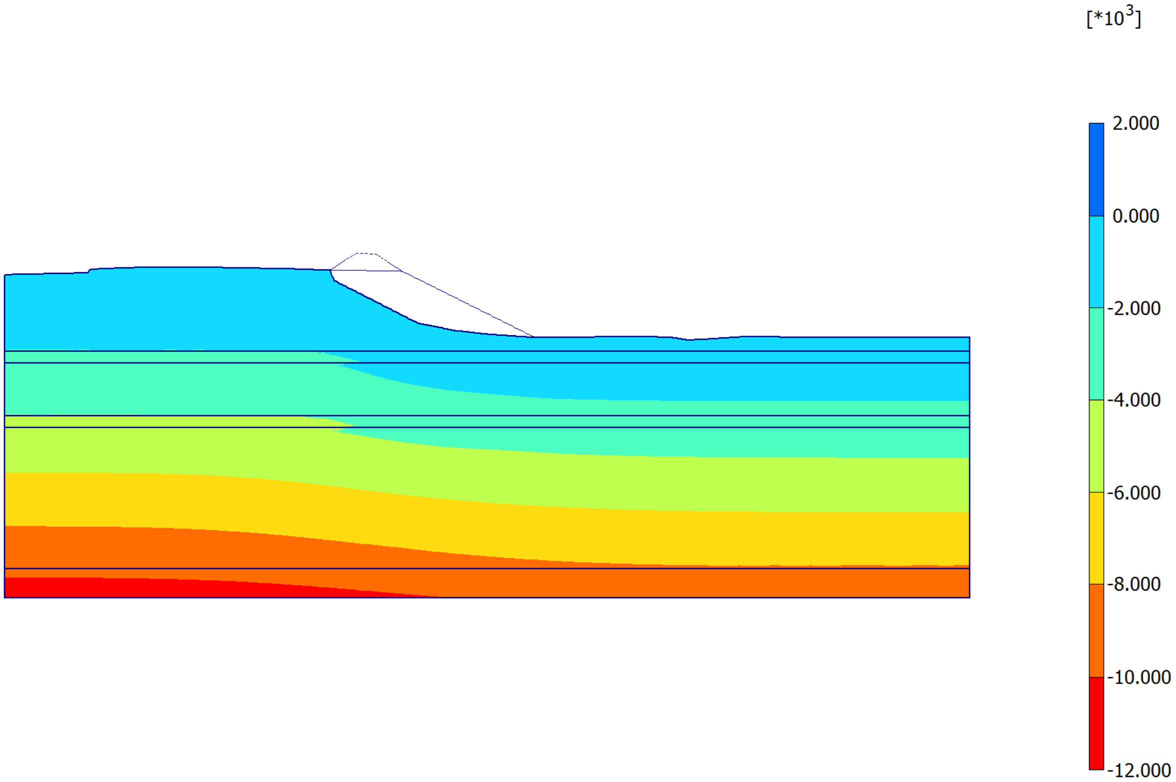


Fig. 30 Plot of total stresses (mean shadings)

- Step no: 31 - (Phase: 1)

8. Results for phase 2

8.9. Calculation information

Table [23] Step Info phase no: 2

Step no:	45
Calculation type	PLASTIC
Extrapolation factor	0.928
Relative stiffness	0.131

Table [24] Reached multipliers phase no: 2

Multipliers	Incremental value	Total value
Prescribed displacements	0.0000	1.0000
Load system A	0.0000	1.0000
Load system B	0.0000	1.0000
Soil weight	0.0000	1.0000
Acceleration	0.0000	0.0000
Strength reduction factor	0.0000	1.0000
Time	0.0000	0.0000

Table [25] Staged construction info phase no: 2

Staged construction	Incremental value	Total value
Active proportion of total area	0.000	1.000
Active proportion of stage	0.040	1.000

Table [26] Iteration info phase no: 2

Iter. no.	Global error	Plastic points	Plastic Cap + Hard. points	Inacc. Pl. pts.	Plastic Intf. pts.	Inacc. Intf. pts.	Apex & Tension	Inacc. Apx. pts.
1	0.010	9105	5462	310	0	0	128	66
2	0.009	9053	5444	440	0	0	125	74

8.10. Deformations

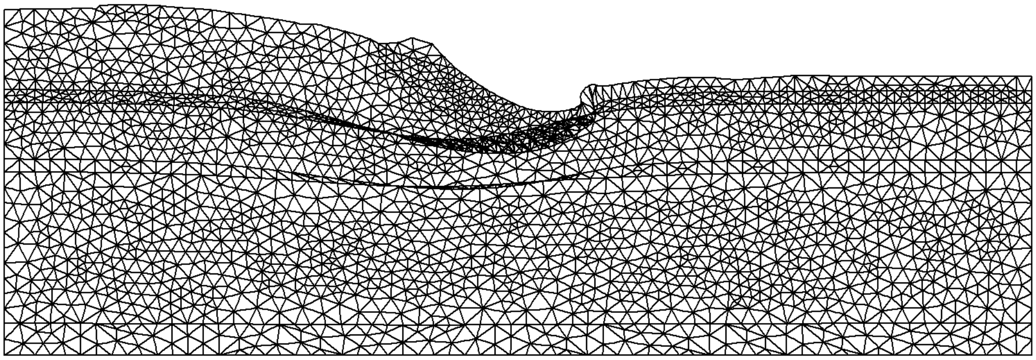


Fig. 31 Plot of deformed mesh

- Step no: 45 - (Phase: 2)

8.10.13. Plot of total displacements

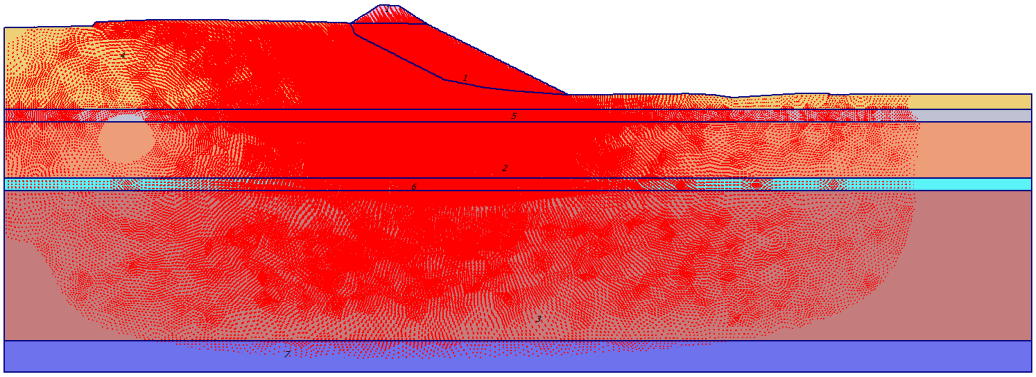


Fig. 32 Plot of total displacements (arrows)

- Step no: 45 - (Phase: 2)

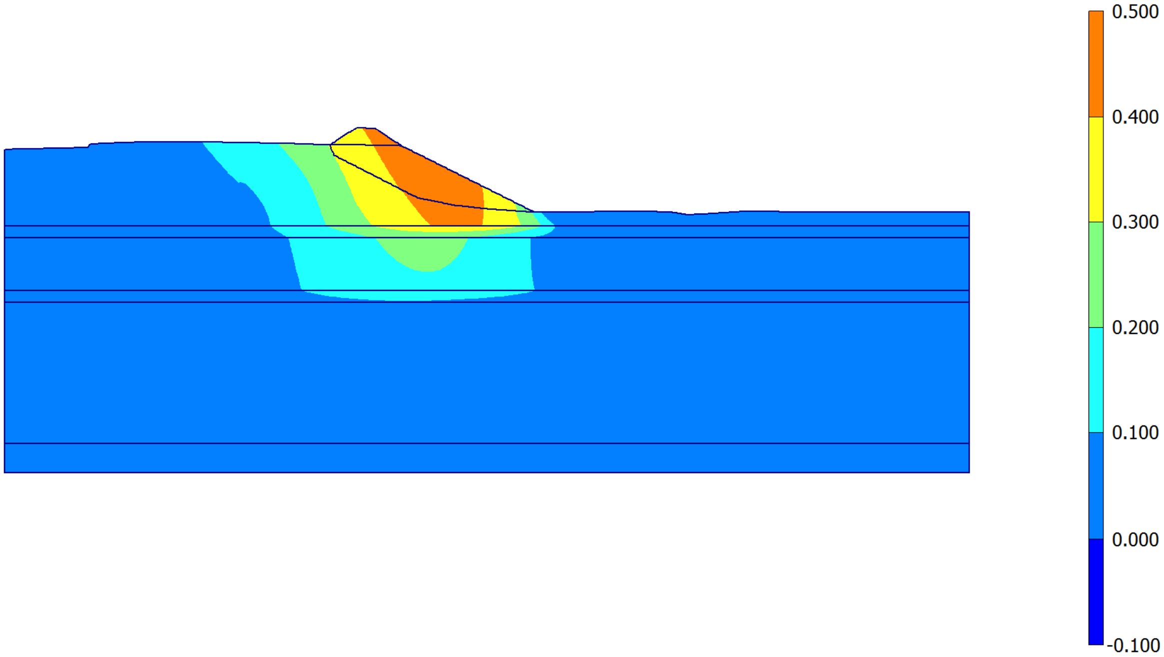


Fig. 33 Plot of total displacements (shadings)

- Step no: 45 - (Phase: 2)

8.10.14. Plot of horizontal displacements

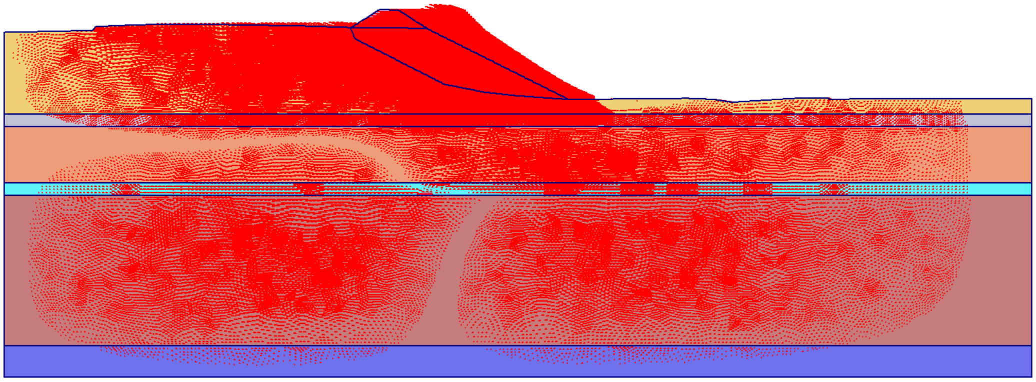


Fig. 34 Plot of horizontal displacements (arrows)

- Step no: 45 - (Phase: 2)

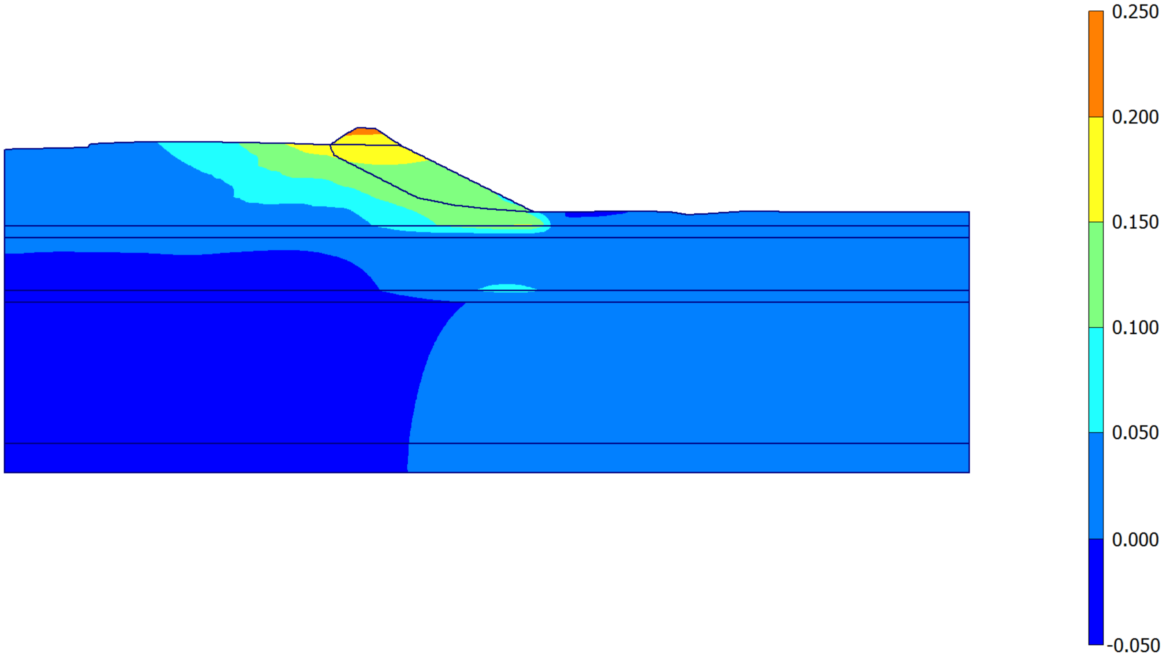


Fig. 35 Plot of horizontal displacements (shadings)

- Step no: 45 - (Phase: 2)

8.10.15. Plot of vertical displacements

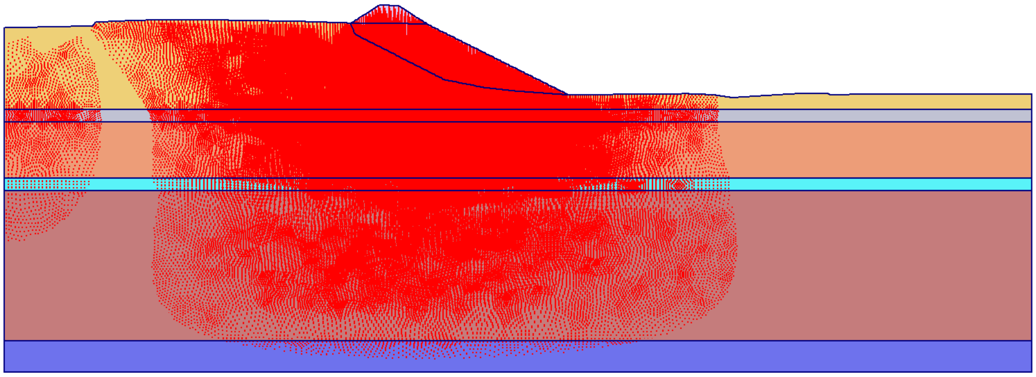


Fig. 36 Plot of vertical displacements (arrows)

- Step no: 45 - (Phase: 2)

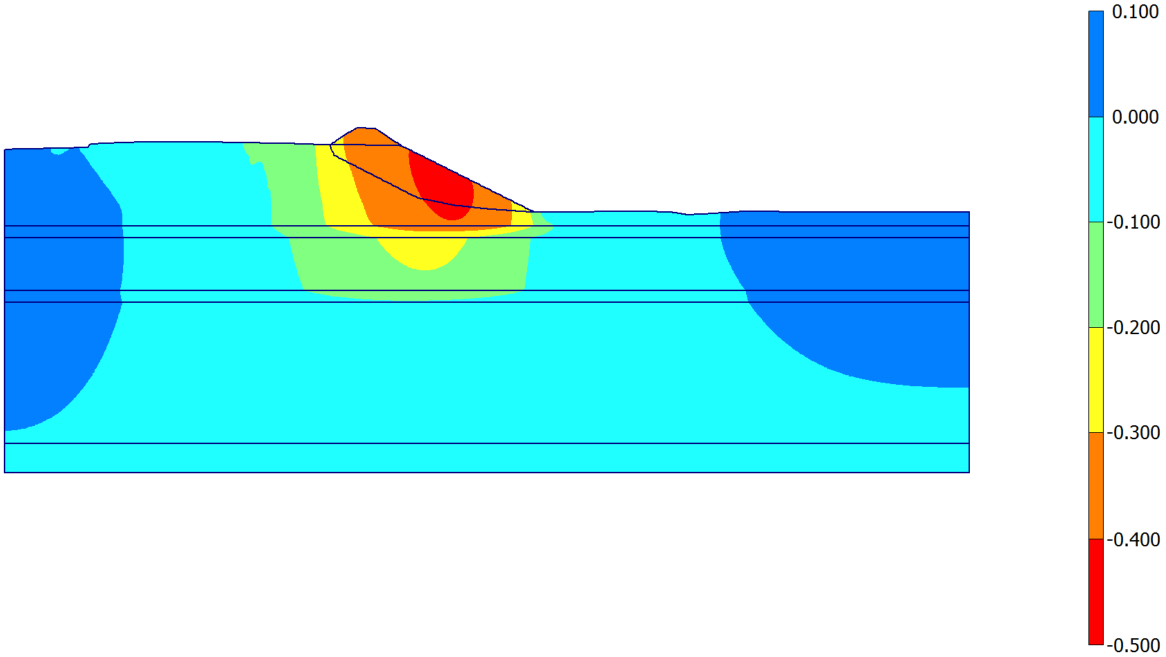


Fig. 37 Plot of vertical displacements (shadings)

- Step no: 45 - (Phase: 2)

8.10.16. Plot of total strains

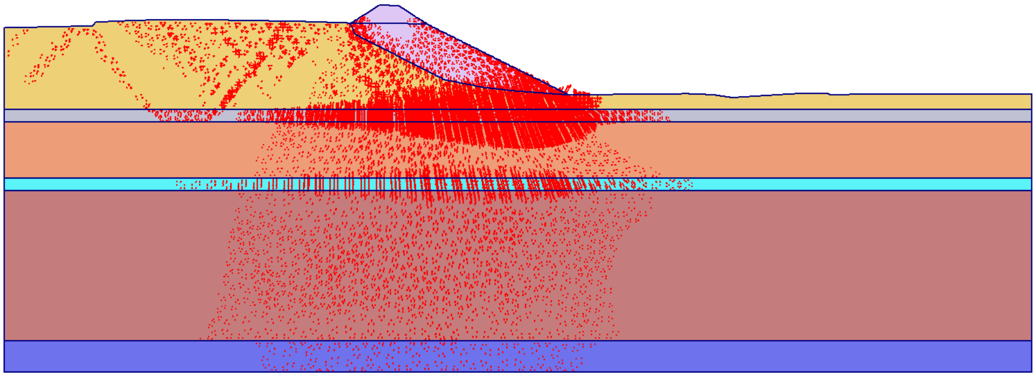


Fig. 38 Plot of total strains (principal directions)

- Step no: 45 - (Phase: 2)

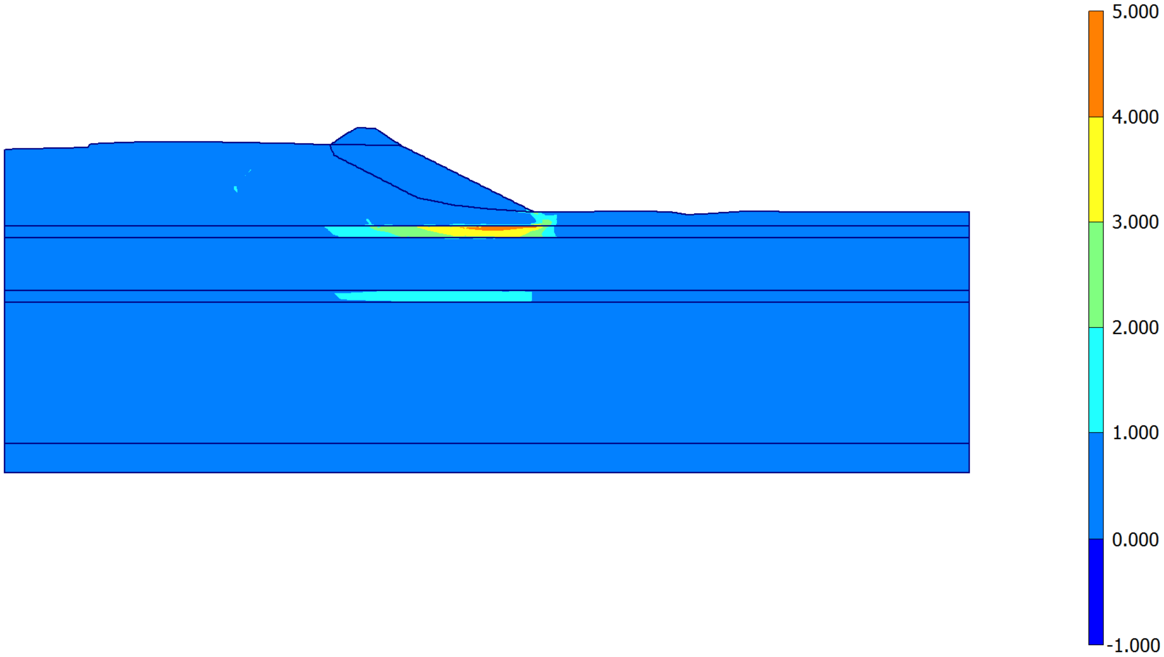


Fig. 39 Plot of total strains (shear shadings)

- Step no: 45 - (Phase: 2)

8.11. Stresses

8.11.17. Plot of effective stresses

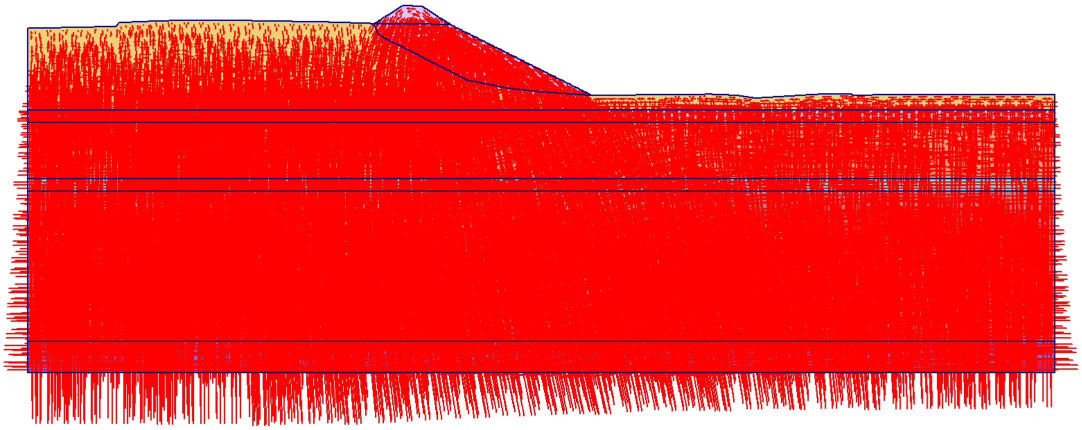


Fig. 40 Plot of effective stresses (principal directions)

- Step no: 45 - (Phase: 2)

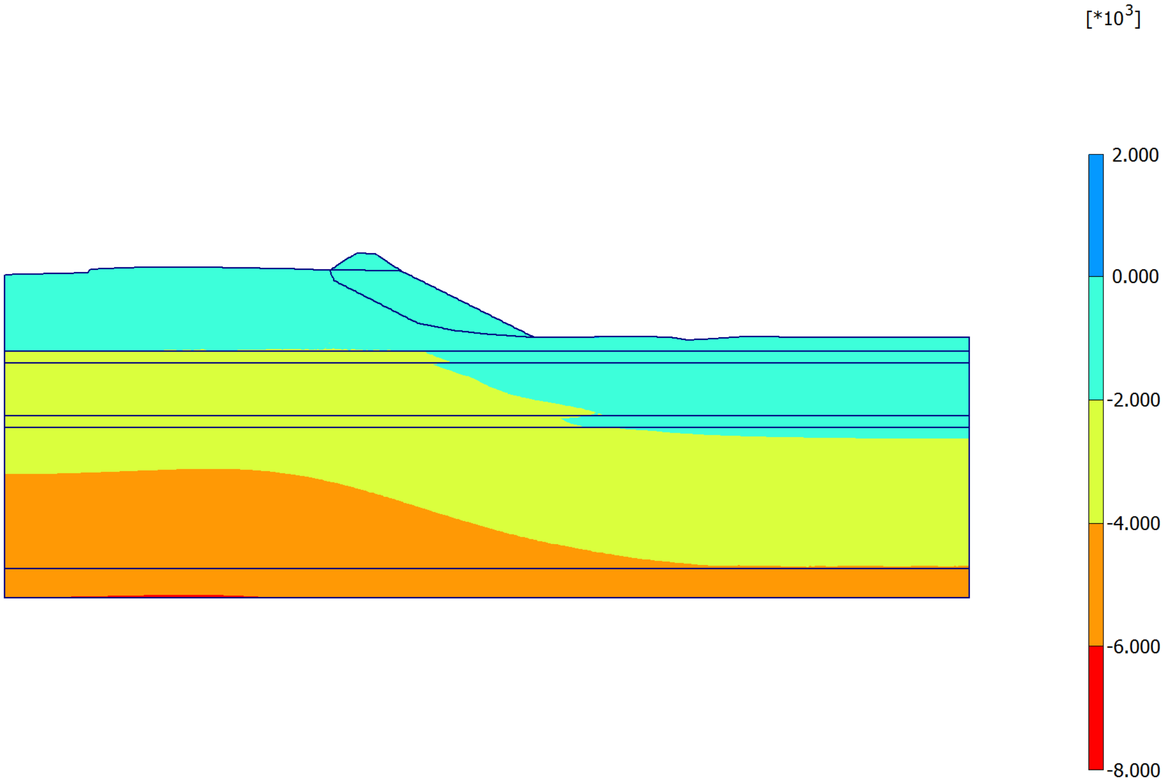


Fig. 41 Plot of effective stresses (mean shadings)

- Step no: 45 - (Phase: 2)

8.11.18. Plot of total stresses

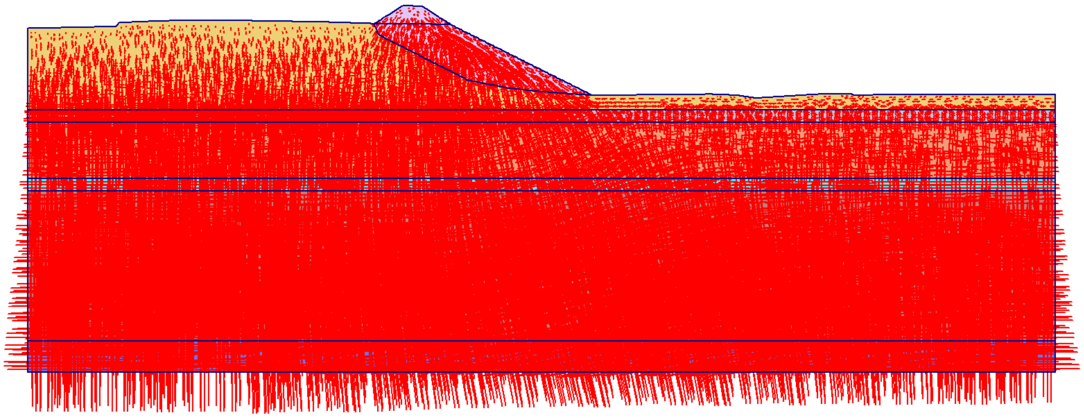


Fig. 42 Plot of total stresses (principal directions)

- Step no: 45 - (Phase: 2)

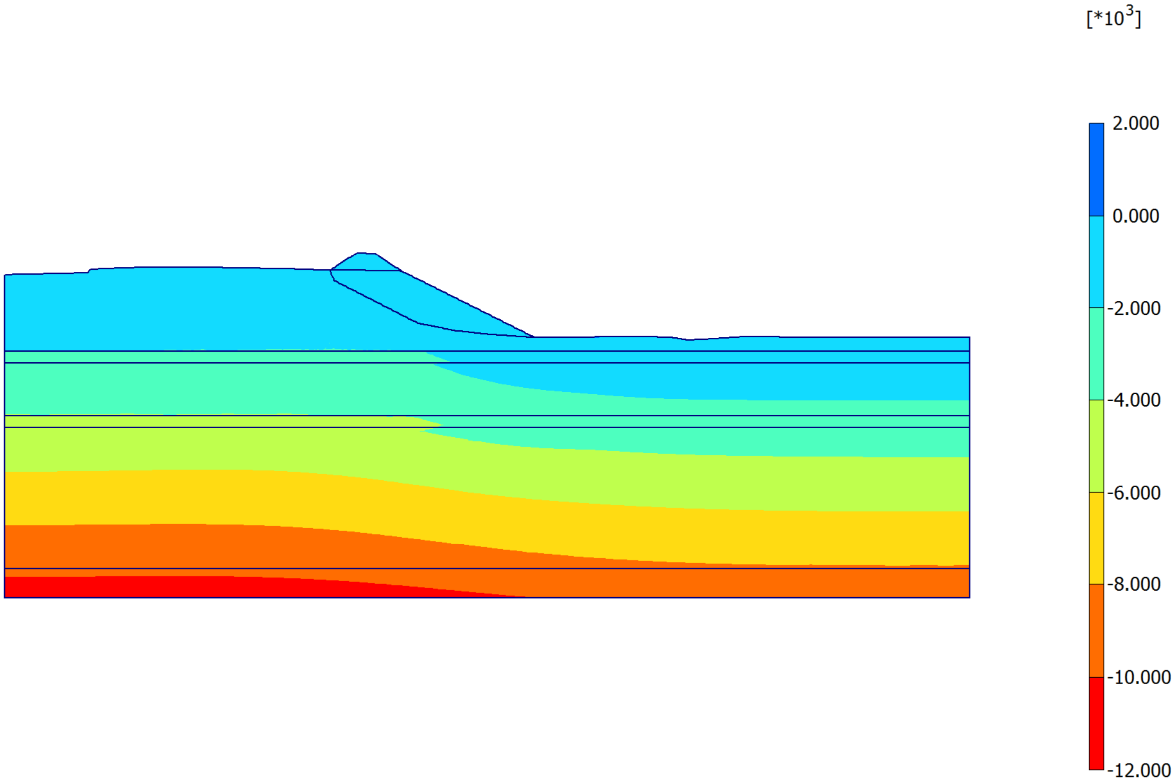


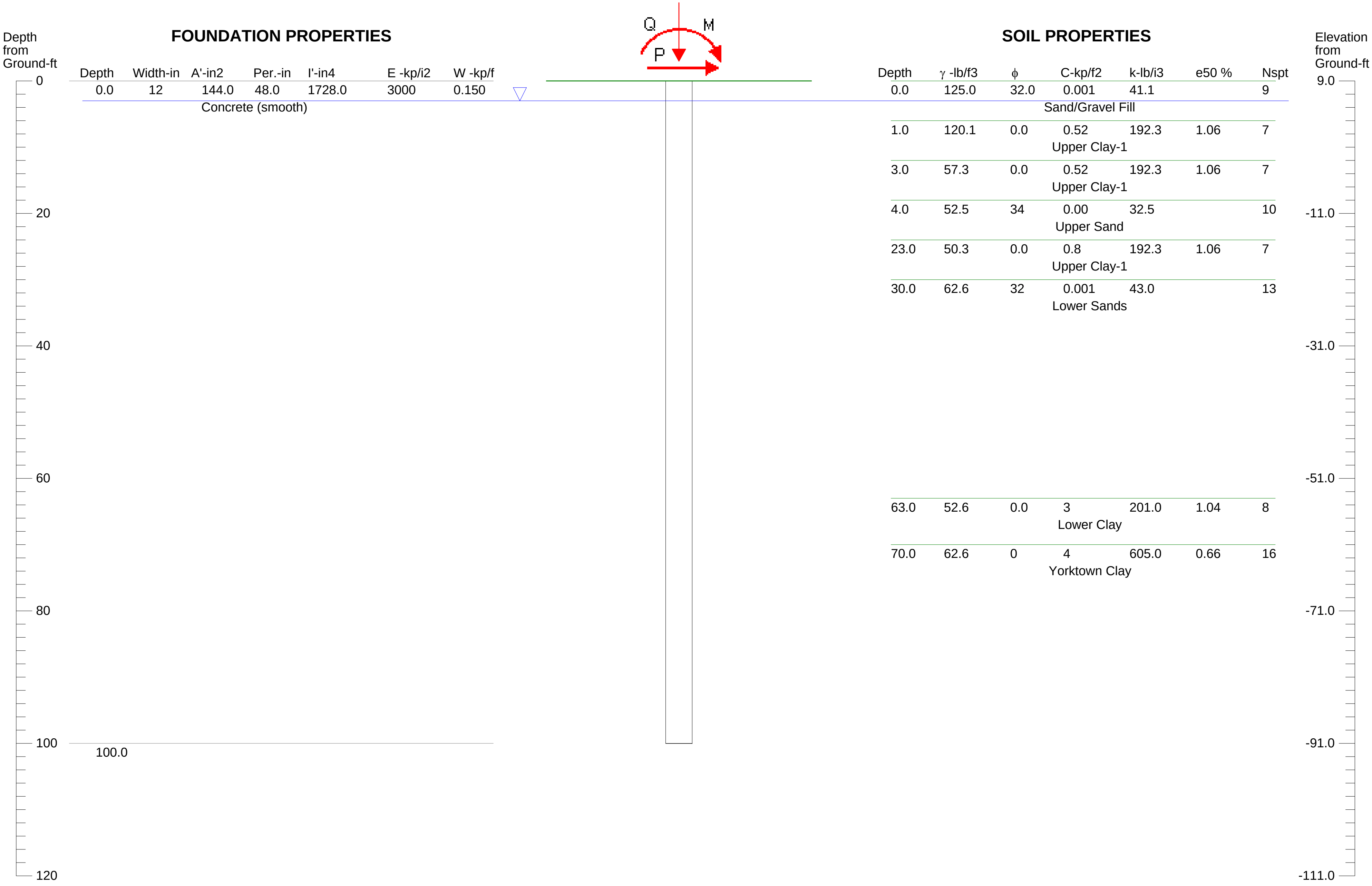
Fig. 43 Plot of total stresses (mean shadings)

- Step no: 45 - (Phase: 2)

Appendix E

Pile Supported Embankment Calculations

FOUNDATION PROFILE & SOIL CONDITIONS



FOUNDATION PROPERTIES

Depth	Width-in	A'-in2	Per.-in	I'-in4	E -kp/i2	W -kp/f
0.0	12	144.0	48.0	1728.0	3000	0.150
		Concrete (smooth)				
100.0						

SOIL PROPERTIES

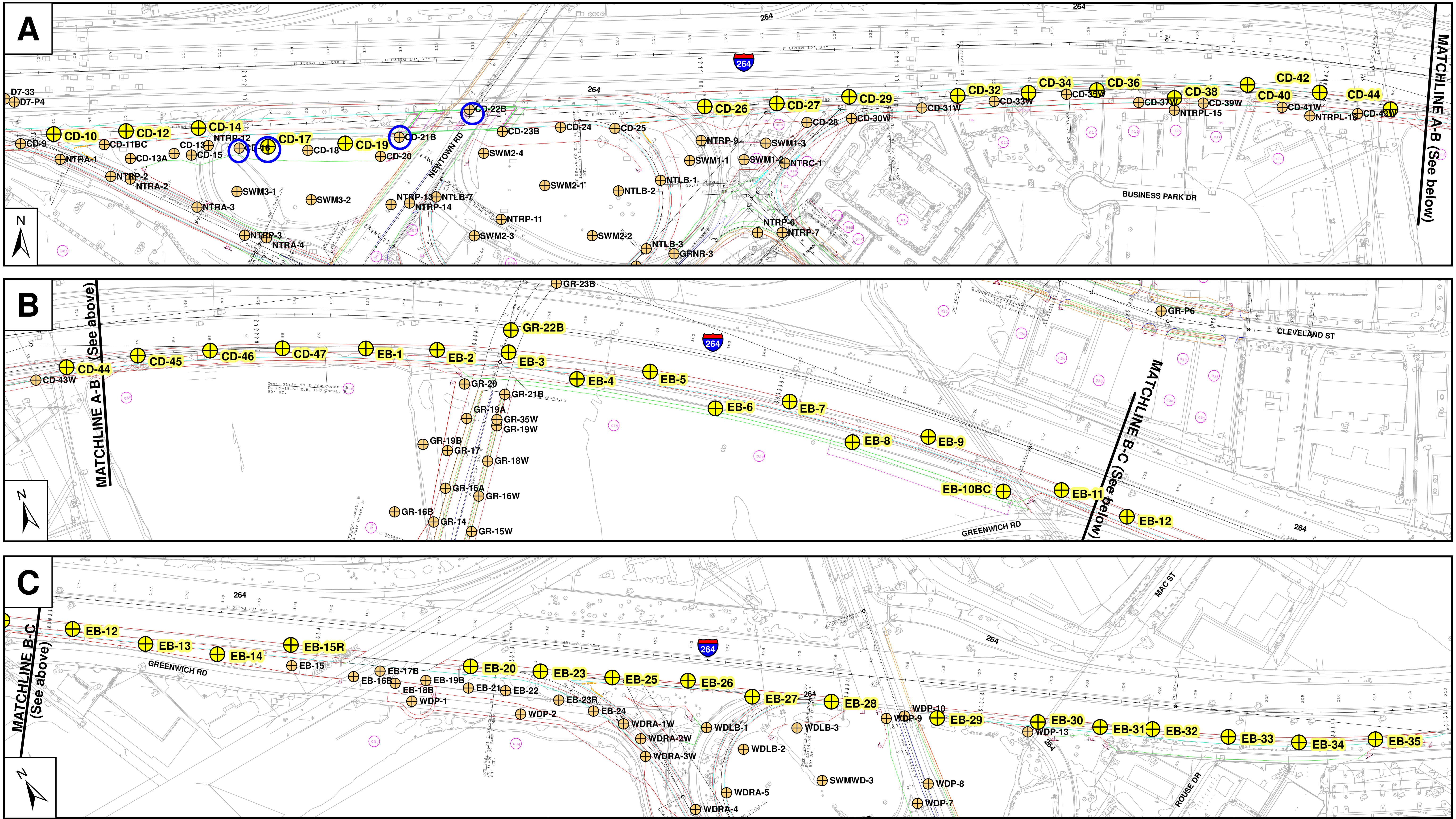
Depth	γ -lb/f3	ϕ	C-kp/f2	k-lb/i3	e50 %	Nspt
0.0	125.0	32.0	0.001	41.1		9
			Sand/Gravel Fill			
1.0	120.1	0.0	0.52	192.3	1.06	7
			Upper Clay-1			
3.0	57.3	0.0	0.52	192.3	1.06	7
			Upper Clay-1			
4.0	52.5	34	0.00	32.5		10
			Upper Sand			
23.0	50.3	0.0	0.8	192.3	1.06	7
			Upper Clay-1			
30.0	62.6	32	0.001	43.0		13
			Lower Sands			
63.0	52.6	0.0	3	201.0	1.04	8
			Lower Clay			
70.0	62.6	0	4	605.0	0.66	16
			Yorktown Clay			

Batter Angle=0 (Pile diameter not to scale) Surface Angle=0

CivilTech Software

I-64/264 Witchduck Road Interchange
Pile Embankment at STA 53+00-12PCC

Figure 1



0 125 250 Feet

⊕	SPT Exploration Locations
⊕	Borings in other PSAs

Prepared by: HDR

Date: November 2011

VDOT Virginia Department of Transportation

Project 0264-122-108
City of Norfolk

Project 0264-134-102
City of Virginia Beach

Project Study Area
I264 CD

Drawing 2:
Exploration Location Plan

53+00

increased Qult = original Qult + 0.25xQ-skin Yorktown

Downward Capacity vs Pile Length

The results are for single section pile. Multiple sections may not be correct!

****

Length ft	Qtip kips	Qside kips	Q_dw ult kips (Qside + Qtip)	Q-skin Yorktown kips (skin friction contribution by Yorktown)	Q_dw ultimate kips (increased ultimate pile capacity after increasing Yorktown skin friction contribution by 25%)	
0	1	0	1	0	1	
1.52	2.96	0	3	0	3	
3.03	9.07	0	9.1	0	9.1	
4.55	18.69	0	18.7	0	18.7	
6.06	22	0	22	0	22	
7.58	25.28	0	25.3	0	25.3	
9.09	28.57	0	28.6	0	28.6	
10.61	31.9	0	31.9	0	31.9	
12.12	35.18	0	35.2	0	35.2	
13.64	26.77	0	26.8	0	26.8	
15.15	13.94	0	13.9	0	13.9	
16.67	11.09	0	11.1	0	11.1	
18.18	10.64	0	10.6	0	10.6	
19.7	9.88	0	9.9	0	9.9	
21.21	9.58	0	9.6	0	9.6	
22.73	9.44	0	9.4	0	9.4	
24.24	10.33	0	10.3	0	10.3	
25.76	11.47	0	11.5	0	11.5	
27.27	12.56	0	12.6	0	12.6	
28.79	20.54	0	20.5	0	20.5	
30.3	36.85	0.66	37.5	0	37.5	
31.82	36.87	4.86	41.7	0	41.7	
33.33	36.79	8.89	45.7	0	45.7	
34.85	36.81	13.1	49.9	0	49.9	
36.36	36.9	17.27	54.2	0	54.2	
37.88	36.86	21.28	58.1	0	58.1	
39.39	36.96	25.42	62.4	0	62.4	
40.91	36.8	29.63	66.4	0	66.4	
42.42	36.95	33.86	70.8	0	70.8	
43.94	37.01	38.02	75	0	75	
45.45	36.8	41.83	78.6	0	78.6	
46.97	36.84	46.08	82.9	0	82.9	
48.48	36.8	50.16	87	0	87	
50	36.8	54.19	91	0	91	
51.52	36.96	58.6	95.6	0	95.6	
53.03	36.51	62.76	99.3	0	99.3	
54.55	20.71	66.66	87.4	0	87.4	
56.06	18.44	70.84	89.3	0	89.3	
57.58	20.33	75.17	95.5	0	95.5	
59.09	22.17	79.07	101.2	0	101.2	
60.61	24.58	83.01	107.6	0	107.6	
62.12	27.83	87.84	115.7	0	115.7	
63.64	30.27	96.1	126.4	0	126.4	
65.15	31.64	115.12	146.8	0	146.8	
66.67	33	133.3	166.3	0	166.3	
68.18	34.36	150.78	185.1	0	185.1	
69.7	35.73	169.38	205.1	0	205.1	
71.21	36	192.78	228.8	23.4	234.65	YORKTOWN BEGINS
72.73	36	216.41	252.4	47.03	264.1575	
74.24	36	241.07	277.1	71.69	295.0225	
75.76	36	265.25	301.3	95.87	325.2675	
77.27	36	289.9	325.9	120.52	356.03	
78.79	36	312.82	348.8	143.44	384.66	
80.3	36	338.08	374.1	168.7	416.275	
81.82	36	362.01	398	192.63	446.1575	
83.33	36	385.16	421.2	215.78	475.145	

Required nominal capacity

Fill pressure = 30 ft x 130 pcf = 390 psf

Piles are at 7 ft square spacing

Fill load = 390 psf x 49 sq. ft = 191.1 kips

Factored load = 191.1 x 1.35 = 258 kips

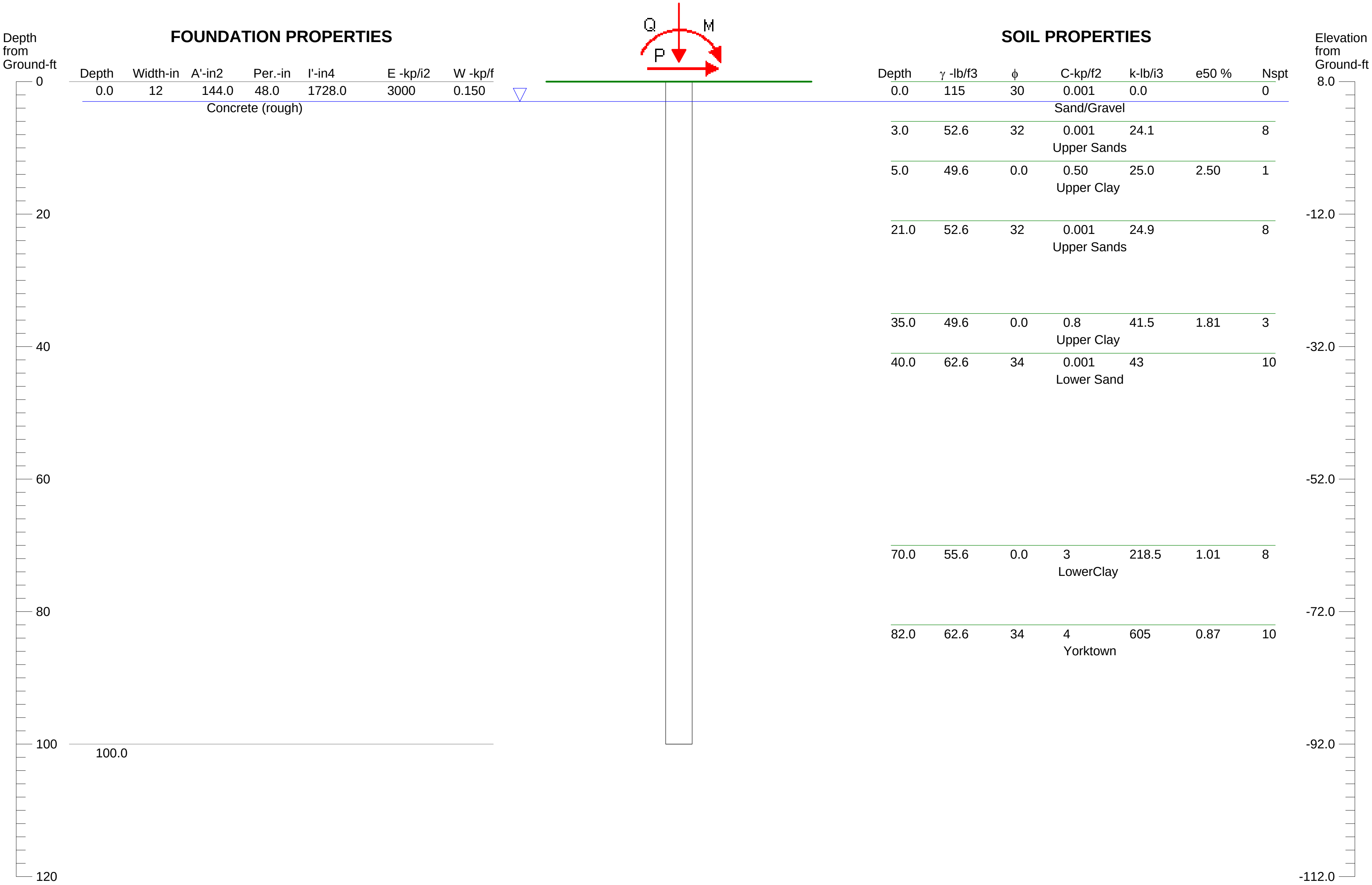
Factored Load = Factored capacity

Nominal Capacity = Factored capacity/0.65

Required nominal capacity = 258/0.65 = 397 kips

FOUNDATION PROFILE & SOIL CONDITIONS

Displacement pile: Higher friction.
Stinger helps smoothen driving.
Pile has two sections. H-section
on tip.



FOUNDATION PROPERTIES

Depth	Width-in	A'-in2	Per.-in	I'-in4	E -kp/i2	W -kp/f
0.0	12	144.0	48.0	1728.0	3000	0.150
		Concrete (rough)				
100.0						

SOIL PROPERTIES

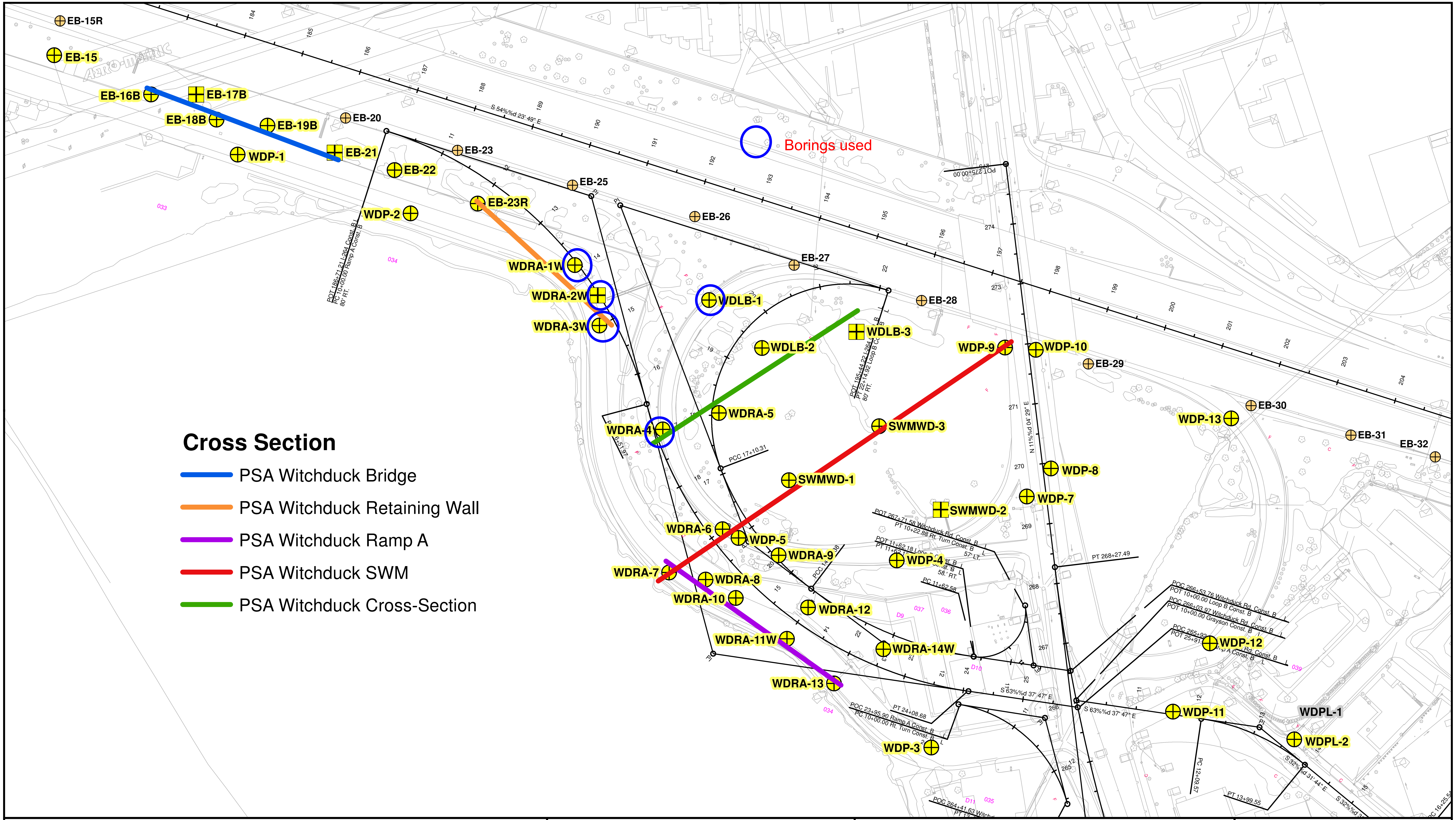
Depth	γ -lb/f3	ϕ	C-kp/f2	k-lb/i3	e50 %	Nspt
0.0	115	30	0.001	0.0		0
			Sand/Gravel			
3.0	52.6	32	0.001	24.1		8
			Upper Sands			
5.0	49.6	0.0	0.50	25.0	2.50	1
			Upper Clay			
21.0	52.6	32	0.001	24.9		8
			Upper Sands			
35.0	49.6	0.0	0.8	41.5	1.81	3
			Upper Clay			
40.0	62.6	34	0.001	43		10
			Lower Sand			
70.0	55.6	0.0	3	218.5	1.01	8
			LowerClay			
82.0	62.6	34	4	605	0.87	10
			Yorktown			

Batter Angle=0 (Pile diameter not to scale) Surface Angle=0

CivilTech Software

I-264 Witchduck Improvements embankments near Wall K

Figure 1



N

0 75 150 Feet

Scale: 1" = 150'

⊕ SPT Exploration

⊞ CPT Exploration

⊕ PSA I-264 CD Borings

Prepared by: HDR

Date: February 13, 2013

VDOT Virginia Department of Transportation

Project 0264-134-102

City of Virginia Beach

Project Study Area
Witchduck

Drawing 4: Subsurface
Cross Section Locations

EMBANKMENTS NEAR WALL K - Witchduck Rd area

Downward Capacity vs Pile Length

increased Qult = original Qult + 0.25xQ-skin Yorktown

The results are for single section pile. Multiple sections may not be correct!

****

Length FT	Qtip KIPS	Qside KIPS	Q_dw ult kips (Qside + Qtip)	Q-skin Yorktown kips (skin friction contribution by Yorktown)	Q_dw ultimate kips (increased ultimate pile capacity after increasing Yorktown skin friction contribution by 25%)
0	1.6	0	1.6	0	1.6
1.01	2.86	0	2.9	0	2.9
2.02	3.76	0	3.8	0	3.8
3.03	4.31	0	4.3	0	4.3
4.04	4.51	0	4.5	0	4.5
5.05	4.5	0	4.5	0	4.5
6.06	4.5	0	4.5	0	4.5
7.07	4.5	0	4.5	0	4.5
8.08	4.5	0	4.5	0	4.5
9.09	4.5	0	4.5	0	4.5
10.1	4.5	0	4.5	0	4.5
11.11	4.55	0	4.5	0	4.5
12.12	5.04	0	5	0	5
13.13	5.65	0	5.6	0	5.6
14.14	6.37	0	6.4	0	6.4
15.15	7.21	0	7.2	0	7.2
16.16	8.17	0	8.2	0	8.2
17.17	9.25	0	9.2	0	9.2
18.18	10.44	0	10.4	0	10.4
19.19	13.97	0	14	0	14
20.2	23.36	0	23.4	0	23.4
21.21	34.79	0	34.8	0	34.8
22.22	34.84	0	34.8	0	34.8
23.23	34.81	0	34.8	0	34.8
24.24	34.77	0	34.8	0	34.8
25.25	30.66	0	30.7	0	30.7
26.26	19.05	0	19.1	0	19.1
27.27	12.28	0	12.3	0	12.3
28.28	11.62	0	11.6	0	11.6
29.29	10.98	0	11	0	11
30.3	10.54	0	10.5	0	10.5
31.31	10.61	0	10.6	0	10.6
32.32	10.71	0	10.7	0	10.7
33.33	10.79	0	10.8	0	10.8
34.34	10.88	0	10.9	0	10.9
35.35	11.22	0	11.2	0	11.2
36.36	11.98	0	12	0	12
37.37	13.19	0	13.2	0	13.2
38.38	21.02	0	21	0	21
39.39	35.04	0	35	0	35
40.4	49.76	1.04	50.8	0	50.8
41.41	49.58	4.53	54.1	0	54.1
42.42	49.68	7.66	57.3	0	57.3
43.43	49.56	10.89	60.4	0	60.4
44.44	49.56	14	63.6	0	63.6
45.45	49.49	17.22	66.7	0	66.7
46.46	49.63	20.64	70.3	0	70.3
47.47	49.67	23.86	73.5	0	73.5
48.48	49.46	27.07	76.5	0	76.5
49.49	49.67	30.3	80	0	80
50.51	49.58	33.46	83	0	83
51.52	49.71	36.88	86.6	0	86.6
52.53	49.75	40	89.8	0	89.8
53.54	49.54	43.35	92.9	0	92.9
54.55	49.57	46.65	96.2	0	96.2
55.56	49.5	49.59	99.1	0	99.1
56.57	49.7	53.25	102.9	0	102.9
57.58	49.86	56.61	106.5	0	106.5
58.59	49.7	59.68	109.4	0	109.4
59.6	49.81	63.15	113	0	113
60.61	36.16	65.89	102.1	0	102.1
61.62	24.18	69.44	93.6	0	93.6
62.63	18.36	72.54	90.9	0	90.9
63.64	19.17	75.78	95	0	95
64.65	20.45	79.44	99.9	0	99.9
65.66	21.68	82.22	103.9	0	103.9

Required nominal capacity
Fill pressure = 29 ft x 130 pcf = 3770 psf
Piles are at 7 ft square spacing
Fill load = 3770 psf x 49 sq. ft = 184.7 kips
Factored load = 184.7 x 1.35 = 249.38 kips
Factored Load = Factored capacity
Nominal Capacity = Factored capacity/0.65
Required nominal capacity = 249.38/0.65 = 383.7 kips

Required min nominal capacity
Fill pressure = 5 ft x 130 pcf = 650 psf
Piles are at 7 ft square spacing
Fill load = 650 psf x 49 sq. ft = 32 kips
Factored load = 32 x 1.35 = 43 kips
Factored Load = Factored capacity
Nominal Capacity = Factored capacity/0.65
Required nominal capacity = 43/0.65 = 67 kips

zero friction was considered for top 40 feet (till el -32)

66.67	22.91	85.51	108.4	0	108.4	
67.68	24.16	89.31	113.5	0	113.5	
68.69	25.39	92.09	117.5	0	117.5	
69.7	26.63	95.52	122.1	0	122.1	
70.71	27	103.98	131	0	131	
71.72	27	115.63	142.6	0	142.6	
72.73	28.73	128.29	157	0	157	
73.74	31.13	141.19	172.3	0	172.3	
74.75	33.54	152.59	186.1	0	186.1	
75.76	35.9	163.9	199.8	0	199.8	
76.77	38.34	176.35	214.7	0	214.7	
77.78	40.75	188.92	229.7	0	229.7	
78.79	43.15	201.18	244.3	0	244.3	
79.8	48.4	213.53	261.9	0	261.9	
80.81	59.95	224.8	284.7	11.27	287.5175	YORKTOWN BEGINS
81.82	80.27	238.26	318.5	24.73	324.6825	
82.83	86	255.43	341.4	41.9	351.875	
83.84	85.81	273.9	359.7	60.37	374.7925	
84.85	85.71	293.47	379.2	79.94	399.185	
85.86	85.95	314.14	400.1	100.61	425.2525	
86.87	85.8	331.59	417.4	118.06	446.915	
87.88	86.02	352.45	438.5	138.92	473.23	
88.89	85.77	371.88	457.7	158.35	497.2875	
89.9	85.94	390.52	476.5	176.99	520.7475	
90.91	85.76	409.18	494.9	195.65	543.8125	
91.92	85.93	428.48	514.4	214.95	568.1375	
92.93	86.08	450.27	536.3	236.74	595.485	
93.94	85.75	468.91	554.7	255.38	618.545	
94.95	85.9	489.13	575	275.6	643.9	
95.96	86.03	506.58	592.6	293.05	665.8625	
96.97	85.74	526.78	612.5	313.25	690.8125	
97.98	85.85	546.44	632.3	332.91	715.5275	
98.99	85.96	566.37	652.3	352.84	740.51	
100	85.52	583.15	668.7	369.62	761.105	

Note: Data can be selected, copied and pasted to Excel to create graphics
Length - Pile length, distance from pile top to tip (not from ground surface)
Qtip - Ultimate pile tip resistance
Qside - Ultimate pile side resistance
Q_dw - Ultimate pile downward resistance
Qd_alw - Allowable pile downward resistance
Weight - Weight of pile shaft
Qsid* - Ultimate pile side uplift resistance
Q_up - Ultimate pile uplift resistance
Qu_alw - Allowable pile uplift resistance

GeogridBridge1.0 analyzes column-supported embankments with geosynthetic-reinforced bridging layers.
The complete report by Filz and Smith (2006), plus all spreadsheet comments, should be read before using this workbook.
Provide the input data in the cells with red text. The cells in blue text are the calculated results based on the input data.
Definition sketches are provided in Figs. 1 through 5, which are located to the right.
Guidance information for material property values is provided in the pdf document to the right.
After providing all the proper input data, use the "Solve" button located at Cell B62.

I-264 Witchduck, CD STA53+00

	Bridging Layer Fill	Embankment Fill #2	Preload
Layer Thickness, H (ft)	3.0	27.0	0.0
Total Unit Weight, γ (pcf)	135	130	110
Friction Angle, ϕ (deg)	38	34	N/A
Young's Modulus, E (psf)	750,000	500,000	N/A
Poisson's Ratio, ν	0.30	0.30	N/A

Pavement plus Traffic Surcharge Pressure, q (psf)	300

Time Available for Consolidation, t (days)	10
Allowable Post-Construction Settlement, S_A (in.)	2.0

Depth to Groundwater, d_w (ft)	3.0
Unit Weight of Groundwater, γ_w (pcf)	62.4

	Exist Sand #1	Exist Sand #2	Clay #1	Clay #2
Layer Thickness, H (ft)	0.0	1.0	3.0	8.0
Total Unit Weight, γ (pcf)	115	125	120	105
Young's Modulus, E (psf)	250,000	250,000	N/A	N/A
Poisson's Ratio, ν	0.33	0.30	0.50	0.50
Lat. Earth Press. Coeff., K_0	0.50	0.50	0.60	0.60
Interface Frict. Angle btwn Soil and Column, δ (deg)	32	32	0	0
Compression Ratio, $C_{\varepsilon c}$	N/A	N/A	0.120	0.170
Recompression Ratio, $C_{\varepsilon r}$	N/A	N/A	0.012	0.014
Coeff. of Consol., c_v (ft^2/day)	N/A	N/A	0.10	
Initial Eff. Vert. Stress at Top of Layer, $\sigma'_{v,top}$ (psf)	N/A	N/A	125	1413
Preconsol. Press. at Top of Layer, $p_{p,top}$ (psf)	N/A	N/A	250	2119.5
Initial Eff. Vert. Stress at Bottom of Layer, $\sigma'_{v,bot}$ (psf)	N/A	N/A	425	1763
Preconsol. Press. At Bottom of Layer, $p_{p,bot}$ (psf)	N/A	N/A	850	2644.5

Reduction in Required Bridging Layer Thickness, $H_{b,red}$ (ft)	0.0

Geogrid Stiffness, J (lb/ft)	48,000
Long-term, In-Service, Allowable Geogrid Strength, S_g (lb/ft)	2,000

	Pile Cap	Column
Vertical Distance from Top to Bottom of Element, H (ft)	1.0	11.0
Column Shape (use R for round and S for square)	S	S
Column Diameter or Width, d_c or a (ft)	3.5	1.0
Young's Modulus, E (psf)	580,000,000	580,000,000
Poisson's Ratio, ν	0.30	0.30
Center-to-center spacing, s (ft)	8.0	

	Value	Criterion
Clear Spacing, $s - a$ (ft)	4.5	≤ 8.0
Area Replacement Ratio at Ground Surface, a_s	0.191	≥ 0.10
Bridging Layer Thickness, H_b (ft)	3.0	≥ 4.5
Maximum differential settlement of geogrid, d (in.)	3.3	N/A
Geosynthetic Strain, ε_g	0.009	≤ 0.05
Tension in the Geosynthetic Reinforcement, T_g (lb/ft)	448	≤ 2,000
Post-Construction Embankment Settlement, S (in.)	1.1	≤ 2.0

GeogridBridge1.0 analyzes column-supported embankments with geosynthetic-reinforced bridging layers.
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I-264 Witchduck Interchange, I-264 STA 188+50

	Bridging Layer Fill	Embankment Fill #2	Preload
Layer Thickness, H (ft)	3.0	24.0	0.0
Total Unit Weight, γ (pcf)	135	130	110
Friction Angle, ϕ (deg)	38	34	N/A
Young's Modulus, E (psf)	750,000	500,000	N/A
Poisson's Ratio, ν	0.30	0.30	N/A

Pavement plus Traffic Surcharge Pressure, q (psf)	300

Time Available for Consolidation, t (days)	10
Allowable Post-Construction Settlement, S_A (in.)	2.0

Depth to Groundwater, d_w (ft)	13.0
Unit Weight of Groundwater, γ_w (pcf)	62.4

	Exist Sand #1	Exist Sand #2	Clay #1	Clay #2
Layer Thickness, H (ft)	0.0	0.0	9.0	9.0
Total Unit Weight, γ (pcf)	125	125	120	105
Young's Modulus, E (psf)	250,000	250,000	N/A	N/A
Poisson's Ratio, ν	0.33	0.30	0.50	0.50
Lat. Earth Press. Coeff., K_0	0.50	0.50	0.60	0.60
Interface Frict. Angle btwn Soil and Column, δ (deg)	32	32	0	0
Compression Ratio, $C_{\varepsilon c}$	N/A	N/A	0.120	0.170
Recompression Ratio, $C_{\varepsilon r}$	N/A	N/A	0.012	0.014
Coeff. of Consol., c_v (ft^2/day)	N/A	N/A	0.10	
Initial Eff. Vert. Stress at Top of Layer, $\sigma'_{v,top}$ (psf)	N/A	N/A	0	2164
Preconsol. Press. at Top of Layer, $p_{p,top}$ (psf)	N/A	N/A	0	3246
Initial Eff. Vert. Stress at Bottom of Layer, $\sigma'_{v,bot}$ (psf)	N/A	N/A	1080	2614
Preconsol. Press. At Bottom of Layer, $p_{p,bot}$ (psf)	N/A	N/A	2160	3921

Reduction in Required Bridging Layer Thickness, $H_{b,red}$ (ft)	0.0

Geogrid Stiffness, J (lb/ft)	48,000
Long-term, In-Service, Allowable Geogrid Strength, S_g (lb/ft)	2,000

	Pile Cap	Column
Vertical Distance from Top to Bottom of Element, H (ft)	1.0	17.0
Column Shape (use R for round and S for square)	S	S
Column Diameter or Width, d_c or a (ft)	3.5	1.0
Young's Modulus, E (psf)	580,000,000	580,000,000
Poisson's Ratio, ν	0.30	0.30
Center-to-center spacing, s (ft)	7.0	

	Value	Criterion
Clear Spacing, $s - a$ (ft)	3.5	≤ 8.0
Area Replacement Ratio at Ground Surface, a_s	0.250	≥ 0.10
Bridging Layer Thickness, H_b (ft)	3.0	≥ 3.5
Maximum differential settlement of geogrid, d (in.)	3.9	N/A
Geosynthetic Strain, ε_g	0.020	≤ 0.05
Tension in the Geosynthetic Reinforcement, T_g (lb/ft)	981	≤ 2,000
Post-Construction Embankment Settlement, S (in.)	1.3	≤ 2.0

GeogridBridge1.0 analyzes column-supported embankments with geosynthetic-reinforced bridging layers.
The complete report by Filz and Smith (2006), plus all spreadsheet comments, should be read before using this workbook.
Provide the input data in the cells with red text. The cells in blue text are the calculated results based on the input data.
Definition sketches are provided in Figs. 1 through 5, which are located to the right.
Guidance information for material property values is provided in the pdf document to the right.
After providing all the proper input data, use the "Solve" button located at Cell B62.

I-264 Witchduck Road Interchange, Embankments near Wall K - Witchduck Rd area

	Bridging Layer Fill	Embankment Fill #2	Preload
Layer Thickness, H (ft)	3.0	27.0	0.0
Total Unit Weight, γ (pcf)	135	130	110
Friction Angle, ϕ (deg)	32	32	N/A
Young's Modulus, E (psf)	750,000	500,000	N/A
Poisson's Ratio, ν	0.30	0.33	N/A

Pavement plus Traffic Surcharge Pressure, q (psf)	300

Time Available for Consolidation, t (days)	10
Allowable Post-Construction Settlement, S_A (in.)	2.0

Depth to Groundwater, d_w (ft)	3.0
Unit Weight of Groundwater, γ_w (pcf)	62.4

	Exist Sand #1	Exist Sand #2	Clay #1	Clay #2
Layer Thickness, H (ft)	3.0	2.0	16.0	5.0
Total Unit Weight, γ (pcf)	125	115	112	112
Young's Modulus, E (psf)	500,000	500,000	N/A	N/A
Poisson's Ratio, ν	0.33	0.30	0.49	0.49
Lat. Earth Press. Coeff., K_0	0.47	0.50	0.61	0.60
Interface Frict. Angle btwn Soil and Column, δ (deg)	24	23	0	0
Compression Ratio, $C_{\varepsilon c}$	N/A	N/A	0.170	0.170
Recompression Ratio, $C_{\varepsilon r}$	N/A	N/A	0.023	0.023
Coeff. of Consol., c_v (ft^2/day)	N/A	N/A	0.10	
Initial Eff. Vert. Stress at Top of Layer, $\sigma'_{v,top}$ (psf)	N/A	N/A	479	2007
Preconsol. Press. at Top of Layer, $p_{p,top}$ (psf)	N/A	N/A	718.5	3010.5
Initial Eff. Vert. Stress at Bottom of Layer, $\sigma'_{v,bot}$ (psf)	N/A	N/A	1279	2257
Preconsol. Press. At Bottom of Layer, $p_{p,bot}$ (psf)	N/A	N/A	1918.5	3385.5

Reduction in Required Bridging Layer Thickness, $H_{b,red}$ (ft)	0.0

Geogrid Stiffness, J (lb/ft)	48,000
Long-term, In-Service, Allowable Geogrid Strength, S_g (lb/ft)	2,000

	Pile Cap	Column
Vertical Distance from Top to Bottom of Element, H (ft)	1.0	90.0
Column Shape (use R for round and S for square)	S	S
Column Diameter or Width, d_c or a (ft)	3.5	1.0
Young's Modulus, E (psf)	580,000,000	580,000,000
Poisson's Ratio, ν	0.30	0.30
Center-to-center spacing, s (ft)	7.0	

	Value	Criterion
Clear Spacing, $s - a$ (ft)	3.5	≤ 8.0
Area Replacement Ratio at Ground Surface, a_s	0.250	≥ 0.10
Bridging Layer Thickness, H_b (ft)	3.0	≥ 3.5
Maximum differential settlement of geogrid, d (in.)	2.9	N/A
Geosynthetic Strain, ε_g	0.011	≤ 0.05
Tension in the Geosynthetic Reinforcement, T_g (lb/ft)	529	≤ 2,000
Post-Construction Embankment Settlement, S (in.)	1.0	≤ 2.0