June 4, 2015

Geotechnical Engineering Report

Route 340 Bridge Replacement and Approaches Over Cub Run Page County, Virginia

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June 4, 2015

Mr. James D. Davidson, PE, DBIA
Dewberry
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Subject: **Geotechnical Engineering Report, Route 340 Bridge Replacement and Approaches Over Cub Run, Page County, Virginia (VDOT Project No. 0340-069-777, B611, UPC NO. 90187) (GeoConcepts Project No. 13004.01)**

Dear Mr. Davidson:

GeoConcepts Engineering, Inc. (GeoConcepts) is pleased to present the following geotechnical engineering report prepared for the Route 340 Bridge over Cub Run in Page County, Virginia.

We appreciate the opportunity to serve as your geotechnical consultant on this project. Please do not hesitate to contact me if you have any questions or want to meet to discuss the findings and recommendations contained in the report.

Sincerely,

GEOCONCEPTS ENGINEERING, INC.

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1.0 Introduction

This geotechnical engineering report presents the recommendations for the proposed Route 340 Bridge Replacement and Approaches over Cub Run located in Page County, Virginia. The project site is located approximately 0.17 to 0.44 miles south of the intersection of Route 685 and Route 340, with a project length of 0.27 miles. A site vicinity map is presented in Figure 1 at the end of this report.

The recommendations presented in this report are based on a review of test borings drilled during the Phase 2 study and information presented in our revised preliminary soil survey report (PSSR) dated November 4, 2012 prepared during the Phase 1 study. The PSSR is attached as Appendix F of this report.

2.0 Project Description

The purpose of this project is to replace the existing two-lane bridge of Route 340 over Cub Run with a new two-span or alternate three span bridge of similar length. The new two span bridge will be approximately 44 feet wide and 243 feet long, with 121.5 feet long spans. The alternate three span bridge option is still being evaluated and design details are not available. Further, the existing approaches will be realigned and the Route 340 travel lanes will be widened from 10 feet to 12 feet within the project limits.

2.1 Existing Conditions

Route 340 is a rural minor arterial route in Page County, Virginia. During a site visit, a small hole was observed on the southern embankment where soil was raveling down between the rip-rap. The topography at the site slopes down from the north and south towards Cub Run. The vegetation at the site consists of grass and shrubbery. The existing slopes appeared to be stable and we did not observe surface failures at embankment and approach slopes. Utilities on both sides of the roadway were observed in the project vicinity.

2.2 Existing Bridge Conditions

According to the existing bridge plan dated January 8, 1980, the existing bridge is approximately 197 feet long and 23 feet wide. The existing bridge has five reinforced concrete beam spans and an asphalt overlay. Further, the existing bridge abutments and piers are founded on shallow foundations.

3.0 Subsurface Conditions

This section summarizes the field exploration and subsurface conditions in the project vicinity. Subsurface conditions were investigated by drilling 18 test borings during the Phase 2 study in the proposed bridge replacement area. Test boring logs, rock core photographs, pavement core photographs, and subsurface investigation plans are presented in Appendix A of this report.

3.1 Geologic Units and Features

The project is located in Page County, Virginia, within the Valley and Ridge Physiographic Province. The Valley and Ridge forms a broad arc that is bounded on the east by the Blue Ridge Province and on the west by the Appalachian Plateau Province. The entire Valley and Ridge is underlain by folded and faulted sedimentary rocks dating from the Paleozoic Geologic Era. Igneous intrusive rocks of the Paleogene Geologic Period are present at scattered locations throughout the region, and more recent alluvial deposits typically floor the river valleys. Colluvial gravels are also present on the flanks of the steeper ridges.

The geography of the Province consists of parallel, strike-controlled linear ridges of resistant rock such as sandstone, conglomerate, and well-indurated carbonates, with intervening valleys floored by less resistant, poorly indurated clastic and carbonate rocks. The river systems of the Province form a trellis pattern, following the valley bottoms and passing through numerous structurally controlled "gaps" and canyons in the mountain ridges.

The Valley and Ridge is often divided into two sections: an eastern "Great Valley" Section; and a western "Allegheny Highlands" Section. The Great Valley is a topographic lowland, bounded on the east by the Blue Ridge Massif and on the west by the closely packed ridges of the Allegheny Highlands. The Allegheny Highlands extend from northeast to southwest, forming the western edge of the Great Valley. The parallel ridges gradually rise in summit elevations, eventually transitioning on their western edge to the gently folded upland of the Appalachian Plateau Province. The site is located in the eastern part of the Great Valley Subsection of the Ridge and Valley Province, locally known as the "Page Valley".

Specifically, the site is mapped as underlain by the Beekmantown Dolomite (Map Symbol - Ob) of the Lower Ordovician Geologic Period. The unit is a thickbedded carbonate with dolostone, limestone, and chert nodules scattered throughout. In the incised valley of the Cub Run, the Beekmantown Dolomite is exposed; however it is flanked by a stratum of Quaternary colluvial gravels to the north and south. The contact between the Beekmantown Dolomite and the overlying Middle Ordovician Limestone's (Map symbol - Oeln) is located approximately 580-feet upstream (west) of the bridge alignment. The contact between the Beekmantown and the overlying Middle Ordovician Limestone's is unconformable, and represents an erosional surface. The Oeln consists of (from top to bottom) the Edinburg, Lincolnshire, and New Market Formations, respectively. They are typically mapped as one unit. There are no significant geologic faults mapped at this site.

It should be noted that as in any area underlain by soluble bedrock such as the Beekmantown Dolomite, the site is prone to the development of a karst terrain, characterized by the presence of pinnacled bedrock, sinkholes, caves, and large springs. However, no obvious surface karst features (e.g. sinkholes) were observed in the immediate vicinity of the bridge or the approach roadways.

3.2 Field Exploration

Published karst feature information for the project vicinity includes the Virginia Division of Mineral Resources' map for the Northern Valley and Ridge Province (Hubbard, 1983). Cave location data was derived from the proprietary database of the Virginia Speleological Survey (VSS, 2012). A 2-foot contour map of the site derived from triangulated irregular network (TIN) maps provided by the Virginia County Data Series of Virginia Tech. The project is mapped as underlain by Quaternary age colluvium which mantles the Beekmantown Dolomite below. The dolomite is only well exposed in the stream valley and in scattered outcrops along the flanks of the valley. Based on our on-site reconnaissance, review of available literature, mapping, and databases, there are no sinkholes, closed depressions, filled or un-filled cavities, or caves located within the project area. However, the Beekmantown Dolomite is known for the development of karst features, many of which are concealed beneath the regional colluvial gravel mantle. It should be noted that based on data obtained from the Virginia Speleological Survey, a small cave (Huffman's Cave) is located approximately 350 feet upstream from the bridge in the bluff above Cub Run. Thus, although there are no surface karst features located within the immediate project bounds, regionally the project is located in an area that should be considered as having known karst development. The following note should be added to the plans: "In the event a cave, sinkhole, spring, blowhole, swallet or other karst feature is observed within the project limits or is encountered during construction, the Contractor shall immediately contact the VDOT Project Inspector and the VDOT District Environmental Manager at (540) 332-9101." In the event the subsequent soil survey investigation encounters karst features, this will be addressed in the final soil survey report.

3.3 Field Exploration

GeoConcepts monitored the drilling of nine bridge borings (designated BR-1 through BR-9), four roadway borings (designated R-1 through R-4), and five slope borings (designated SL-1 through SL-6). Test borings were drilled using an all-terrain vehicle drill rig. Rock coring was performed in all bridge borings. Soil samples were obtained at selected intervals, and soil and rock samples were taken to our laboratory for further examination and physical testing. Multiple Shelby tubes were advanced across the project site, but due to the abundant amount of oversized material and shallow bedrock, poor sample recovery prevented further laboratory testing. Test boring locations are shown on the Boring Location Plans included as Figures

3 and 4 in Appendix A. A detailed description of the field exploration method is included in Appendix A. Due to limited rock exposure at the surface, strike and dip could not be measured.

3.4 Stratification

The subsurface materials encountered have been stratified for purposes of our discussions herein. These stratum designations do not imply that the materials encountered are continuous across the site. Stratum designations have been established to characterize similar subsurface conditions based on material gradations and parent geology. The subsurface materials encountered in the test borings completed at the site have been assigned to the following strata:

Stratum A (Existing Fill)	loose to very dense , clayey SAND (SC), silty clayey SAND (SC-SM), SILTY GRAVEL (GM), sandy LEAN CLAY (CL), contains brick fragments, moist, brown, gray
Stratum B (Alluvium)	very loose to very dense, clayey SAND (SC), silty clayey SAND (SC-SM), silty GRAVEL (GM), POORLY GRADED SAND (SP), contains rock fragments, moist to wet, brown, orange, tan
Stratum C1 (Residual)	loose to very dense, or very soft to very hard, clayey SAND (SC), silty clayey SAND (SC-SM), FAT CLAY (CH), contains rock fragments, moist, brown, gray, orange, tan
Stratum C2 (Dolostone Rock)	slightly unweathered, hard, slightly to highly fractured, DOLOSTONE, contains calcite veins, gray, white to dark gray

The two letter designations included in the strata descriptions presented above and on the test boring logs represent the Unified Soil Classification System (USCS) group symbol and group name for the samples based on laboratory testing per ASTM D-2487 and visual classifications per ASTM D-2488. It should be noted that visual classifications per ASTM D-2488 may not match classifications determined by laboratory testing per ASTM D-2487.

3.5 Groundwater Conditions

Groundwater level observations were made in the field during drilling of the test borings. Twenty-four hour groundwater level readings were recorded in the test borings where possible. A summary of groundwater level readings is presented in Table C-1 in Appendix C. Groundwater was encountered at about 2.0 feet to 13.5 feet below the existing ground surface.

The groundwater observations presented herein are considered to be an indication of the groundwater levels at the dates and times indicated. Where rock coring was performed, the groundwater observations presented in Table C-1 may be influenced by the water used for rock coring. Where more impervious clay and silt soils are encountered, the amount of water seepage into the borings is limited, and it is generally not possible to establish the location of the groundwater table through short term water level observations. Accordingly, the groundwater information presented herein should be used with caution. Also, fluctuations in groundwater levels should be expected with seasons of the year, construction activity, and changes to surface grades, precipitation, or other similar factors.

3.6 Soil and Rock Laboratory Test Results

Selected soil samples obtained from the field investigation were tested for grain size distribution including hydrometer, Atterberg limits, California Bearing Ratio (CBR), compaction characteristics, natural moisture contents, consolidation, and unconfined compressive strength and elastic moduli of rock. A summary of soil laboratory test results and the individual test results are presented in Appendix B.

3.6.1 Classification Test Results

A summary of the range of percent fines passing the US Standard No. 200 sieve, liquid limits, and plasticity indices for soil samples tested in the laboratory are presented below in Table 1.

Table 1: Classification Test Results

Stratum	USCS Group Name and Symbol	Range of % Passing #200 Sieve	Range of Liquid Limit	Range of Plasticity Index
A* (Existing Fill)	silty clayey SAND (SC-SM)	16	17	4
Stratum B (Alluvium)	clayey SAND (SC), POORLY GRADED SAND with gravel (SP), clayey SAND with gravel (SC)	1 to 44	NP to 36	NP to 22
Stratum C1 (Residual)	clayey SAND (SC), FAT CLAY with sand (CH)	40 to 85	25 to 68	12 to 46

* Only one sample tested

3.6.2 Standard Proctor and California Bearing Ratio (CBR) Test Results

Three standard proctor tests (VTM-1) and three California Bearing Ratio (CBR) tests (VTM-8) were performed on bulk samples collected from the test borings drilled under this contract. The test results are presented below in Table 2.

Table 2: Standard Proctor and California Bearing Ratio (CBR) Test Results

Test Boring No.	Sample Depth (ft)	USCS Symbol	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	CBR Value
B-1*	0.0-5.0	CL	116	14	4.2
R-1	3.0-5.0	SC	128	9	8.3
R-3	1.0-5.0	CH	110	16	4.1

* Test result from PSSR dated November 4, 2014

3.6.3 Metal Corrosion/Concrete Attack Test Results

In addition to standard geotechnical soil laboratory testing, four samples were submitted to an analytical laboratory for metal corrosion and concrete attack testing. Corrosion testing consisted of analysis for moisture content (ASTM D-2216), pH (CA643), resistivity (ASTM G187), sulfides (water soluble EPA 376.2), and reduction-oxidation potential (Electrode). The test results are presented below in Table 3.

Table 3: Metal Corrosion Test Results

Test Boring No.	Sample Depth (ft)	Moisture Content (%)	pH	Resistivity (ohm – cm)	Sulfides (ppm)	Red-ox Potential (mV)
B-3*	6.5-10.5	30.9	7.5	900	<1.2	+154
BR-2	0.0-5.0	9.2	6.2	10,000	<1.2	+211
BR-5	5.0-8.1	27.0	6.4	5,300	<1.2	+227
BR-8	0.0-5.0	12.0	6.5	13,000	<1.2	+238

* Test result from PSSR dated November 4, 2014

According to Section 10.7.5 of AASHTO LRFD Bridge Design Specifications (2012), the soils should be considered corrosive if the resistivity of soils is less than 2000 ohm-cm or pH value is less than 5.5. Therefore, the soils near Abutment A should be considered corrosive, and foundations and utilities in this area should be designed accordingly. The types of pipes should be selected based on the allowable pH and resistivity ranges presented in Standard PC-1 (page 107.21) of Section 100 of VDOT Road and Bridge Standard.

Sulfate (water soluble CA417) tests were performed on selected soil samples to determine the severity of sulfate attack on concrete structures. The test results are presented below in Table 4.

Table 4: Sulfate Results

Test Boring No.	Sample Depth (ft)	Sulfate Concentration (ppm)
B-3*	6.5-10.5	48.0
BR-2	0.0-5.0	<5.0
BR-5	5.0-8.1	21.0
BR-8	0.0-5.0	12.0

* Test result from PSSR dated November 4, 2014

Based on correlations between sulfate concentrations and severity of sulfate attack as presented in American Concrete Institute (ACI) 318, the above sulfate concentrations are considered to pose a negligible threat of sulfate attack on concrete.

3.6.4 Rock Compressive Strength Test Results

Three rock core samples were tested for unconfined compressive strength and elastic modulus in the laboratory. The test results are presented below in Table 5.

Table 5: Rock Unconfined Compressive Strength and Elastic Modulus Test Results

Test Boring No.	Rock Sample Depth (ft)	Unconfined Compressive Strength (psi)	Young's Modulus (psi)
B-1*	6.50-6.83	4,591	-
B-3*	42.2-42.33	3,466	-
B-3*	46.0-46.33	4,257	-
BR-1#	10.32-10.69	35,845	15,930,000
BR-1	10.80-11.50	7,606	-
BR-3#	13.63-14.0	32,881	12,300,000
BR-3	14.0-15.0	7,720	-
BR-4	9.60-10.10	15,508	-
BR-4#	11.33-11.70	17,829	12,200,000
BR-7#	5.65-6.02	28,014	10,900,000

Test Boring No.	Rock Sample Depth (ft)	Unconfined Compressive Strength (psi)	Young's Modulus (psi)
BR-7	6.50-7.60	6,681	-
BR-8	18.80-19.60	12,426	-
BR-8#	20.75-21.12	25,843	14,300,000

*Rock compressive strength tested during Phase I investigation
Tested by GeoTesting Express

The average strength of the five samples (from Phase II) which GeoConcepts tested was 8,641 psi ranging from 6,681 to 15,508 psi; samples from the same cores which were tested by GeoTesting averaged 28,082 psi, and ranged from 17,829 to 35,845 psi. The samples were all of similar length and width, and from similar depths. There was no significant difference in the lithology of the samples, and they all appeared as the type of dolostone representative of the Beekmantown Dolomite in the southern Page County region. GeoConcepts ran a total of nine (9) sample from this project site, with a mean compressive strength of 7,091 psi and a standard deviation of 372 psi.

3.6.5 Consolidation Test Results

One consolidation test was performed on an undisturbed tube sample of the Stratum C1 silt. The results of the consolidation test are presented below in Table 6.

Table 6: Consolidation Test Results

Test Boring No.	Sample Depth (ft)	e_o	Po (ksf)	Pc (ksf)	OCR	Cc	Cr	Cv (ft^2/day)
SL-3	6.0-8.0	0.87	0.9	11.0	13.5	0.11	0.011	0.047

e_o = initial void ratio; Pc = preconsolidation pressure; Cc = compression index; Cr = recompression index; Cv = coefficient of consolidation.

3.6.6 Scour

Gradation testing was performed on soil samples collected from the Cub Run streambed to aid in evaluation of the scour potential. The resulting estimated D90 and D50 values are presented below in Table 7.

Table 7: Gradation Tests of Streambed Samples

Sample Location	Classification (ASTM D2487)	D90	D50
Streambed	POORLY GRADED SAND with gravel (SP)	15.0 mm	1.5 mm
BR-4	CLAYEY SAND (SC) with gravel	30.0 mm	1.0 mm
BR-7	CLAYEY SAND (SC)	2.0 mm	0.32 mm

4.0 Geotechnical Recommendations

Recommendations regarding foundations, pavements, earthwork, rock excavation, and slope stability are presented herein.

4.1 Foundations

According to the information provided to us, we understand that the existing bridge will be demolished and replaced with a new 2-span or alternate 3-span bridge. The new two span bridge will be approximately 44 feet wide and 243 feet long, with 121.5 feet long spans. The alternate three span bridge option is still being evaluated. Loads were not provided to us at the time of writing this report. We have evaluated both shallow and deep foundation recommendations for support of the bridge abutments and piers as presented below.

4.1.1 Spread Footing Foundations

Spread footings may be used for support of the bridge piers at test borings BR-4 to BR-7, and may be designed with a factored resistance of 15,000 psf (7.5 tsf) when bearing on dolostone rock. In accordance with Table 10.5.5.2.2-1 of the 2012 AASHTO LRFD Design Specifications, a resistance factor of 0.45 was used to determine the factored resistance of 15,000 psf. We recommend that a resistance factor of 0.80 be used for sliding between rock and foundation, and a resistance factor of 0.5 be used for passive soil resistance. We recommend a coefficient of friction of 0.70 should be used for the footings bearing on rock.

Bearing resistance of 33,333 psf may be used for the extreme limit state when bearing on rock. A resistance factor (ϕ) of 1.0 is used to determine the resistance for extreme limit states. A factored resistance of 15,000 psf may also be used for service limit state. Bearing capacity calculations are presented in Appendix D of this report.

Estimated highest spread footing bearing elevations for bridge piers at the boring locations are presented below in Table 8. The footing subgrade should be 1 foot below the 100 year scour depth or at the 500 year scour depth, whichever is higher. However, in no case should footing subgrades be higher than the estimated highest footing subgrade elevations presented below in Table 8.

Table 8: Estimated Highest Footing Subgrade Bearing Elevations

Substructure	Test Boring No.	Ground Surface Elevation (ft)	Estimated Highest Footing Subgrade Elevation for 15,000 psf Factored Resistance (Rock)	Estimated Elevation Top of Bedrock (ft)
Pier	BR-4	EL 904.7	EL 896.0	EL 896.4
	BR-5	EL 903.5	EL 895.0	EL 895.4
Pier	BR-6	EL 904.6	EL 896.0	EL 896.6
	BR-7	EL 905.2	EL 901.0	EL 901.2

Footing subgrades should be observed and approved prior to placement of concrete to ascertain that footings are placed on suitable bearing materials as recommended herein. Disturbance of footing subgrades by exposure to water seepage or weather conditions should be avoided. Any existing fill, disturbed, frozen, or soft subgrade soils should be removed prior to placing footing concrete. It may be desirable to place a 3-inch to 4-inch thick "mud mat" of lean concrete immediately on the approved footing subgrade to avoid softening of the exposed subgrade. It should be noted that the mud mat should consist of VDOT designation Class A-3 concrete and that additional excavation below design subgrades will be required to accommodate the mud mat. Forms may be used if necessary, but less subgrade disturbance is anticipated if excavations are made to the required dimensions and concrete placed against the soil. If footings are formed, the forms should be removed and the excavation backfilled as soon as possible. Water should not be allowed to pond along the outside of footings for long periods of time.

Based on the groundwater data, we recommend that the contractor be prepared to provide temporary dewatering during construction of foundations. We recommend that the dewatering consist of an aggressive system of individual sumps and pumps during excavation of footings. It is critical that as soon as water seepage is observed, the contractor should excavate surface trenches from the observed water seepage to a sump pit and sump pump. If the water is allowed to saturate subgrades, softening of the subgrade will occur very quickly and extra costs will be incurred.

4.1.2 Pre-Drilled H-Pile Foundations

H-piles of Grade 50 steel set in 24-inch predrilled holes are considered suitable for support of Abutments A and B for the proposed bridge over Cub Run. Pre-drilled holes should be filled with VDOT T3 concrete after placement of the H-pile.

Geotechnical factored resistances of H-piles are calculated using a resistance factor of 0.45, Table 9 presents the geotechnical factored resistances. However, we recommend a 12-inch square steel plate be welded at the base of each H-pile to provide more end bearing, so as to raise the geotechnical factored resistance to be in excess of the design structural resistance. The design structural resistance should be calculated by the structural engineer. Considering the soil profile encountered in the test borings completed at the proposed bridge location, it is expected that negative skin friction (downdrag) on the H-piles due to the wingwall backfill will be negligible. Pile settlement under the factored resistance is not expected to exceed about half-inch. The geotechnical factored resistance and pile settlement calculations are presented in Appendix D of this report.

The corrosion series test results indicated that the resistivity of the existing soils were as low as 900 ohm-cm. Since the H-piles will be cast in concrete, we believe a protective coating will not be required. Pile center-to-center spacing of at least three pile widths is recommended. Factored axial compression resistances are presented below in Table 9.

Table 9: Factored Axial Compression Resistances

Pile Section	Steel Area A_s (in^2)	Geotechnical Factored Axial Resistance (tons)
HP 10x42	12.4	46
HP 12x53	15.5	58
HP 12x74	21.8	82

Pre-drilled holes for the H-piles should extend a minimum of 2 feet into bedrock to ensure that suitable bearing elevation is reached. In addition, we suggest that a minimum of 10 feet rock coring be performed below the H-pile tip elevation to evaluate the quality of rock and to ensure that rock is not underlain by soil or a void. Estimated highest H-pile tip bearing elevations at the boring locations are presented below in Table 10. The pile tip bearing elevations presented below are not based on the scour depth. We should re-evaluate the tip elevations once the scour depths are available. The variability of the stratigraphy at the site (i.e. cobbles and boulders), both among boreholes and within boreholes, suggests that it may be necessary that to re-evaluate pile tip bearing elevations during construction.

Table 10: Estimated Tip Bearing Elevations for H-Piles

Substructure	Test Boring No.	Ground Surface Elevation (ft)	Estimated Elevation Top of Bedrock (ft)	Estimated Highest Tip Elevation for H-Piles	Rock Socket Length (ft)
Abutment A	B-3	EL 941.3	EL 901.3	EL 899.0	2.3
	BR-1#	EL 910.5	EL 904.0	EL 899.5	4.5

Substructure	Test Boring No.	Ground Surface Elevation (ft)	Estimated Elevation Top of Bedrock (ft)	Estimated Highest Tip Elevation for H-Piles	Rock Socket Length (ft)
Abutment B	BR-8	EL 932.0	EL 920.5	EL 918.5	2.0
	BR-9	EL 932.6	EL 926.6	EL 924.5	2.0

Void or cavity from 8.6 to 8.9 feet

4.1.3 Temporary Shoring System

Recommendations are presented below for a temporary RW-3 retaining wall and a temporary wire wall system.

4.1.3.1 Retaining Wall (RW-3)

According to the project plans provided to us, temporary shoring will be required between Stations 15+50 and 18+50 on the west side of existing Route 340. A concrete gravity retaining wall (VDOT RW-3) is considered a feasible option for this temporary support system. The maximum height of the temporary shoring VDOT RW-3 wall will be about 7 feet at about Station 18+50, with a backfill slope at 1.5H:1V. Concrete gravity retaining wall dimensions and porous backfill shall be as specified in Section 400 of VDOT Road and Bridge Standards. For concrete gravity retaining walls, backfill against the wall (i.e., specified backfill) should consist of materials classified as SC, SM, or more granular per ASTM D-2487, with a maximum particle size of 3 inches and a liquid limit and plasticity index less than 40 and 15, respectively. The minimum embedment for the concrete gravity retaining wall should be 2.0 feet below the final grade in front of the wall, for frost protection. The upper 1.5 feet of soil at the base of wall should not be included in the design of passive soil resistance. Recommended soil design parameters for the concrete gravity retaining wall backfill material are summarized below in Table 11.

Table 11: Recommended Soil Design Parameters for Concrete Gravity Retaining Walls

Material	Description	γ (pcf)	ϕ (degrees)	c (psf)	Coefficient of Base Sliding
Foundation Soils	Suitable Existing Fill or New Compacted Fill	120	28	0	0.35
Specified Backfill	Compacted Backfill (SC, SM, or more granular)	120	30	0	N/A

Key to abbreviations: N/A = not applicable; γ = Moist Unit Weight, ϕ= Friction Angle, and **c** = Cohesion.

We have performed global stability analysis of the concrete gravity retaining wall and the results of the global stability analysis are presented in Section 4.5 of this report.

Spread footings supported on suitable existing fill or new compacted fill are considered suitable for support of the concrete gravity retaining wall. A coefficient of sliding of 0.35 may be used to evaluate the average frictional resistance along the bottom of the wall. We have computed the bearing resistance for the concrete gravity retaining wall when supported on suitable existing fill or new compacted fill. The factored bearing resistance at the strength limit state is calculated using a resistance factor of 0.50. For the service and extreme event limit state, a resistance factor of 1.0 is used in the calculations. Bearing resistances for strength limit, service limit, and extreme limit states are plotted in the following figure and calculations are presented in Appendix D of this report. Bearing resistance values as shown in the following figure were calculated assuming a construction joint will be provided at least at a 100 feet interval.

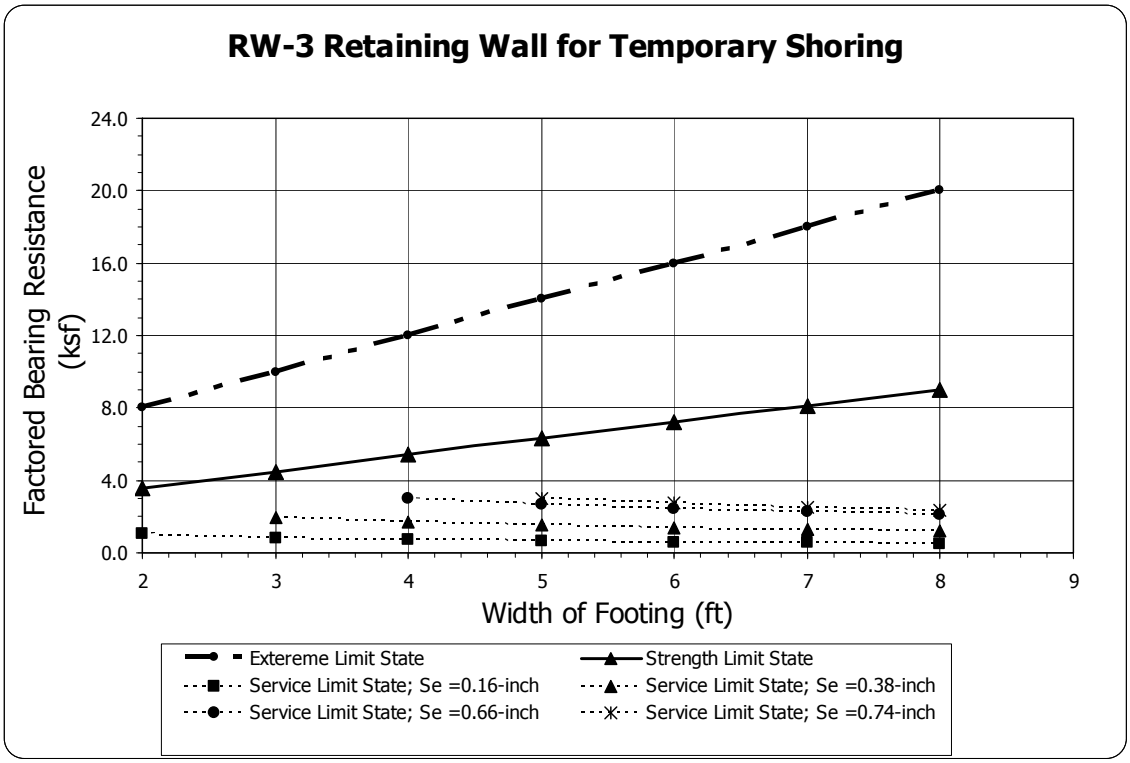

Figure1: Factored Bearing Resistance for a Footing of Length L'=L=100 ft (no eccentricity) and Depth of Embedment Df= 2.0 ft. ("Se" in legend refers to immediate settlement; L=length of footing; L'=effective length of footing).

Footing subgrades should be observed and approved prior to placement of concrete, to ascertain that footings are placed on suitable bearing soils as recommended herein. Footings should be excavated and concrete placed the same day in order to avoid disturbance from water or weather. Disturbance of footing subgrades by exposure to water seepage or weather conditions should be avoided. Any existing fill, disturbed, frozen, or soft subgrade soils should be removed prior to placing footing concrete. Forms may be used if necessary, but less subgrade disturbance is anticipated if excavations are made to the required dimensions and concrete placed against the soil. If footings are formed, the forms should be removed and the excavation backfilled as soon as possible. Water should not be allowed to pond along the outside of footings for long periods of time.

4.1.3.2 Temporary Wire Wall (MSE) System

Alternatively, a temporary wire wall (MSE) system consisting of steel wire facing with geotextile in the wall face and geogrid soil reinforcement installed horizontally in the wall backfill may be used for the temporary shoring. The wire facing consists of L-shaped baskets typically 18 inches high and 18 inches deep. Galvanized steel wire is typically used for permanent structures and black steel for temporary walls. A typical temporary wire wall system in presented in Figure 2. The geotextile is a UV stabilized woven or nonwoven filter fabric used to retain the backfill placed in the wall face. Long Term Design Strengths (LTDS) and length of the geogrids should be selected based on the external and internal stability of the wall by the contractor.

For the MSE walls, backfill placed in the reinforced zone (i.e., reinforced backfill) should consist of select Type I material in accordance with the requirement of Section 207 of the VDOT Road and Bridge Specifications. The minimum embedment for MSE walls should be 2.5 feet or one-tenth of the height of the wall (H/10), whichever is greater, below the final grade in front of the wall. Recommended soil design parameters for retaining wall backfill materials are presented below in Table 12.

Table 12: Recommended Soil Design Parameters for MSE Walls

Recommended Soil Design Parameters for MSE Walls				
Material	**Description**	**γ (pcf)**	**Φ (degrees)**	**c (psf)**
Foundation Soils	Residual Soil or New Compacted Fill	120	28	0
Retained Fill	New Compacted Fill	120	30	0
Reinforced Backfill	Select Material (Type I)	135	38	0

Notes:
1. Minimum required wall embedment, excluding leveling pad = 2.5 ft or one-tenth of the height of the wall (H/10), whichever is greater, below the final grade in front of the wall.
2. Minimum required soil reinforcement length = 70% of total wall height.
3. Key to abbreviations: N/A = not applicable; **γ** = Moist Unit Weight, **ϕ** = Friction Angle, and **c** = Cohesion.
4. Design parameters may be revised by the geotechnical engineer if additional information is obtained regarding borrow material to be used as backfill.

We have computed the bearing resistance for the proposed MSE walls when supported on suitable natural soil or new compacted fill. The factored bearing resistance at the strength limit state is calculated using a resistance factor of 0.45. A summary of factored resistance for service, strength, and extreme event limits, are presented below in Table 13.

Table 13: Bearing Resistance for MSE Wall

Location	Service Limit State Factored Resistance Φ_b = 1.00 (ksf)	Strength Limit State Factored Resistance Φ_b = 0.65 (ksf)*	Extreme Event Limit State Factored Resistance Φ_b = 1.00 (ksf)	Expected Footing Subgrade Bearing Material	Coefficient of Friction
Between Stations 15+50 and 18+50	3.0	15	23.0	CL	0.35

*For 1-inch elastic settlement

Factored resistance and settlement of MSE retaining wall footings are calculated using Equations 10.6.3.1.3-1 and 10.6.2.4.2-1, respectively, of the AASHTO LRFD Bridge Design Specifications. Maximum elastic settlement of about 1.10 inch was calculated. Bearing resistance and elastic settlement calculations are presented in Appendix D of this report.

We believe that a drainage system will not be required behind the temporary MSE wall as the front of the wall is free draining. The reinforced backfill behind the wall should be free-draining backfill (e.g., AASHTO or VDOT No. 57 crushed stone). As part of the drainage control for the retaining walls, all proposed or existing slopes above and below the retaining walls should be maintained and protected against erosion.

4.2 Pavements

4.2.1 Existing Pavements

A total of four pavement cores were collected from the existing pavement during the Phase I and Phase II field investigations. Table 13A below presents a summary of the existing pavement thicknesses. Pavement core pictures are presented in Appendix A and Appendix F.

The existing northern and southern approach pavements in the vicinity of the existing bridge are in good condition; however, there is a separation crack where the northern approach meets the bridge deck. The VDOT Staunton district office provided us the information regarding the past maintenance history for Route 340. In 1978, 0.2 inches of slurry Seal-Type B was used to protect the pavement. The most recent pavement maintenance for Route 340 was completed in 2007, where the pavement was resurfaced with 1.5 inches of SM-12.5A.

Table 13A: Existing Pavement Thickness

Pavement Core Location	Asphalt Thickness (inch)	Subbase Thickness (inch)	Subbase Material Type
R-1	9.75	6.0	Crushed Stone
R-2	10.0	8.0	Crushed Stone
C-1*	22.0	8.0	Crushed Stone
C-3*	18.0	12.0	Crushed Stone

* Pavement core collected during Phase I investigation.

4.2.2 Traffic Analysis Summary

A pavement design was performed using the traffic data and information provided in the Field Review and Scoping Report dated November 3, 2010 by the VDOT Project Management Office. Based on the traffic data, the proposed roadway is classified as a high volume secondary route. The proposed bridge and approaches will be two lanes, one 12-foot wide lane in each direction, with 8-foot wide shoulders. We have used the traffic data presented below in Table 14 for the pavement section design.

Table 14: Pavement Section Design

Traffic Data	Value
Highway Classification	Undivided Primary - Rural*
Design Years	20*
Two Way ADT (2017)	5,838***
Percent Trucks (Class 5 or Greater)	4.8**
Traffic Growth Rate (%)	1.3***
Number of Lanes in Design Direction	1*
Average Initial Truck factor (ESALs/Truck)	1.05*

* Values from VDOT Pavement Design Manual
** Information provided by Client
*** Value calculated from information provided by Client

Based on traffic data presented in Table 14 above, design ESALs of 1,218,368 were developed for the design lane for a 20-year service life.

4.2.3 Pavement Design Recommendations

Pavement sections were designed based on the 1993 AASHTO Guide for Design of Pavement Structures and Section 604.02 of VDOT Manual of Instructions Chapter VI Pavement Evaluation and Design. As indicated in Table 2 of this report, the laboratory CBR test conducted on soil samples obtained from test

borings R-1, B-1, and R-3 have values of 8.3, 4.2, and 4.1 percent, respectively. However, a design CBR value was obtained by reducing the lowest CBR value by 2/3, and a CBR of 2.7 percent was used for the pavement design. Hence, a design roadbed soil resilient modulus of 4,100 psi is used for the pavement design. Other design parameters used in the AASHTO Design Equation for the flexible pavement are presented below in Table 15.

Table 15: Design Values for the Flexible Pavement

Design Parameter	Design Value – Flexible Pavements
Initial Serviceability	4.2
Terminal Serviceability	2.8
Standard Deviation	0.49
Reliability	85%

Table 16 below presents the recommended flexible pavement section for the approaches of the proposed bridge. Pavement design calculations are presented in Appendix D of this report.

Table 16: Recommended Flexible Pavement Section – Mainline and Shoulder

Flexible Pavement Layer
165 lbs/sq. yd. Asphalt Concrete, Type SM-9.5A
5.0-inch Asphalt Concrete Base Course, Type BM-25.0A
8.0-inch Aggregate Base Material, Type I, No. 21-B
10.0-inch Select Material

Proper drainage is imperative in the design and construction of flexible pavements. The aggregate base material, Type I, size No. 21-B should be daylighted to provide for positive lateral drainage. Depending on the bridge profile, a transverse cross-drain (CD-2) may also be placed at the bridge approaches. The roadway shoulder or adjacent ground should be graded so that surface drainage runs away from the pavement and does not stand on the pavement's edge. The overall pavement design should also include diversion structures for collecting surface runoff and to limit excessive ponding on paved surfaces.

Construction loading conditions may be more severe than post-construction conditions and typically occurs prior to placement of the total pavement sections. Construction traffic activity on partially constructed pavement sections may result in subgrade and pavement failures due to the reduced support qualities of a partial section and the relatively heavy loads associated with construction traffic. Accordingly, consideration should be given to the construction of designated haul roads where the thickness of the granular subbase and/or asphalt base course has been increased to account for the heavier-loaded construction traffic. We suggest that placement of the asphalt surface course not occur until all the major construction has been completed for pavement areas subjected to construction traffic.

4.2.4 Temporary Pavement Section

Temporary bridge approaches will be required for the proposed construction. A temporary asphalt pavement section is presented below in Table 17 below based on the assumption that the design life for the temporary asphalt pavement is 2 years and that all other design parameters used in the AASHTO Design Equation for the permanent flexible pavement remain the same. Temporary pavement design calculations are presented in Appendix D of this report.

Table 17: Recommended Flexible Pavement Section – Temporary Pavement

Flexible Pavement Layer
220 lbs/sq. yd. Asphalt Concrete, Type IM-19.0A
2.5-inch Asphalt Concrete Base Course, Type BM-25.0A
6.0-inch Aggregate Base Material Type I, No. 21-B
6-0-inch Select Material

4.2.5 Pavement Sawcuts

Pavement sawcuts will be required at the project limits. Asphalt thicknesses of between approximately 8 and 11.5 inches were measured at the pavement cores and test borings. Full-depth sawcuts will be required where existing and proposed pavements join to create a clean, vertical joint for quality construction. Existing pavements along mainline and connectors shall be milled to a depth of 1.5 inches for a minimum of 5 feet distance beyond the sawcut.

4.3 Earthwork

4.3.1 General

Fill will be required for the proposed roadway construction. All earthwork procedures should conform to Section 303 of the VDOT Road and Bridge Specifications. Unsuitable existing fill, soft or loose natural soils, organic material, etc. should be stripped to approved subgrades as determined by the geotechnical engineer. Topsoil depths presented on the test borings herein should not be considered as stripping depths, as topsoil depths may vary widely across the site. Stripping depths will probably extend to greater depths than the topsoil depths indicated herein due to the presence of minor amounts of organics, roots, and other surficial materials that will require removal as a part of the stripping operations. In addition, seasonal soil moisture variations can affect stripping depths. In general, less stripping may occur during summer months when drier weather conditions can be expected. The actual depth of stripping necessary to provide a suitable base for placement and compaction of earthwork may include topsoil and other soft surficial layers with or without organic matter. All subgrades should be proofrolled with a minimum 20 ton, loaded dump truck or suitable rubber tire construction equipment approved by the geotechnical engineer, prior to the placement of new fill.

If soils with CBR value less than 4, soft or loose soils, and CH, MH, OL, OH soils are encountered within 3 feet of pavement subgrades, removal and replacement of these unsuitable soils with properly compacted material with a minimum CBR value of 4 are recommended to limit potential total and differential settlement of structures. A summary of the locations of unsuitable soils at the test boring locations is presented as Table C-3 in Appendix C of this report, and it is assumed that the unsuitable soils extend across the entire roadway width at the station numbers shown in Table C-3.

Fill embankments with a maximum height of about 40 to 50 feet will be required to reach the proposed roadway subgrade. The embankment shall be placed in successive uniform layers not more than 8 inches in thickness before compaction over the entire roadbed area. Each layer shall be compacted within a tolerance of ±20 percent of optimum moisture content to a density of at least 95 percent of the theoretical maximum density. Material having a moisture content above optimum by more than 30 percent shall not be placed on a previously placed layer for drying unless it is shown that the layer will not become saturated by downward migration of moisture in the material.

Existing slopes should be benched in accordance to Section 303.04(h) of VDOT R&B Specifications. "Existing slopes shall be continuously benched where embankments are constructed one-half width at a time; against slopes of existing embankments or hillsides; or across existing embankments, hillsides, and depressions at a skew angle of 30 degrees or more or the existing slopes are steeper than 4:1. For slopes

steeper than 4:1 but not steeper than 1.5:1, the bench shall be at least 6 feet in width. For slopes steeper than 1.5:1 but less than 0.5:1, the bench shall be at least 4 feet in width. Benching shall consist of a series of horizontal cuts beginning at the intersection with the original ground and continuing at each vertical intersection of the previous cut. Material removed during benching operations shall be placed and compacted as embankment material."

Pursuant to Section 303.04(h) of the VDOT Road and Bridge Specifications, all borrow material and fill material for the embankments for this project shall have a minimum CBR of 5, shall not include USCS CH or MH soils unless stabilized with lime (per VTM-11) or cement (per VTM-72), and shall be in accordance with Section 303.04(h) of the 2007 Road and Bridge Specifications or as approved by the District Materials Engineer. Materials used for compacted fill for support of the roadway should consist of soils classifying CL, ML, SC, SM, SP, SW, GC, GM, GP, or GW per ASTM D-2487, with a minimum CBR value of 5, and liquid limit and plasticity index less than 45 and 25, respectively. Materials used for compacted fill for support of the approach slabs within 100 feet from the face of the bridge abutments should consist of VDOT Select material Type I with a minimum CBR value of 30. Fill material within 3 feet depth of the pavement subgrade should have a minimum CBR value of 5.

Based on the test borings and soil laboratory test results, it is expected that minor portions of the soils excavated at the site will be suitable for re-use as fill based on soil classification. However, drying of excavated soils by spreading and aerating may be necessary to obtain proper compaction. This may not be practical during the wet period of the year. Accordingly, earthwork operations should be planned for early Spring through late Fall, when drier weather conditions can be expected. Drying of fill materials by the use of lime may also be considered. However, in the event that lime is used, refer to the VDOT Road and Bridge Specifications for more specific details regarding the percentage of lime used and installation techniques. Individual borrow areas, both from on-site and off-site sources, should be sampled and tested to verify classification of materials prior to their use as fill.

Fill materials should not be placed on frozen or frost-heaved soils, and/or soils that have been recently subjected to precipitation. All frozen or frost-heaved soils should be removed prior to continuation of fill operations. Borrow fill materials should not contain frozen materials at the time of placement. There may be some areas of deeper subcutting for removal of soft wet soils, particularly along seasonal creeks or drainage channels on the site. Actual undercutting requirements may also depend on groundwater conditions at the time of construction.

Compaction equipment that is compatible with the soil type used for fill should be selected. Theoretically, any equipment type can be used as long as the required density is achieved; however, sheepsfoot roller equipment are best suited for fine-grained soils and vibratory smooth drum rollers are best suited for granular soils. Ideally, a smooth drum roller should be used for sealing the surface soils at the end of the day or prior to upcoming rain events. In addition, compaction equipment used adjacent to wingwalls should be selected so as to not impose undesirable surcharge on walls. All areas receiving fill should be graded to facilitate positive drainage of any water associated with precipitation and surface run-off.

After completion of compacted fill operations in pavement areas, asphalt operations should begin immediately, or the finished subgrade should be protected from exposure to inclement weather conditions. Exposure to precipitation and freeze/thaw cycles will cause the finished subgrade to soften and become excessively disturbed. If construction plans require that finished subgrades remain exposed to weather conditions after completion of fill operations, additional fill should be placed above finished grades to protect the newly placed fill. Alternatively, a budget should be established for reworking of the upper 1 to 2 feet of previously placed compacted fill.

4.4 Rock Excavation

Rock excavation may be required for this project; however, we estimate that the majority of excavations to reach proposed footing elevation and pavement grades will be feasible using normal earth moving equipment. The undercutting of rock should be performed in accordance with the VDOT standard STD RU-

1 "Standard Methods of Undercutting Rocks". Table 18 below presents approximate elevations at the bridge test boring locations where rock excavation may be required.

Table 18: Recommended Elevations for Rock Excavation

Test Boring No.	Estimated Elevation Where Rock Excavation Methods May be Required (ft)	Test Boring No.	Estimated Elevation Where Rock Excavation Methods May be Required (ft)
B-1	954	BR-5	895
BR-1	904	BR-6	897
BR-2	895	BR-7	901
BR-3	896	BR-8	921
BR-4	896	BR-9	927

The elevations given above are based upon the use of normal earth excavation equipment including up to a Caterpillar 330 hydraulic backhoe, or equivalent, for mass excavation. Project specifications should include the following as a definition of rock excavation for mass excavation: "Rock is defined as any material which cannot be dislodged by a Caterpillar 330 hydraulic backhoe, or equivalent, without the use of hoe-ramming or blasting. This classification does not include material such as loose rock, concrete or other materials that can be removed by means other than hoe-ramming or blasting, but which for reasons of economy in excavating, the contractor chooses to remove by hoe-ramming or blasting."

4.5 Slope and Global Stability

An analysis of the estimated critical slopes has been completed to evaluate the proposed grading. The critical slope sections analyzed are designated Sections A-A', B-B', C-C, D-D', and E-E' as shown on Figures 3 and 4 in Appendix A. We have also analyzed the Abutment A slope based on the slope geometry provided on the bridge plan sheet.

4.5.1 Soil Shear Strength Parameters

Soil strength parameters used in the stability analysis were assumed based on soil laboratory testing, VDOT Staunton District's Geotechnical Design Parameters for Retaining Walls, Sound Barrier Walls and Non-Critical slopes, and our experience with similar soil materials and geologic conditions, and are considered a conservative estimation of the actual shear strength characteristics. A summary of the shear strength parameters used in the stability analyses are presented in Table 19.

Table 19: Soil Design Parameters

Material Description	γ (pcf)	Short Term Analysis		Long Term Analysis	
		Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Cohesion, c (psf)	Friction Angle, ϕ (degrees)
New Compacted Fill	120	1500	0	0	30
Existing Fill (Stratum A)	120	1500	0	0	28
Stratum B1 (Residual Dolostone)	120	1000	0	0	32
Stratum B2 (Decomposed Dolostone)	130	1000	0	0	36

Material Description	γ (pcf)	Short Term Analysis		Long Term Analysis	
		Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Cohesion, c (psf)	Friction Angle, ϕ (degrees)
Stratum B3 (Dolostone Rock)	140	0	40	0	40
Class II Riprap	140	0	40	0	40

Key to abbreviations: **γ** = Moist Unit Weight, **ϕ** = Friction Angle, and **c** = Cohesion

4.5.2 Slope and Global Stability Analysis

Stability calculations were made using the Modified Bishop Method for circular failure surfaces using the GSTABL software. This computer program has been used to generate potential failure surfaces with randomly selected radii and centers. The stability analysis was performed assuming static loading and drained soil conditions. A search for the most critical potential failure surfaces occurring within earth materials in the proposed slopes were performed using circular failure modes as calculated by the Modified Bishop Method. A factor of safety of 1.5 is considered satisfactory for the proposed slopes for both short-term and long-term conditions. A factor of safety 1.3 is considered satisfactory for temporary shoring. Slope stability calculations are presented in Appendix E and are summarized below in Table 20.

Table 20: Stability Analysis of Proposed Slopes

Slope Stability Section	Slope Details	Factor of Safety		Remarks
		Short Term	Long Term	
A-A′ (west slope)	Proposed 2H:1V Fill Slope; Height of slope =32.5 feet	2.05	1.34	Not Satisfactory
A-A′ (east slope)	Proposed 2H:1V Fill Slope; Height of slope = 49 feet	1.42	1.06	Not Satisfactory
A-A′ (east slope)	Temporary Shoring with RW-3 wall or MSE wall; Height of slope = 49 feet	1.45	--	Satisfactory
A-A′ (east slope)	Temporary Shoring with RW-3 wall or MSE wall; Height of slope = 12 feet	4.75	--	Satisfactory
B-B′	2H:1V Fill Slope; Height of slope = 10 feet	4.80	1.44	Satisfactory
C-C′ (west slope)	2H:1V Cut Slope; Height of slope = 7 feet	3.41	2.56	Satisfactory
C-C′ (east slope)	2H:1V Cut Slope; Height of slope = 9 feet	3.15	1.75	Satisfactory
D-D′	2H:1V Fill Slope; Height of slope = 19 feet	2.24	1.19	Not Satisfactory

Slope Stability Section	Slope Details	Factor of Safety		Remarks
		Short Term	Long Term	
E-E'	2H:1V Cut Slope; Height of slope = 17.5 feet	2.91	1.94	Satisfactory
Abutment Slope	1.5H:1V Abutment A supported on H-pile	3.08	0.94	Not Satisfactory

The stability of these slopes that are designated non-satisfactory can be improved with various stabilization measures. The results of additional slope stability analyses with the various stabilization measures are presented below in Table 21. Please note that the slope stabilizing measures presented herein will be required only between approximately Stations 17+50 and 18+50 for Section A-A', and from station 21+00 to 21+50 for Section D-D'.

Table 21: Stability Analysis of Proposed Slopes with Slope Stabilization

Slope Stability Section	Slope Details	Factor of Safety		Remarks
		Short Term	Long Term	
Section A-A': West Slope				
Option 1: Flattening of Slope A-A' (west slope)	2.5H:1V Fill Slope; Height of slope =32.5 feet	2.20	1.65	Satisfactory
Option 2: 2H:1V with Geogrids A-A' (west slope)	2.0H:1V Fill Slope; 3 layers of geogrids 35 feet long at 2 feet vertical distance with LTDS = 2625 lb/ft; Height of slope =32.5 feet	2.05	1.51	Satisfactory
Section A-A': East Slope				
Option 1: Flattening of Slope A-A' (east slope)	2.75H:1V Fill Slope Height of slope = 49 feet	1.93	1.57	Satisfactory
Option 2: Stabilizing Pile A-A' (east slope)	2H:1V Fill Slope; with a 36 feet deep stabilizing pile; Height of slope = 49 feet	1.65	1.50	Satisfactory
Section D-D'				
Option: 2H:1V with Geogrids	2.0H:1V Fill Slope; 3 layers of geogrids 40 feet long at 2 feet vertical distance with LTDS = 2625 lb/ft; Height of slope =19.0 feet	2.24	1.52	Satisfactory
Abutment A				
Abutment A Slope	Geogrids 30 feet long or up to H-pile at 3 feet vertical distance with LTDS = 2625 lb/ft;	--	1.51	Satisfactory

For structural analysis and design of the slope stabilization with H-piles, we have used a triangular distribution of unbalanced lateral forces, i.e., linear increase in unbalanced lateral forces with depth, with zero unbalanced lateral force at the top of the pile and maximum at the location where the corresponding

failure surface intersects the stabilizing H-pile. We have used the computer software program LPile V2013 to determine the maximum deflection and to verify the H-pile cross-section for the unbalanced forces. Soil parameters used in the LPile program for lateral load analyses are presented below in Table 22.

Table 22: Soil Parameters for LPile Analysis

Soil and Rock Layer Information	Subgrade Modulus, k (pci)	Unit Weight (pcf)	Angle of Internal Friction (degree)
Sand (Reese)	30	120	30
Sand (Reese)	75	120	32
Sand (Reese)	150	130	36
Sand (Reese)	124,000	140	40

Printout of lateral capacity calculations and plots of moment, shear, and displacement are presented in Appendix D of this report. Based on the calculated maximum applied moments and shears, a 12x53 H-Pile section with 3.0 feet center to center spacing is recommended for the slope stabilization.

4.5.4 Slope Design - General

Slope gradients must be in accordance with the OSHA regulations. According to the project plans and cross-sections provided to us, the majority of embankments will be less than 20 feet in height and constructed over level ground. Generally, cut and fill slopes in rock and soil should be no steeper than 2H:1V and 3H:1V, respectively, unless supported by engineering analyses based on site specific field investigation and site specific laboratory strength testing. Slopes steeper than 2H:1V must be approved by VDOT.

5.0 General Limitations

Recommendations contained in this report are based upon the data obtained from the relatively limited number of test borings. This report does not reflect conditions that may occur between the points investigated, or between sampling intervals in test borings. The nature and extent of variations between test borings and sampling intervals may not become evident until the course of construction. Therefore, it is essential that on-site observations of subgrade conditions be performed during the construction period to determine if re-evaluation of the recommendations in this report must be made. It is critical to the successful completion of this project that GeoConcepts be retained during construction to observe the implementation of the recommendations provided herein.

This report has been prepared to aid in the evaluation of the site and to assist your office and the design professionals in the design of this project. It is intended for use with regard to the specific project as described herein. Changes in proposed construction, grading plans, etc., should be brought to our attention so that we may determine any effect on the recommendations presented herein.

This report should be made available to bidders prior to submitting their proposals to supply them with facts relative to the subsurface conditions revealed by our investigation and the results of analyses and studies that have been performed for this project. In addition, this report should be given to the successful contractor and subcontractors for their information only.

This report was prepared in accordance with generally accepted geotechnical engineering practices. No warranties, expressed or implied, are made as to the professional services included in this report.

We appreciate the opportunity to be of service for this project. Please contact the undersigned if you require clarification of any aspect of this report.

Sincerely,

GEOCONCEPTS ENGINEERING, INC.

Sushant Upadhyaya, PhD, PE, PMP
Senior Engineer

COMMONWEALTH OF VIRGINIA
PAUL E. BURKART
Lic. No. 021556
PROFESSIONAL ENGINEER

Paul E. Burkart, PE
Principal

JA/CM/SU/PEB/clm/shm
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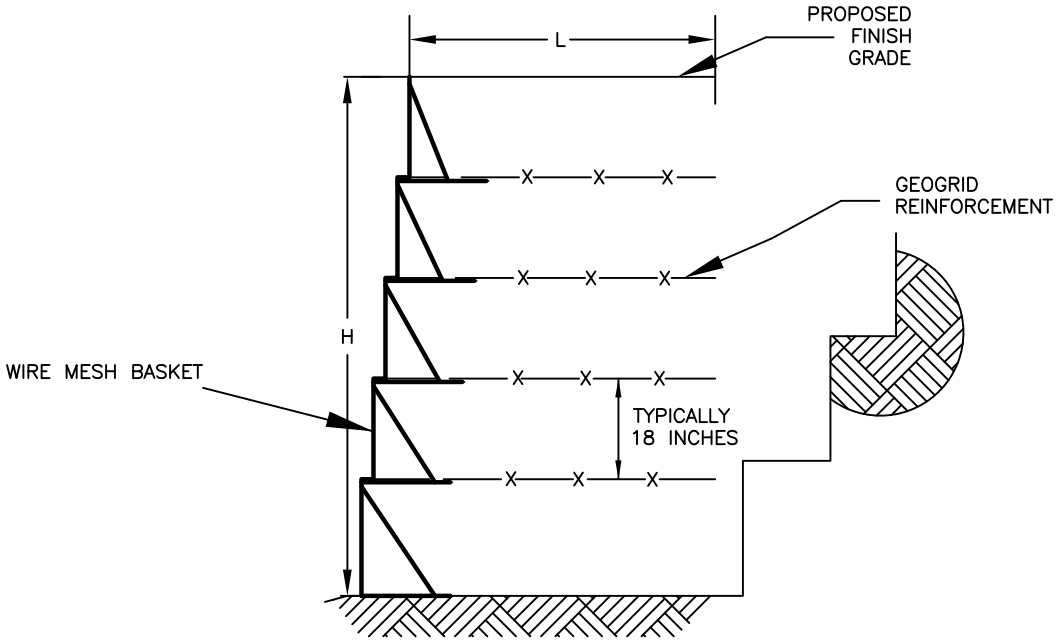
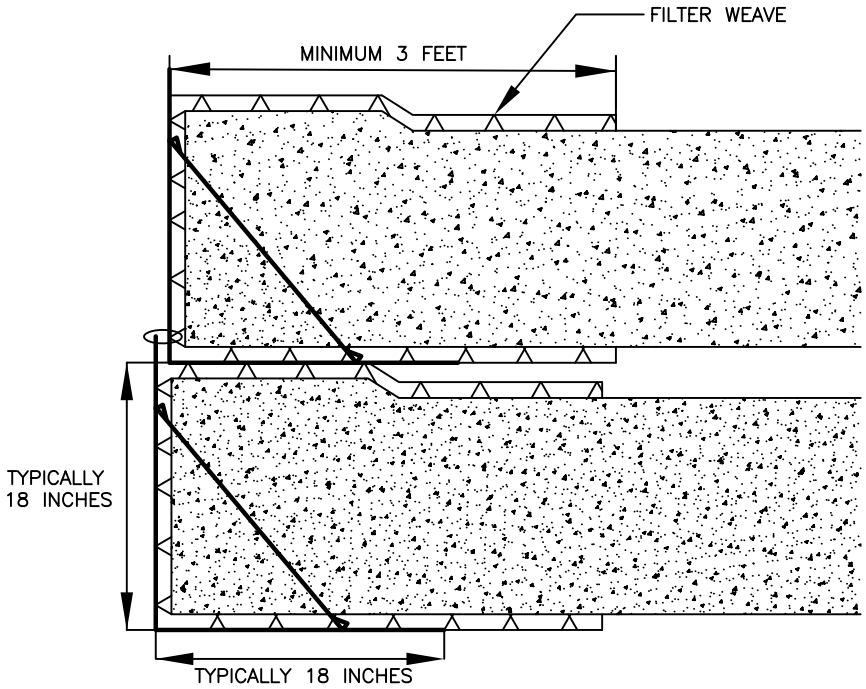
ROUTE 340 OVER CUB RUN
PAGE COUNTY, VIRGINIA

SITE VICINITY MAP		Scale: N.T.S	Fig. 1
Date: JUNE 2015	Checked By: P.E.B.	Project No.: 13004.01	



TYPICAL CROSS SECTION OF WIRE WALL SYSTEM–TEMPORARY



TYPICAL DETAIL OF GEOTEXTILE AT WALL FACE

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ROUTE 340 OVER CUB RUN
PAGE COUNTY, VIRGINIA

TEMPORARY WIRE WALL (MSE) SYSTEM			Scale: N.T.S.	Fig. 2
Date: JUNE 2015	Drawn By: L.N.B.	Checked By: P.E.B.	Project No.: 13004.01	

Appendix A
Subsurface Investigation

Subsurface Investigation Procedures (1 page)

VDOT Unified Soil Classification and Symbols Chart (1 page)

VDOT Material and Sample Symbols List (2 pages)

Test Boring Notes (1 page)

Test Boring Logs (19 pages)

Rock Core Photographs (7 pages)

Pavement Core Photographs (2 pages)

Boring Location Plans, Figures 3 and 4 (2 pages)

Subsurface Investigation Procedures

1. Test Borings – Hollow Stem Augers

The borings are advanced by turning an auger with a center opening of 3-¼ inches. A plug device blocks off the center opening while augers are advanced. Cuttings are brought to the surface by the auger flights. Sampling is performed through the center opening in the hollow stem auger, by standard methods, after removal of the plug. Usually, no water is introduced into the boring using this procedure.

2. Standard Penetration Tests

Standard penetration tests are performed by driving a 2-inch O.D., 1-⅜ inch I.D. sampling spoon with a 140-pound hammer falling 30 inches, according to ASTM D-1586. After an initial 6 inches penetration to assure the sampling spoon is in undisturbed material, the number of blows required to drive the sampler an additional 12 inches is generally taken as the N value. In the event 30 or more blows are required to drive the sampling spoon the initial 6 inch interval, the sampling spoon is driven to a total penetration resistance of 100 blows or 18 inches, whichever occurs first. The sampling operation is terminated after a total of 100 hammer blows and the depth of penetration is recorded.

3. Rock Core Drilling

Rock is core drilled using NQ size core bits set with carbide steel or diamond, depending upon the rock texture. The bit is fitted onto a double tube swivel-type core barrel in which an exterior tube and bit rotate, and an interior barrel remains stationary to receive the rock core. Water is circulated between the barrels and across the bit face to cool the core bit and to flush away cuttings.

4. Test Boring Stakeout

The test boring stakeout was provided by Dewberry.

UNIFIED SOIL CLASSIFICATION SYSTEM

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS
(more than 50% of material is larger than No. 200 sieve size.)

GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)	
	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)	
	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)	
	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	
	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures

FINE-GRAINED SOILS
(50% or more of material is smaller than No. 200 sieve size.)

SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

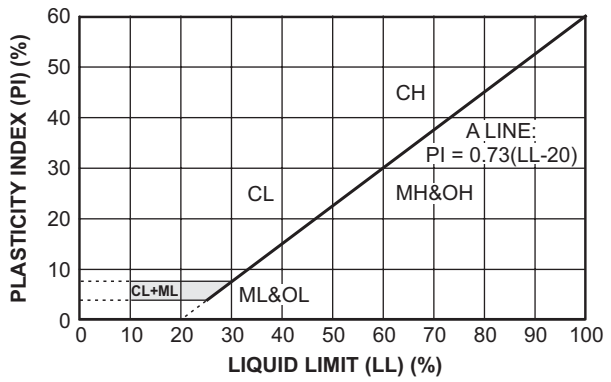
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent ..... GW, GP, SW, SP
More than 12 percent ..... GM, GC, SM, SC
5 to 12 percent ..... Borderline cases requiring dual symbols

PLASTICITY CHART



MATERIAL AND SAMPLE SYMBOLS LIST

Pavement/Soils

ASPH- ASPHALT PVT
GP - Poorly-graded Gravel
MH - Elastic Silt
SC - Clayey Sand
CH - Fat Clay
GP-GC
MH/CH
SM - Silty Sand
CL - Lean Clay
GP-GM
MH/ML
SP - Poorly-Graded Sand
CL-ML
GW - Well-Graded Gravel
MH/SM
SP-SC
CONC- CONCRETE PVT
GW-GC
ML - Silt
SP-SM
FL -Fill
GW-GM
ML/CL
SW - Well-Graded Sand
GC - Clayey Gravel
GM/GP
ML/GM
SW-SC
GC-GM
GM/ML
ML/SM
GM - Silty Gravel
GM/SM
SW-SM

Sedimentary Rocks

CGL - Conglomerate
SE - Shell Bed
CLST - Cherty Limestone
SHL - Shale
COL - Coal
SLS - Siltstone
MST Mudstone
SST - Sandstone
GWK - Graywacke
SST-SHL - Interbedded Sandstone/Shale
LST - Limestone
SST-SLS - Interbedded Sandstone/Siltstone
UCY - Underclay
SHLS-Shaly Limestone
SHDS Shaly Dolostone
MSH Silty Shale
CHK Chalk
SSHL Sandy Shale

Igneous Rocks

AND - Andesite
BST - Basalt
DBS - Diabase
DRT - Diorite
GBR - Gabbro
GRD - Granodiorite
GRN Granite
POR - Porphyry
RHY - Rhyolite

Metamorphic Rocks

GGE - Gouge
GNS - Gneiss
MYL - Mylonite
PHY - Phyllite
SCH - Schist
SLT - Slate

Misc.

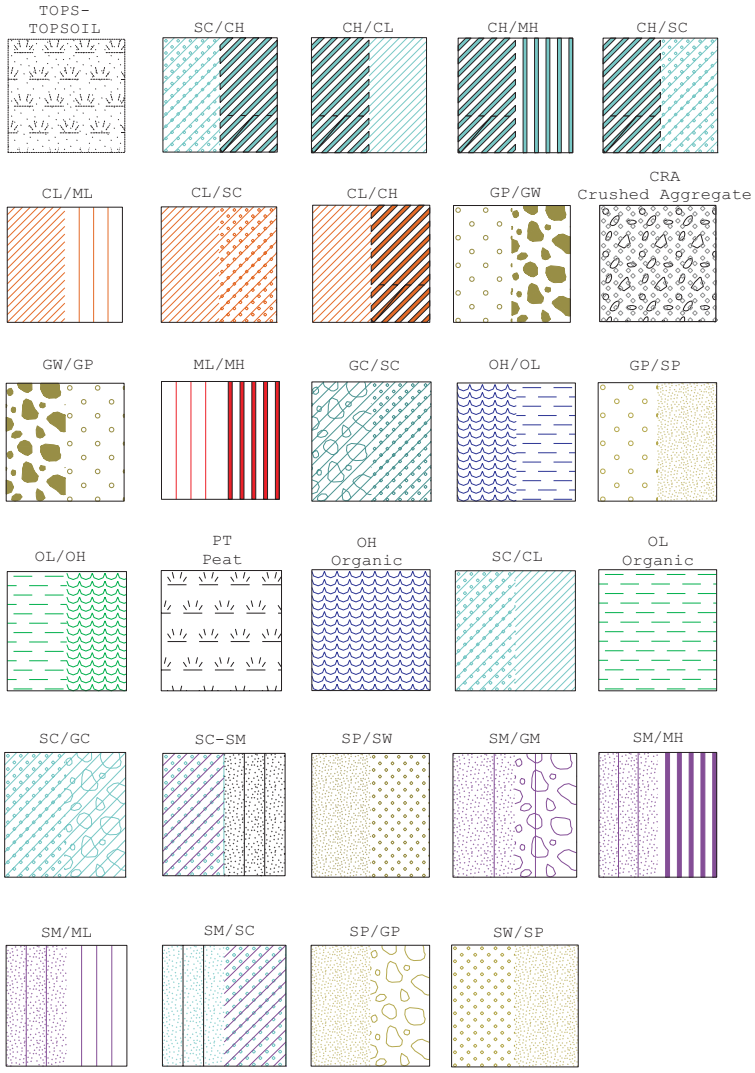
CAV - Cavity
HWR Highly Weathered Rock
BRC - Breccia

Sampling

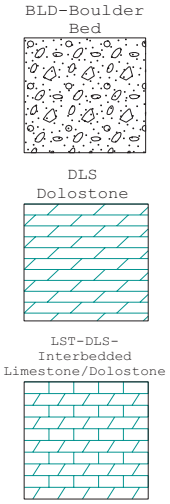
SPT
Core
Auger
Vane
Undisturbed
Grab
No Recovery
Other

MATERIAL AND SAMPLE SYMBOLS LIST

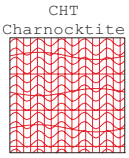
Pavement/Soils



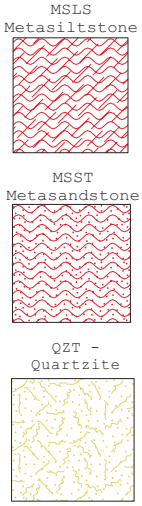
Sedimentary Rocks



Igneous Rocks



Metamorphic Rocks



Sampling

Test Boring Notes

1. Classification of soil is by visual inspection and is in accordance with the Unified Soil Classification System.

2. Estimated groundwater levels are indicated on the logs. These are only estimates from available data and may vary with precipitation, porosity of soil, site topography, etc.

3. Sampling data presents standard penetrations for 6-inch intervals or as indicated with graphic representations adjacent to the sampling data. Where undisturbed tube samples are taken, they are designated "Shelby Tube" on the test boring log.

4. The logs and related information depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at the test locations. Also, the passage of time may result in a change in the subsurface conditions at the test locations.

5. The stratification lines represent the approximate boundary between soil types as determined in the sampling operation. Some variation may be expected vertically between samples taken. The soil profile, groundwater level observations and penetration resistances presented on the logs have been made with reasonable care and accuracy and must be considered only an approximate representation of subsurface conditions to be encountered at the particular location.

6. Intermediate Geomaterial (IGM) is defined as residual earth material with a penetration resistance greater than 50 blows per 6-inches. Spoon refusal at the surface of rock, boulders, or obstructions is defined as a penetration resistance of 50 blows for 0 inches penetration. Auger refusal is taken as the depth at which further penetration of the auger is not possible without risking significant damage to the drilling equipment.

7. Rock Quality Designation (RQD) represents the sum of cores recovered with lengths of 4-inches or longer, divided by the total length of rock core, expressed in percentage.

Virginia Department of Transportation

PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: BRIDGE

BR-1
PAGE 1 OF 1

STATION: 18+50 OFFSET: 21.2 ft. Left
LATITUDE: 38.553583° N LONGITUDE: -78.606639° W
SURFACE ELEVATION: 910.5 ft COORD. DATUM: NAD 83

Date(s) Drilled: 09/15/2014 - 09/15/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
	910	6 8 6 5	100		2						0.0 / 910.5 Topsoil = 0.25ft. **TOPS**	23	9	10.4
		4 7 9 7	100		4						0.25 / 910.25 *Alluvial*, orange - brown, **f-m**, CLAYEY SAND, medium dense, moist **SC** 2.0 / 908.5 SAME: brown, **f**, with gravel			5.7
5	905	3 3 16 50/4"	94		5.8									1.2
		50/0"			6.5						6.4 / 904.1 Auger and spoon refusal at 6.5 ft. 6.5 / 904.0 Slightly weathered, hard, dark gray, DOLOSTONE, highly fractured to moderately fractured, calcite veins along fractures **DLS**			
						94	78				8.6 / 901.9 void or cavity (lost water) between 8.6 to 8.9 ft.			
10	900				11.5						8.9 / 901.6 Slightly weathered, hard, dark gray, DOLOSTONE, highly fractured to moderately fractured, calcite veins along fractures **DLS**			
						100	96							
15	895				16.5						16.5 / 894.0 BOTTOM OF BORING AT 16.5 FT.			

REMARKS: Cave-in Depth at 5.2 ft.
Offset 3.5 ft. north due to trees.

PAGE 1 OF 1
BR-1

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Virginia Department of Transportation

PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: BRIDGE

BR-2
PAGE 1 OF 1

STATION: 19+25 OFFSET: 23.4 ft. Left
LATITUDE: 38.553778° N LONGITUDE: -78.606556° W
SURFACE ELEVATION: 902.8 ft COORD. DATUM: NAD 83

Date(s) Drilled: 09/15/2014 - 09/15/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
STABILIZED AT 4.0 ft

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	DIP °: STRATA	DIP °: JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		4 50/2"	71		0.7						0.0 / 902.8 Topsoil = 0.25ft. **TOPS**			17.3
					2						0.25 / 902.55 *Alluvial*, orange - brown, **f**, SILTY SAND, medium dense, moist **SM**			
	900	8 12 13 21	59											12.3
					4						4.0 / 898.8 SAME: dense			
5		6 26 16 10	50											4.4
		13 50/6	50		6 7						6.0 / 896.8 *Alluvial*, tan, **f-c**, SILTY GRAVEL WITH SAND, very dense, moist **GM**			6.3
	895	50/0			7.5						7.4 / 895.4 Auger and spoon refusal at 7.5 ft. 7.5 / 895.3 cored through cobbles and boulders			
10						0	0							
	890				13.5						13.5 / 889.3 Slightly weathered, hard, dark gray, DOLOSTONE, slightly fractured **DLS**			
15						100	94							
	885				18.5									
20						100	92							
	880				23.5						BOTTOM OF BORING AT 23.5 FT.			

REMARKS: Cave-in Depth at 5.6 ft.
Offset 5.0 ft. south due to boulders along cub run.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: BRIDGE

BR-3

STATION: 19+25 | OFFSET: 23.1 ft. Right
LATITUDE: 38.553750° N | LONGITUDE: -78.606471° W
SURFACE ELEVATION: 901.0 ft | COORD. DATUM: NAD 83

Date(s) Drilled: 09/15/2014 - 09/15/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
STABILIZED AT 3.0 ft

FIELD DATA / LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
	900	5 5 8 18	75		2						0.0 / 901.0 Topsoil = 0.25ft. **TOPS** 0.25 / 900.75 *Alluvial*, orange - brown, **f-m**, SILTY SAND, medium dense, moist **SM**			10.8
		20 33 33 50/4"	56		3.8						2.0 / 899.0 SAME: tan, **f-c**, with gravel, very dense			1.7
5		38 43 50/6	67		4 5.5									2.1
	895										Auger and spoon refusal at 5.5 ft. 5.5 / 895.5 cored through cobbles and boulders from 5.5 to 13.0 ft.			
					9									
10	890					0	0							
					13						13.0 / 888.0 Slightly weathered, hard, dark gray, DOLOSTONE, slightly fractured, calcite veins along fractures **DLS**			
15	885					100	98							
					18						18.0 / 883.0 SAME: unweathered to slightly weathered			
20	880					100	100							
					23						23.0 / 878.0 BOTTOM OF BORING AT 23.0 FT.			

REMARKS: Cave-in Depth: 3.4 ft.
Offset 30.0 ft. west and 7.0 ft. elevation increase due to boulders along bank.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: BRIDGE

BR-4
PAGE 1 OF 1

STATION: 19-75 | OFFSET: 23.3 ft. Right
LATITUDE: 38.553861° N | LONGITUDE: -78.606361° W
SURFACE ELEVATION: 904.7 ft | COORD. DATUM: NAD 83

Date(s) Drilled: 09/11/2014 - 09/11/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
- FIRST ENCOUNTERED AT 5.0 ft DEPTH
- STABILIZED AT 3.0 ft

FIELD DATA / LAB DATA

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS (SOIL)	SOIL RECOVERY (%)	SAMPLE LEGEND / SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		2 2 3 8	15	2						0.0 / 904.7 Topsoil = 0.25ft. **TOPS** 0.25 / 904.45 *Alluvial*, brown, **f-m**, SILTY SAND, loose, moist **SM**			24.6
		5 1 4 6	40	4						2.0 / 902.7 *Alluvial*, light brown, **f-c**, POORLY GRADED SAND WITH SILT AND GRAVEL, loose, moist **SP-SM**			13.9
5	900	7 14 50/5"	36	5.4						4.0 / 900.7 *Alluvial*, light brown, **f-c**, CLAYEY SAND WITH GRAVEL, very dense, wet **SC**	28	7	20.5
		14 27 16 17	25	6 8						6.0 / 898.7 *Alluvial*, light brown, **f-c**, POORLY GRADED SAND WITH SILT AND GRAVEL, dense, wet **SP-SM**			4.0
				8.3						Auger refusal at 8.3 ft. 8.3 / 896.4 Slightly weathered, hard, gray, DOLOSTONE, moderately fractured, calcite veins along fractures **DLS**			
10	895				100	84							
				13.3									
15	890				100	88							
				18.3						BOTTOM OF BORING AT 18.3 FT.			

REMARKS: Cave-in Depth: 4.0 ft.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: BRIDGE

BR-5

STATION: 19+75 | OFFSET: 23.3 ft. Right
LATITUDE: 38.553861° N | LONGITUDE: -78.606360° W
SURFACE ELEVATION: 903.5 ft | COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 09/11/2014 - 09/11/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
- FIRST ENCOUNTERED AT 2.0 ft DEPTH
- STABILIZED AT 1.0 ft

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		5, 6, 7, 3	25	2						0.0 / 903.5 Topsoil = 0.25ft. **TOPS**			17.7
	900	8, 3, 11, 12	15	4						0.25 / 903.25 *Alluvial*, brown, **f-m**, SILTY SAND WITH GRAVEL, medium dense, moist **SM**			10.9
5		21, 4, 5, 4	35	6						4.0 / 899.5 *Alluvial*, gray, **f-c**, POORLY GRADED SAND with silt and gravel, loose, wet **SP-SM**			7.6
		12, 21, 50/4"	71	7.4						6.0 / 897.5 *Alluvial*, brown, **f-c**, SILTY SAND WITH GRAVEL, very dense, wet **SM**			25.6
	895	50/1"	100	8 8.1						Auger and spoon refusal at 8.1 ft. 8.1 / 895.4 Slightly weathered, hard, gray, DOLOSTONE, moderately fractured, calcite veins along fractures **DLS**			29.0
10					100	92							
	890			13.1						13.1 / 890.4 SAME: slightly weathered to unweathered			
15					100	100							
				18.1						18.1 / 885.4 BOTTOM OF BORING AT 18.1 FT.			

REMARKS: Cave-in Depth: 1.5 ft.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: BRIDGE

BR-6

STATION: 20+00 | OFFSET: 23.1 ft. Left
LATITUDE: 38.554028° N | LONGITUDE: -78.606472° W
SURFACE ELEVATION: 904.6 ft | COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 09/09/2014 - 09/10/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
- FIRST ENCOUNTERED AT 5.0 ft DEPTH
- STABILIZED AT 1.0 ft

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		2 4 7 10	65		2						0.0 / 904.6 Topsoil = 0.5ft. **TOPS**			11.6
		7 6 5 3	65		4						0.5 / 904.1 *Alluvial*, brown, **f-c**, SILTY SAND, medium dense, moist **SM**			
		2 2 1 1	25		6						2.0 / 902.6 *Alluvial*, brown, **f-c**, CLAYEY SAND, medium dense, moist **SC**			9.5
5	900	10 50/1" 50/0"	83		6.6 7						4.0 / 900.6 SAME: dark brown, contains organics			27.8
											6.0 / 898.6 *Alluvial*, dark brown, **f-c**, SILTY SAND, very dense, wet **SM** Auger and spoon refusal at 7.0 ft.			21.7
											7.0 / 897.6 cored through cobbles from 7.0 to 8.0 ft.			
10	895				12	100	46				8.0 / 896.6 Slightly weathered, hard, gray, DOLOSTONE, highly fractured **DLS**			
15	890				17	100	44				17.0 / 887.6 SAME: highly fractured to moderately fractured			
20	885				22	100	60				22.0 / 882.6 BOTTOM OF BORING AT 22.0 FT.			

REMARKS: Cave-in Depth: 6.0 ft.
Offset 5.0 ft. east due to overhead branches.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: BRIDGE

BR-7

STATION: 20+00 | OFFSET: 23.4 ft. Right
LATITUDE: 38.554000° N | LONGITUDE: -78.606333° W
SURFACE ELEVATION: 905.2 ft | COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 09/11/2014 - 09/11/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
STABILIZED AT 1.0 ft

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
	905	3 3 4 4	25		2						0.0 / 905.2 Topsoil = 0.5ft. **TOPS**	36	22	9.8
		2 14 9 50/1"	50		4						0.5 / 904.7 *Alluvial*, brown, **f-c**, CLAYEY SAND, loose, moist **SC** 2.0 / 903.2 SAME: contains rock fragments, medium dense			16.7
		50/0									Auger and spoon refusal at 4.0 ft.			
5	900					96	66				4.0 / 901.2 Slightly weathered, hard, gray, DOLOSTONE, highly fractured to moderately fractured, calcite veins along fractures **DLS**			
					9						9.0 / 896.2 SAME: moderately fractured			
10	895					100	100							
					14						14.0 / 891.2 BOTTOM OF BORING AT 14.0 FT.			

REMARKS: Cave-in Depth: 3.5 ft.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: BRIDGE

BR-8

STATION: 21+00 | OFFSET: 22.6 ft. Left
LATITUDE: 38.554222° N | LONGITUDE: -78.606417° W
SURFACE ELEVATION: 932.0 ft | COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 09/08/2014 - 09/08/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
STABILIZED AT 3.8 ft

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		3 4 4 3	40	2						0.0 / 932.0 Topsoil = 0.5ft. **TOPS**			10.9
	930	5 2 4 2	35	4						0.5 / 931.5 *Fill*, brown, **f**, SILTY SAND WITH GRAVEL, loose, moist **FL** 2.0 / 930.0 SAME: without gravel			12.1
5		4 5 4 5	25	6						4.0 / 928.0 *Fill*, brown, **f-m**, CLAYEY SAND, loose, moist **FL**			16.5
	925	3 12 41 50/2"	77	7.3						6.0 / 926.0 *Fill*, brown, **f-c**, SILTY GRAVEL WITH SAND, contains brick fragments, very dense, moist, **FL**			12.3
10		5 6 11 13	50	10						8.0 / 924.0 *Fill*, brown, **f-c**, CLAYEY SAND, medium dense, moist **FL**			9.0
	920	50/0"		11.5	100	100				Auger and spoon refusal at 11.5 ft. 11.5 / 920.5 Slightly weathered, hard, white and dark gray, DOLOSTONE, moderately fractured, calcite veins along fractures **DLS**			
15				16.5									
	915				100	100				16.5 / 915.5 SAME: Unweathered, very widely fractured			
20				21.5						21.5 / 910.5 BOTTOM OF BORING AT 21.5 FT.			

REMARKS: Cave-in Depth: 9.0 ft.
Offset 5.0 ft. north and 0.5 ft. elevation gain due to trees.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: BRIDGE

BR-9

STATION: 21+00 | OFFSET: 23.2 ft. Right
LATITUDE: 38.554194° N | LONGITUDE: -78.606250° W
SURFACE ELEVATION: 932.6 ft | COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 09/08/2014 - 09/08/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
DRY AFTER 48 HRS

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		9, 12, 10, 10	50	2						0.0 / 932.6 Topsoil = 0.25ft. **TOPS**			6.7
	930	12, 5, 4, 4	50	4						0.25 / 932.35 *Fill*, light gray, **f-c**, SILTY SAND WITH GRAVEL, medium dense, moist **FL**			8.5
5		3, 1, 50/4"	71	5.4						2.0 / 930.6 *Fill*, brown, **f-m**, CLAYEY SAND, loose, moist **FL**			9.9
		50/1"	100	6 6.1						4.0 / 928.6 *IGM*, gray, **f-m**, SILTY SAND, contains rock fragments, very dense, moist **SM**			2.6
	925				100	98				Auger and spoon refusal at 6.1 ft. 6.1 / 926.5 Slightly weathered, hard, gray, DOLOSTONE, slightly fractured, calcite veins along fracture **DLS**			
10				11.1						SAME: highly fractured			
	920				100	62							
15				16.1						16.1 / 916.5 BOTTOM OF BORING AT 16.1 FT.			

REMARKS: Cave-in Depth: 5.0 ft.
Offset 20.0 ft. north due to overhead powerlines.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: ROADWAY

R-1
PAGE 1 OF 1

STATION: 13+50 | OFFSET: 9.3 ft. Left
LATITUDE: 38.552250° N | LONGITUDE: -78.607000° W
SURFACE ELEVATION: 971.5 ft | COORD. DATUM: NAD 83

Date(s) Drilled: 09/22/2014 - 09/22/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA | **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
											0.0 / 971.5 Asphalt = 10 inches **ASPH**			
	970	23 14 5 4	75		1.3						0.83 / 970.67 Crushed stone = 6 inches **CRA**			
											1.33 / 970.17 *Fill*, brown, **f-m**, SILTY SAND FILL with gravel, medium dense, moist **FL**			10.5
		6 6 8 7	100		3.3						3.3 / 968.2 *Residual*, orange - brown, **f-m**, CLAYEY SAND, medium dense, moist **SC**	25	12	12.1
5		6 3 7 5	100		5.3						5.3 / 966.2 SAME: loose			14.7
	965	3 6 6 8	100		7.3						7.3 / 964.2 SAME: medium dense			9.6
10		6 9 9 8	100		9.3									11.0
					11.3						11.3 / 960.2 BOTTOM OF BORING AT 11.3 FT.			

REMARKS: Cave-in Depth: 7.5 ft.
Offset 3.5 ft. east into roadway.
Bulk sample collected from 1.5 to 3.5 ft. and 3.0 to 5.0 ft.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: ROADWAY

R-2
PAGE 1 OF 1

STATION: 23+00 OFFSET: 10.4 ft. Right
LATITUDE: 38.554778° N LONGITUDE: -78.606139° W
SURFACE ELEVATION: 965.8 ft COORD. DATUM: NAD 83

Date(s) Drilled: 09/12/2014 - 09/12/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA											LAB DATA		
		SOIL				ROCK							
								DIP °					
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	STRATA	JOINTS	STRATA LEGEND	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT (%)
											LL	PI	
		4											
		50/5"	100										19.0
	965				0.9								

FIELD DESCRIPTION OF STRATA

0.0 / 965.8
Topsoil = 2 inches **TOPS**

0.17 / 965.63
Residual, gray and orange-brown, **f-m**, SILTY SAND, contains rock fragments, very dense, moist **SM**

0.9 / 964.9
AUGER AND SPOON REFUSAL AT 0.9 FT.

REMARKS: Cave-in Depth: 0.5 ft.
Offset 7.0 ft. toward R-2A, 7.0 ft south, auger and spoon refusal at 1.0 ft.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: ROADWAY

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STATION: 25+00 OFFSET: 4.0 ft. Left
LATITUDE: 38.555306° N LONGITUDE: -78.606111° W
SURFACE ELEVATION: 974.9 ft COORD. DATUM: NAD 83

Date(s) Drilled: 09/12/2014 - 09/12/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		10 17 17 17	75		2						0.0 / 974.9 Topsoil = 2 inches **TOPS** 0.17 / 974.73 *Residual*, tan, **f-m**, SILTY SAND, dense, moist **SM**			5.7
		4 6 5 5	100		4						1.0 / 973.9 *Residual*, orange - brown, FAT CLAY WITH SAND, stiff, moist **CH**	68	46	26.9
5	970	3 4 6 5	100		6									21.7
		3 14 18 23	100		8						6.0 / 968.9 SAME: gray and orange brown			21.5
		5 14 9 9	100		10						8.0 / 966.9 SAME: very stiff			21.6
10	965										10.0 / 964.9 BOTTOM OF BORING AT 10.0 FT.			

REMARKS: Cave-in Depth: 9.2 ft.
Offset toward R-3A, auger and spoon refusal at 13.0 ft.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: ROADWAY

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PAGE 1 OF 1

STATION: 27+00 OFFSET: 2.8 ft. Left
LATITUDE: 38.558610° N LONGITUDE: -78.606167° W
SURFACE ELEVATION: 976.5 ft COORD. DATUM: NAD 83

Date(s) Drilled: 09/22/2014 - 09/22/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
											0.0 / 976.5 Asphalt =10 inches **ASPH**			
	975	10 5 4 4	25		1.5						0.83 / 975.67 Crushed stone = 8 inches **CRA**			
					3.5						1.5 / 975.0 *Fill*, brown and black, **f-m**, SILTY CLAYEY SAND FILL WITH GRAVEL, loose, moist **FL**	17	4	5.4
5		3 3 3 3	40		5.5						3.5 / 973.0 *Residual*, orange and brown, FAT CLAY, firm, moist **CH**			27.5
	970	2 4 4 6	60		7.5						SAME: with sand			30.9
		4 5 8 50/5"	95		9.4						SAME: Contains rock fragments, stiff			29.6
		50/0"			9.5						BOTTOM OF BORING AT 9.5 FT.			

REMARKS: Cave-in Depth: 7.9 ft.
Offset 4.5 ft. east into roadway.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: SLOPE

SL-1

STATION: 17+75 | OFFSET: 55.2 ft. Left
LATITUDE: 38.553389° N | LONGITUDE: -78.606806° W
SURFACE ELEVATION: 941.6 ft | COORD. DATUM: NAD 83

Date(s) Drilled: 09/16/2014 - 09/16/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA											LAB DATA		
DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
	940	WOH 1 2 1	100		2								19.2
			65								18	4	25.4
		50/0"			4								

FIELD DESCRIPTION OF STRATA

0.0 / 941.6
Topsoil =3 inches **TOPS**

0.25 / 941.35
Alluvial, orange - brown, **f-m**, SILTY CLAYEY SAND, very loose, moist **SC/SM**

4.0 / 937.6
AUGER AND SPOON REFUSAL AT 4.0 FT.

REMARKS: Cave-in Depth: 3.4 ft.
Offset 50.0 ft. north and +28.0 ft elevation decrease.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: SLOPE

SL-1A

STATION: 17+75 | OFFSET: 55.2 ft. Left
LATITUDE: 38.553389° N | LONGITUDE: -78.606806° W
SURFACE ELEVATION: 941.6 ft | COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 09/16/2014 - 09/16/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
	940										0.0 / 941.6 Auger probe down to 5.0 ft.			
5		5 8 5 1 2 2 50/0" 50/2"	40 58		5 7 8.2						5.0 / 936.6 *Alluvial*, brown, **f-c**, CLAYEY SAND WITH GRAVEL, medium dense, moist **SC**			18.6 26.1
	935										8.0 / 933.6 *Alluvial*, gray, **f-c**, SILTY SAND, contains rock fragments, very dense, moist **SM** 8.2 / 933.4 AUGER AND SPOON REFUSAL AT 8.2 FT.			

REMARKS: Cave-in Depth: 6.3 ft.
Offset 5.0 ft. north from SL-1.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: SLOPE

SL-2

STATION: 21+25 | OFFSET: 41.0 ft. Left
LATITUDE: 38.554333° N | LONGITUDE: -78.606444° W
SURFACE ELEVATION: 934.9 ft | COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 09/11/2014 - 09/11/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		5 6 6 6	75		2						0.0 / 934.9 *Fill*, brown, **f-m**, SILTY SAND FILL WITH GRAVEL, medium dense, moist **FL**			15.0
			83		3.33									
					4									
			75		5.2									
5	930	50/0"			5.8						5.0 / 929.9 SAME: very dense 5.8 / 929.1 AUGER AND SPOON REFUSAL AT 5.8 FT.			

REMARKS: Cave-in Depth: 1.0 ft.
Offset 12.0 ft. southwest and 1.5 ft. decrease in elevation due to overhead powerlines

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: SLOPE

SL-3
PAGE 1 OF 1

STATION: 15+50 OFFSET: 57.8 ft. Right
LATITUDE: 38.552750° N LONGITUDE: -78.606611° W
SURFACE ELEVATION: 973.8 ft COORD. DATUM: NAD 83

Date(s) Drilled: 09/16/2014 - 09/16/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		4 13 23 20	50		2						0.0 / 973.8 Topsoil = 0.25ft. **TOPS** 0.25 / 973.55 *Residual*, light brown, **f-m**, SILTY SAND, dense, moist **SM**			4.4
	970	12 17 12 9	75		4						2.0 / 971.8 *Residual*, orange - brown, CLAYEY SAND, medium dense, moist **SC**			19.7
5		4 6 8 8	75		6						4.0 / 969.8 SAME: stiff			23.4
			100		8							51	24	29.9
	965	4 6 5 5	100		10						8.0 / 965.8 *Residual*, orange - brown, FAT CLAY WITH SAND, stiff, moist **CH**	63	34	28.3
10														
	960	5 5 4	100		13.5 15									37.0
15														
		50/0"			16.4						16.0 / 957.8 SAME: very hard 16.4 / 957.4 AUGER AND SPOON REFUSAL AT 16.4 FT.			

REMARKS: Cave-in depth: 13.3 ft.
Offset 7.0 ft east due to edge of slope and trees.

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: SLOPE

SL-4
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STATION: 23+00 OFFSET: 65.5 ft. Left
LATITUDE: 38.554806° N LONGITUDE: -78.606389° W
SURFACE ELEVATION: 971.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 09/12/2014 - 09/12/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
FIRST ENCOUNTERED AT 13.5 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
	970	6 21 20 15	75		2						0.0 / 971.0 Topsoil = 0.25ft. **TOPS** 0.25 / 970.75 *Residual*, light brown and tan, **f**, SILTY SAND, dense, moist **SM**			4.6
		8 16 18 16	100		4									8.8
5		5 13 35 15	75		6						4.0 / 967.0 SAME: With quartz fragments			9.9
	965	3 5 9 10	100		8						6.0 / 965.0 *Residual*, orange - brown, FAT CLAY, stiff, moist **CH**			28.2
			100											
10		4 6 9 11	100		10									30.8
	960				12									
		1 0 1	100		13.5						13.5 / 957.5 *Residual*, orange - brown, **f**, SILT, very soft, moist **ML**			40.8
15					15									
	955													
		50/1"	100		18.5 18.6						Bottom of borehole at 18.6 feet.			23.6

REMARKS: Cave-in Depth: 4.4 ft.

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SL-4

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PROJECT #: 0340-069-777, B611 90187
LOCATION: Page County, Virginia
STRUCTURE: SLOPE

SL-5

STATION: 24+00 | OFFSET: 74.6 ft. Left
LATITUDE: 38.555056° N | LONGITUDE: -78.606389° W
SURFACE ELEVATION: 979.1 ft | COORD. DATUM: NAD 83

Date(s) Drilled: 09/12/2014 - 09/12/2014
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic
Other Test(s):
Driller: H. Roberts
Logger: H. Scott

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		6 19 15 6	60		2						0.0 / 979.1 Topsoil = 0.25ft. **TOPS** 0.25 / 978.85 *Residual*, light brown, **f-m**, SILTY SAND, dense, moist **SM**			2.8
		5 6 6 5	100		4						2.0 / 977.1 *Residual*, orange - brown, FAT CLAY, stiff, moist **CH**			27.1
	975	4 4 6 10	100		6						4.0 / 975.1 *Residual*, gray and orange brown, **f-m**, CLAYEY SAND, loose, moist **SC**			28.3
5		11 34 24 50/4"	100		7.8						6.0 / 973.1 *Residual*, gray, **f-m**, SILTY SAND, very dense, moist **SM**			2.6
	970	28 7 25 16	100		8 10						8.0 / 971.1 *Residual*, orange and brown, FAT CLAY, contains rock fragments, hard, moist **CH**			8.1
10											Auger and spoon refusal at 10.0 feet.			

REMARKS: Cave-in Depth: 5.4 ft.
Offset 7.0 ft. south toward SL-5A, auger and spoon refusal at 5.5 ft.

SPT_LOG:VDOT LOGS - COPY.GPJ:8.30.002:021011:11/18/14
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Route 340 Bridge Replacement and Approaches over Cub Run
(VDOT Project Number: 0340-069-777, B611, UPC: 90187)
(GeoConcepts Project Number: 13004.01)

Boring No. BR-1
Date: 9/15/2014
Project Name: Route 340 Bridge Replacement and Approaches over Cub Run

Boring No.	Run	From (Feet)	To (Feet)	Length (Feet)	Rec. (Feet)	% Rec.	RQD (%)
BR-1	1	6.5	11.5	5	4.7	94	78
	2	11.5	16.5	5	5.0	100	96

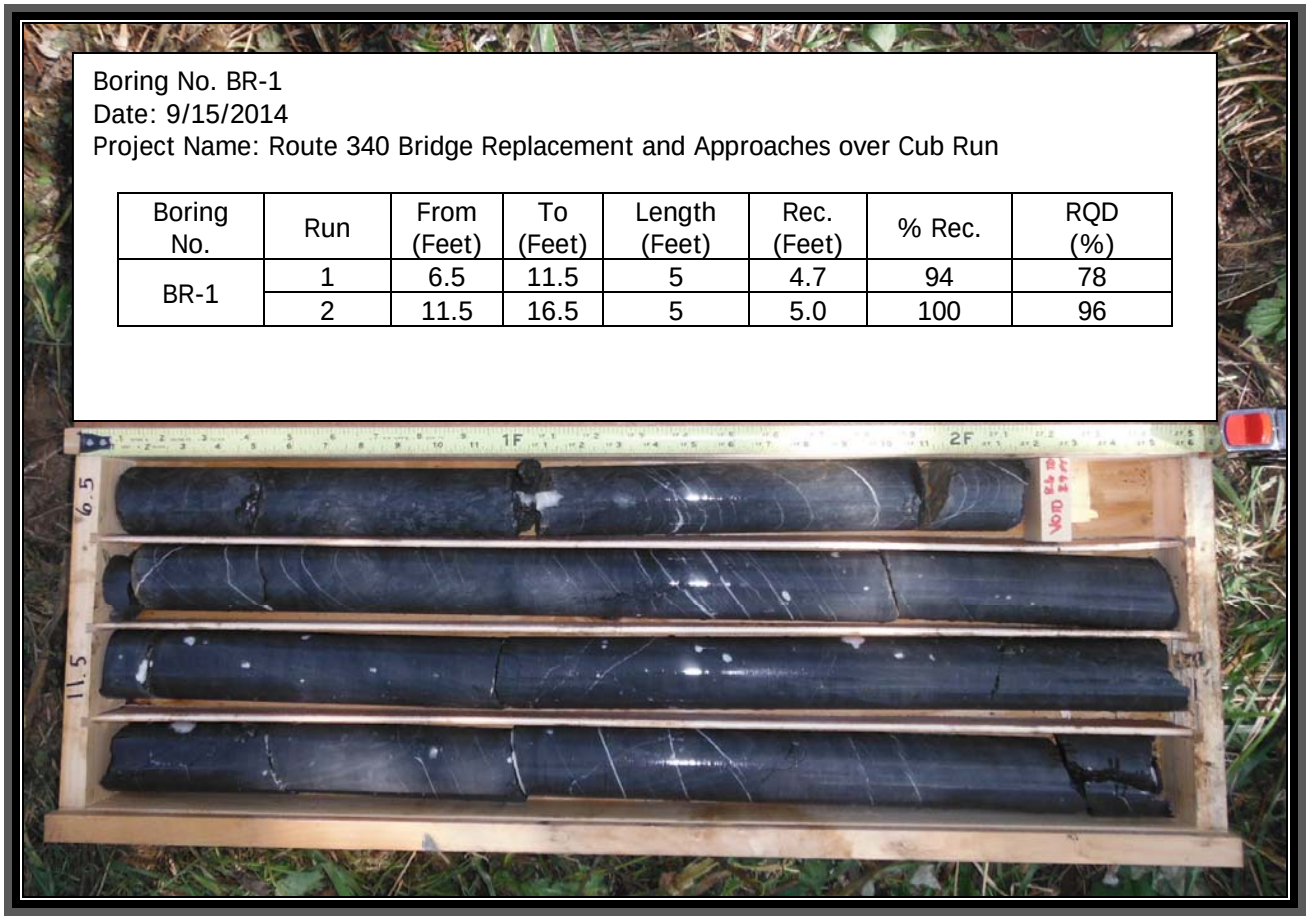


Photo 1: BR-1 (Runs 1 to 2)

GeoConcepts Engineering, Inc.

Route 340 Bridge Replacement and Approaches over Cub Run
(VDOT Project Number: 0340-069-777, B611, UPC: 90187)
(GeoConcepts Project Number: 13004.01)

Boring No.	Run	From (Feet)	To (Feet)	Length (Feet)	Rec. (Feet)	% Rec.	RQD (%)
BR-2	1	13.5	18.5	5	5.0	100	94
	2	18.5	23.5	5	5.0	100	92

Photo 2: BR-2 (Runs 1 to 2)

GeoConcepts Engineering, Inc.

Route 340 Bridge Replacement and Approaches over Cub Run
(VDOT Project Number: 0340-069-777, B611, UPC: 90187)
(GeoConcepts Project Number: 13004.01)

Boring No. BR-3
Date: 9/15/2014
Project Name: Route 340 Bridge Replacement and Approaches over Cub Run

Boring No.	Run	From (Feet)	To (Feet)	Length (Feet)	Rec. (Feet)	% Rec.	RQD (%)
BR-3	1	13.0	18.0	5	5.0	100	98
	2	18.0	23.0	5	5.0	100	100

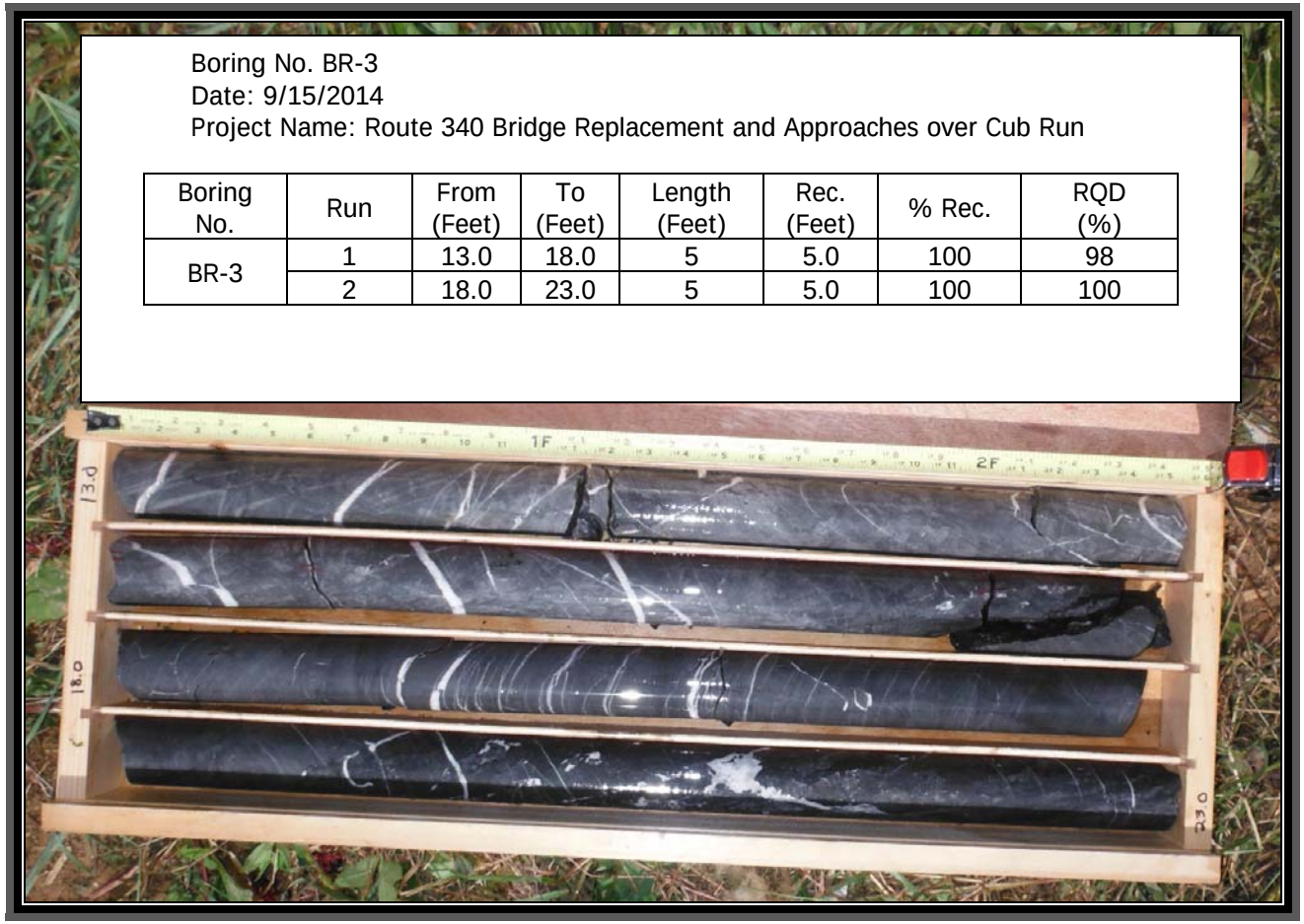


Photo 3: BR-3 (Runs 1 to 2)

GeoConcepts Engineering, Inc.

Route 340 Bridge Replacement and Approaches over Cub Run
(VDOT Project Number: 0340-069-777, B611, UPC: 90187)
(GeoConcepts Project Number: 13004.01)

Boring No. BR-7 & BR-4
Date: 9/11/2014
Project Name: Route 340 Bridge Replacement and Approaches over Cub Run

Boring No.	Run	From (Feet)	To (Feet)	Length (Feet)	Rec. (Feet)	% Rec.	RQD (%)
BR-7	1	4.0	9.0	5	4.8	96	66
	2	9.0	14.0	5	5.0	100	100
BR-4	1	8.3	13.3	5	5.0	100	84
	2	13.3	18.3	5	5.0	100	88

Photo 4: BR-7 (Runs 1 to 2)
BR-4 (Runs 1 to 2)

GeoConcepts Engineering, Inc.

Route 340 Bridge Replacement and Approaches over Cub Run
(VDOT Project Number: 0340-069-777, B611, UPC: 90187)
(GeoConcepts Project Number: 13004.01)

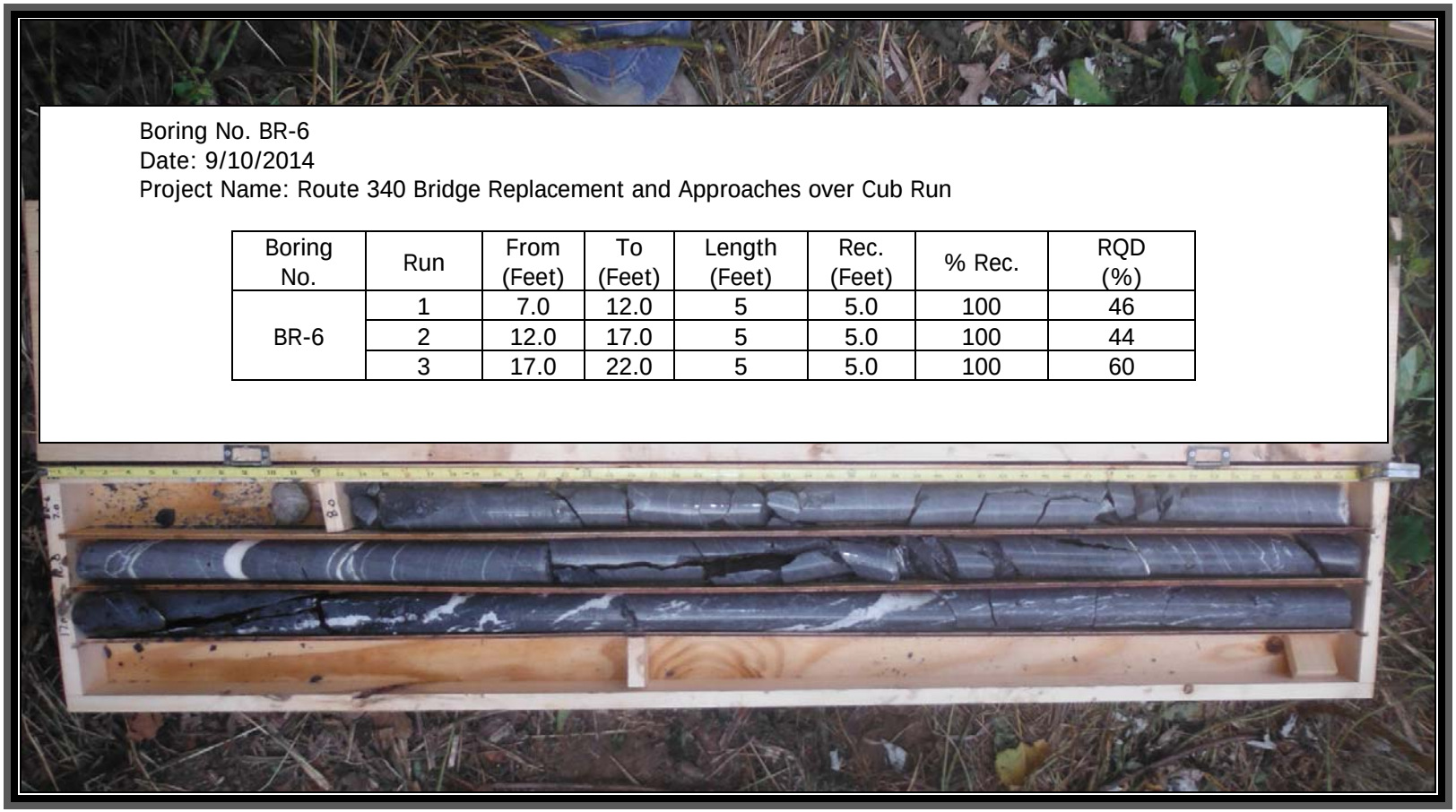
Boring No. BR-5
Date: 9/11/2014
Project Name: Route 340 Bridge Replacement and Approaches over Cub Run

Boring No.	Run	From (Feet)	To (Feet)	Length (Feet)	Rec. (Feet)	% Rec.	RQD (%)
BR-5	1	8.1	13.1	5	5.0	100	92
	2	13.1	18.1	5	5.0	100	100

Photo 5: BR-5 (Runs 1 to 2)

GeoConcepts Engineering, Inc.

Route 340 Bridge Replacement and Approaches over Cub Run
(VDOT Project Number: 0340-069-777, B611, UPC: 90187)
(GeoConcepts Project Number: 13004.01)



Boring No. BR-6
Date: 9/10/2014
Project Name: Route 340 Bridge Replacement and Approaches over Cub Run

Boring No.	Run	From (Feet)	To (Feet)	Length (Feet)	Rec. (Feet)	% Rec.	RQD (%)
BR-6	1	7.0	12.0	5	5.0	100	46
	2	12.0	17.0	5	5.0	100	44
	3	17.0	22.0	5	5.0	100	60

Photo 6: BR-6 (Runs 1 to 3)

GeoConcepts Engineering, Inc.

Route 340 Bridge Replacement and Approaches over Cub Run
(VDOT Project Number: 0340-069-777, B611, UPC: 90187)
(GeoConcepts Project Number: 13004.01)

Boring No. BR-8 & BR-9
Date: 9/8/2014
Project Name: Route 340 Bridge Replacement and Approaches over Cub Run

Boring No.	Run	From (Feet)	To (Feet)	Length (Feet)	Rec. (Feet)	% Rec.	RQD (%)
BR-8	1	11.5	16.5	5	5.0	100	100
	2	16.5	21.5	5	5.0	100	100
BR-9	1	6.0	11.0	5	5.0	100	98
	2	11.0	16.0	5	5.0	100	62

Photo 7: BR-8 (Runs 1 to 2)
BR-9 (Runs 1 to 2)

GeoConcepts Engineering, Inc.

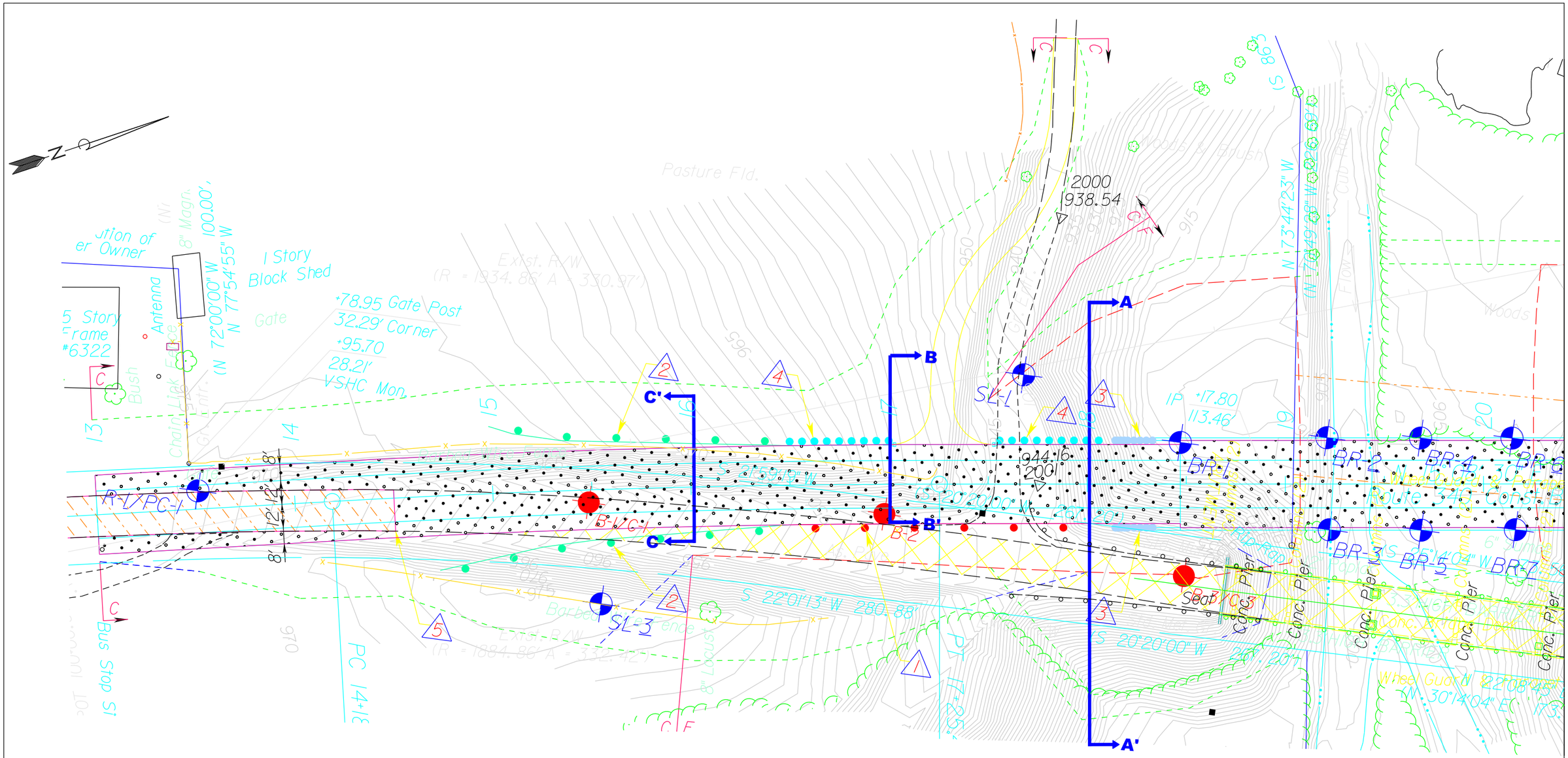
Route 340 Bridge Replacement and Approaches over Cub Run
(VDOT Project Number: 0340-069-777, B611, UPC: 90187)
(GeoConcepts Project Number: 13004.01)

Core #	Total Asphalt Thickness (inch)	Asphalt Thickness (inch)			Subbase Thickness (inch)	Subbase Material Type
		SM	IM	BM		
R-1	9.75	1.0	-	8.75	6.0	Crushed Stone

GeoConcepts Engineering, Inc.

Route 340 Bridge Replacement and Approaches over Cub Run
(VDOT Project Number: 0340-069-777, B611, UPC: 90187)
(GeoConcepts Project Number: 13004.01)

Core #	Total Asphalt Thickness (inch)	Asphalt Thickness (inch)			Subbase Thickness (inch)	Subbase Material Type
		SM	IM	BM		
R-4	10.0	1.5	-	8.5	8.0	Crushed Stone



GRAPHICAL SCALE

50' 0 50' 100'

L E G E N D

TEST BORING LOCATION
R-1/PC-1

PREVIOUS BORING LOCATION
B-1

NOTES:

1. PC IS FOR PAVEMENT CORE
2. BASE PLAN PROVIDED BY ALVI ASSOCIATES DATED AUGUST 2014

A A' SLOPE STABILITY SECTION

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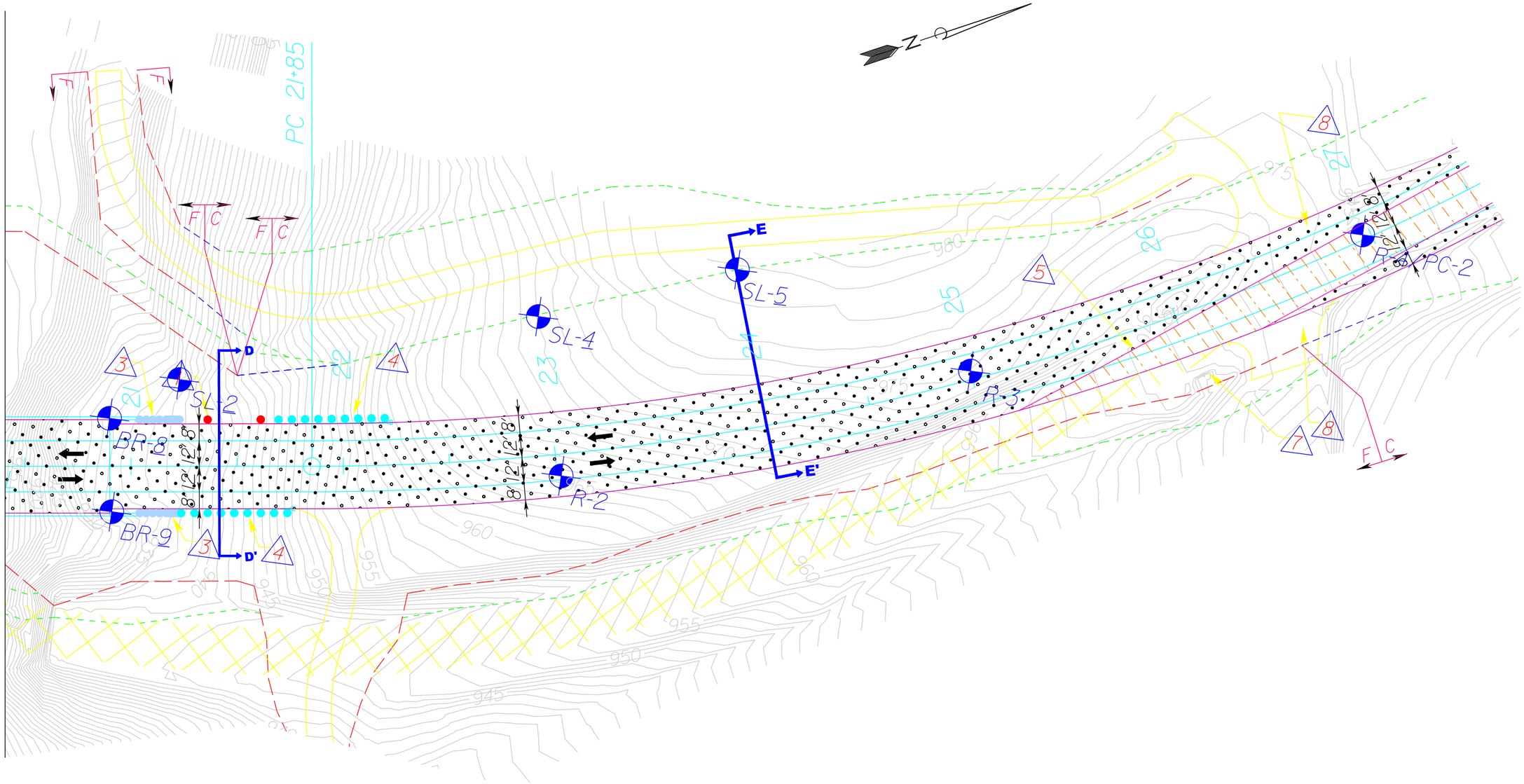
Ashburn, Virginia 20147 (703) 726-8032 fax

ROUTE 340 OVER CUB RUN
PAGE COUNTY, VIRGINIA

BORING LOCATION PLAN		Scale: AS SHOWN	Fig. 3
Date: JUNE 2015	Checked By: P.E.B.	Project No.: 13004.01	



L E G E N D

TEST BORING LOCATION

R-4/PC-2

D D' SLOPE STABILITY SECTION

NOTES:

1. PC IS FOR PAVEMENT CORE
2. BASE PLAN PROVIDED BY ALVI ASSOCIATES DATED AUGUST 2014

GRAPHICAL SCALE

50' 0 50' 100'

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Ashburn, Virginia 20147 (703) 726-8032 fax

ROUTE 340 OVER CUB RUN
PAGE COUNTY, VIRGINIA

BORING LOCATION PLAN		Scale: AS SHOWN	Fig.
Date: JUNE 2015	Checked By: P.E.B.	Project No.: 13004.01	4

Appendix B
Laboratory Test Results

Summary of Soil Laboratory Test Results (1 page)

Atterberg Limits, Grain Size Analysis, CBR, and Standard Proctor Test Results (18 pages)

Consolidation Test Results (28 pages)

Unconfined Rock Compressive Strength and Elastic Modulus Test Report (17 pages)

Corrosion Series Test Results (2 pages)

Summary of Soil Laboratory Test Results

Project: Route 340 Bridge Replacement and Approaches over Cub Run **Contract No. 13004.01**

Test Boring No.	Depth (ft)	Sample Type	Stratum	Description of Soil Specimen	Sieve Results		Atterberg Limits			Natural Moisture Content (%)	Remarks
					Percent Retained #4 Sieve	Percent Passing #200 Sieve	LL	PL	PI		
BR-1	0.0-5.0	Ziploc	B	clayey SAND (SC)	1.9	44.3	23	14	9	7.5	-
BR-4	4.0-6.0	Jar	B	clayey SAND with gravel (SC)	38.4	16.1	28	21	7	20.5	-
BR-7	0.0-2.0	Jar	B	clayey SAND (SC)	6.8	26.7	36	14	22	9.8	-
R-1	3.0-5.0	Bulk	C1	clayey SAND (SC)	6.6	40.3	25	13	12	9.4	CBR=8.3%
R-3	1.0-5.0	Bulk	C1	FAT CLAY with sand (CH)	2.6	72.0	68	22	46	22.7	CBR=4.1%
R-4	1.0-3.0	Jar	A	silty CLAYEY SAND with gravel (SC-SM)	24.3	16.4	17	13	4	5.4	-
SL-1	2.0-3.8	Shelby Tube	B	silty CLAYEY SAND (SC-SM)	2.8	34.5	18	14	4	25.4	-
SL-3	6.0-8.0	Shelby Tube	C1	clayey SAND (SC)	1.4	46.7	51	27	24	29.9	-
SL-3	8.0-10.0	Jar	C1	FAT CLAY with sand (CH)	0.4	84.9	63	29	34	28.3	-
Streambed	0.0-1.0	Jar	B	POORLY GRADED SAND with gravel (SP)	26.3	1.2	NP	NP	NP	8.0	-

Notes:
1. Soil tests are in accordance with applicable ASTM standards
2. Soil classification symbols are in accordance with Unified Soil Classification System
3. Visual identification of samples is in accordance with ASTM D-2488
4. Key to abbreviations: LL = liquid limit; PL = plastic limit; PI = plasticity index; NP = nonplastic; N/T = not tested

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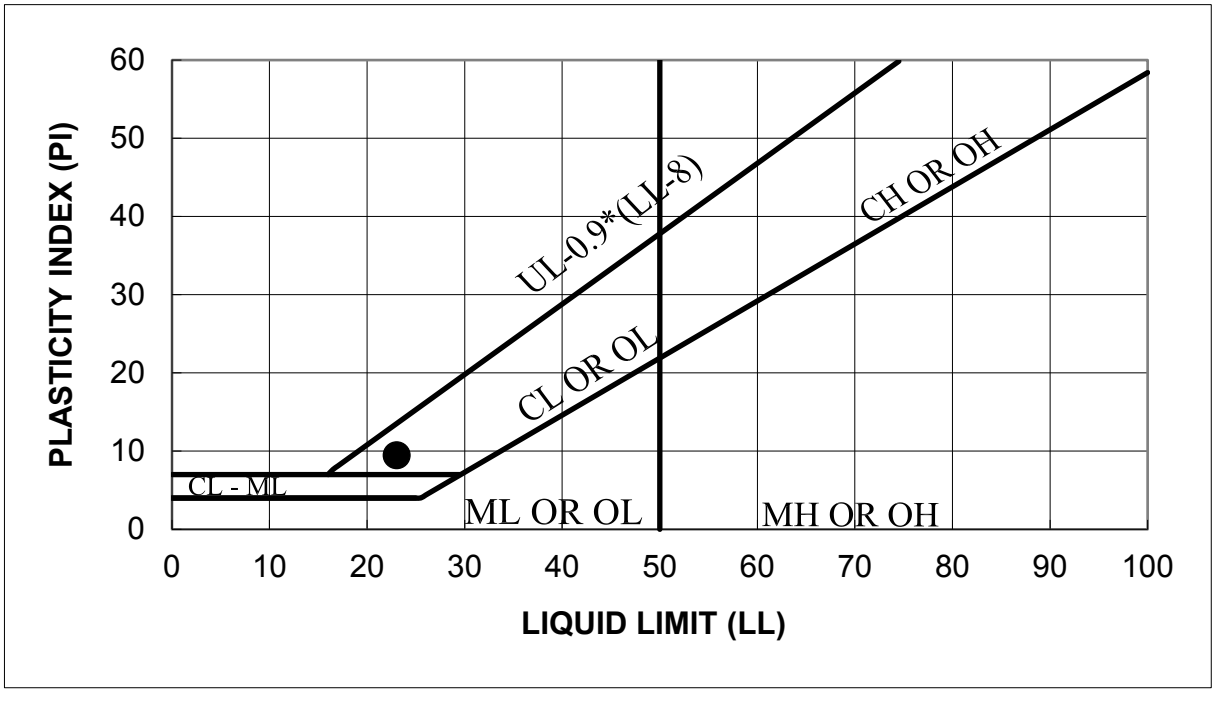
LIQUID AND PLASTIC LIMIT			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	BR-1	**Depth (Feet)**	0.0'-5.0'
Lab Order No.	3384-1	**Date**	10/2/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
CLAYEY SAND	23	14	9	98.1	44.3	SC	7.5
			AASHTO Classification			A-4	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____

Reviewed by _____

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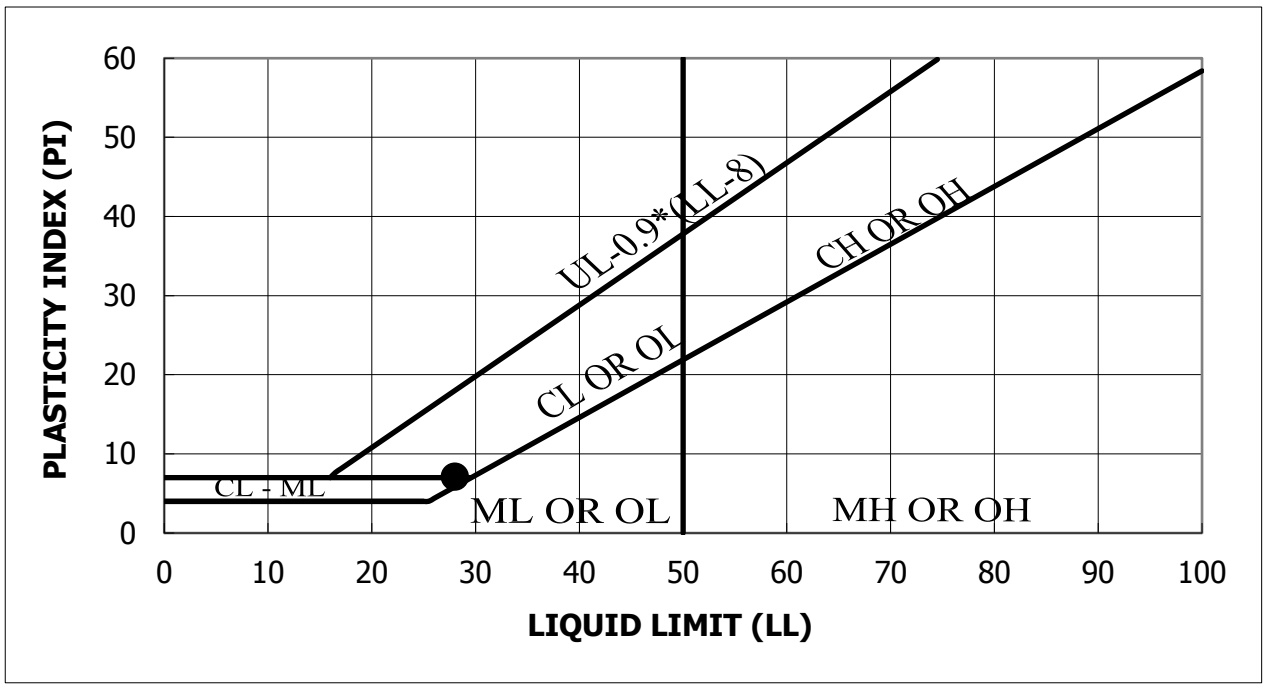
LIQUID AND PLASTIC LIMIT - ASTM D4318			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	BR-4	**Depth (Feet)**	4.0'-6.0'
Lab Order No.	3384-14	**Date**	10/2/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
CLAYEY SAND with gravel	28	21	7	61.6	16.1	SC	20.5
Color	Gray		AASHTO Classification			A-2-4	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

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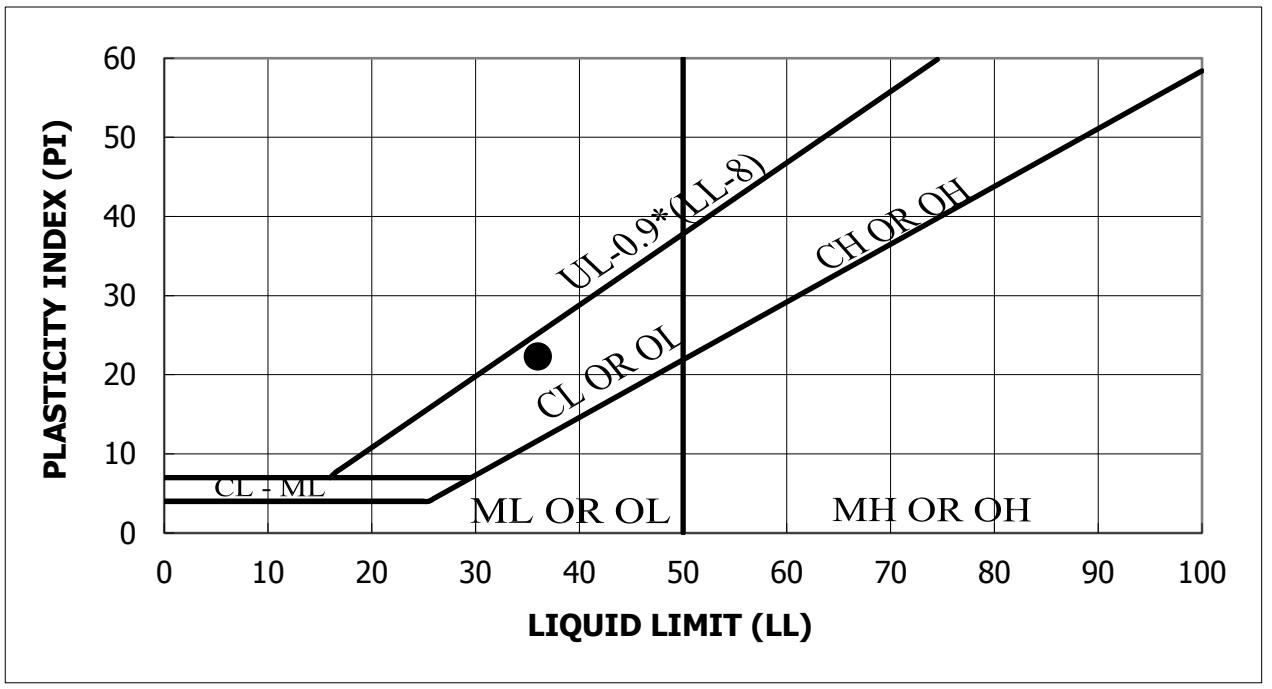
LIQUID AND PLASTIC LIMIT - ASTM D4318			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	BR-7	**Depth (Feet)**	0.0'-2.0'
Lab Order No.	3384-25	**Date**	10/2/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
CLAYEY SAND	36	14	22	93.2	26.7	SC	9.8
Color	Dark Brownish Gray		AASHTO Classification			A-2-6	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

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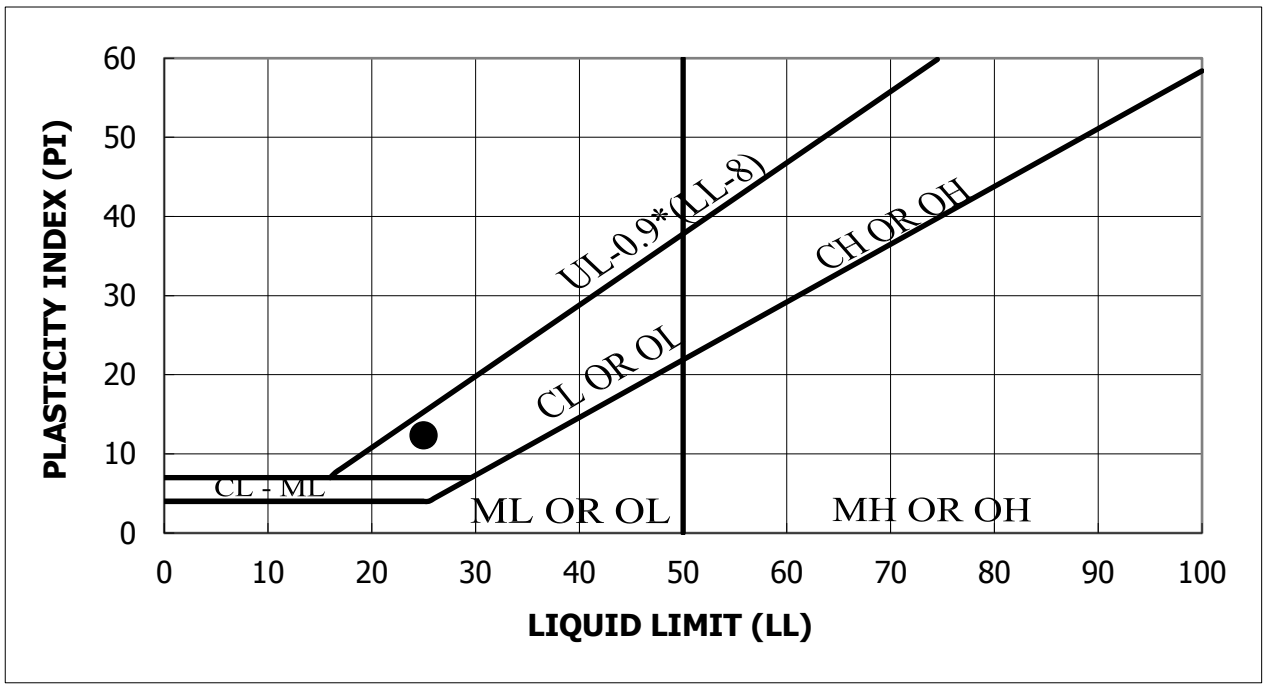
LIQUID AND PLASTIC LIMIT - ASTM D4318			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	R-1	**Depth (Feet)**	3.0'-5.0'
Lab Order No.	3388-1	**Date**	10/2/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
CLAYEY SAND	25	13	12	93.4	40.3	SC	9.4
Color	Dark Brownish Gray		AASHTO Classification			A-6	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

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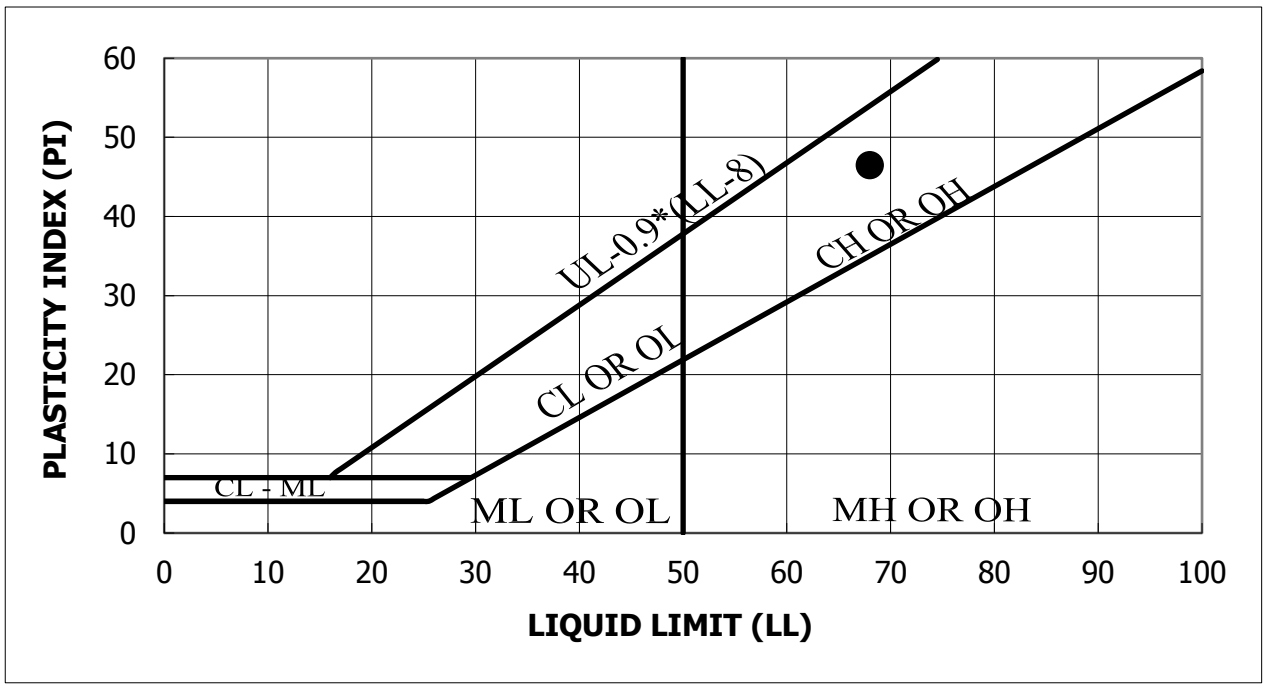
LIQUID AND PLASTIC LIMIT - ASTM D4318			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	R-3	**Depth (Feet)**	1.0'-5.0'
Lab Order No.	3384-37	**Date**	10/2/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
Fat Clay with sand	68	22	46	97.4	72.0	CH	22.7
Color	Brown		AASHTO Classification			A-7-6	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

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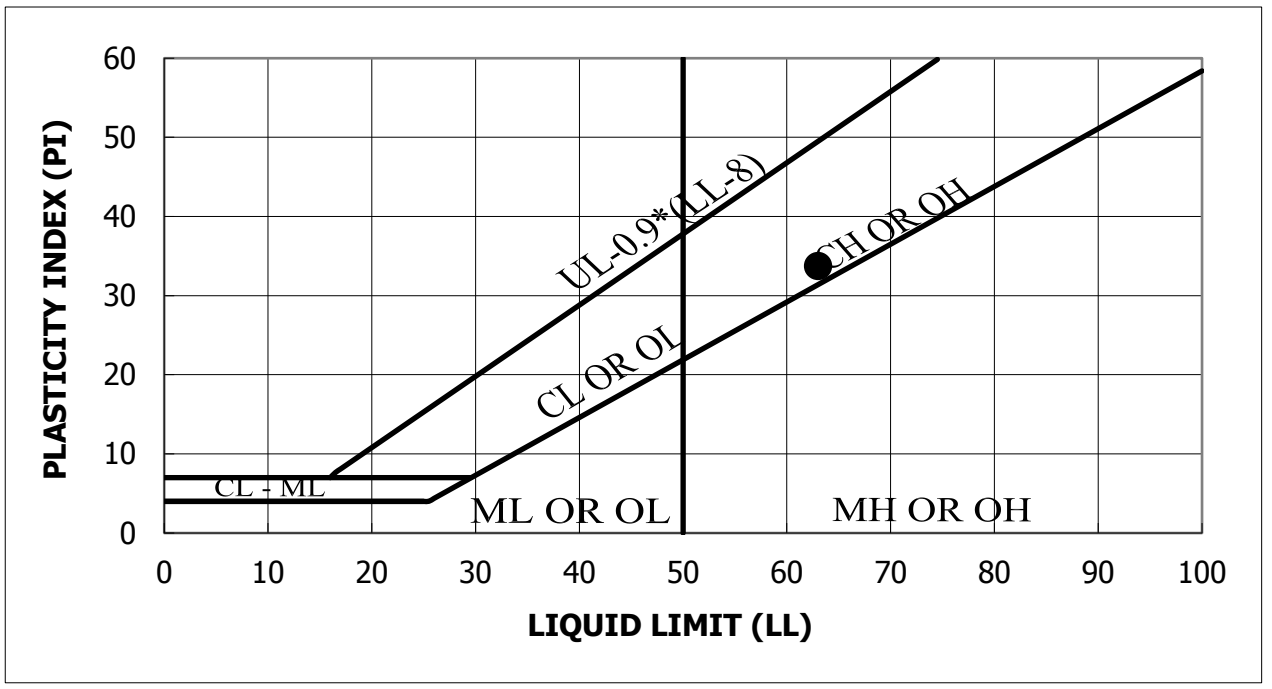
LIQUID AND PLASTIC LIMIT - ASTM D4318			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	SL-3	**Depth (Feet)**	8.0'-10.0'
Lab Order No.	3384-50	**Date**	10/2/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
Fat Clay with sand	63	29	34	99.6	84.9	CH	28.3
Color	Orange Brown		AASHTO Classification			A-7-6	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

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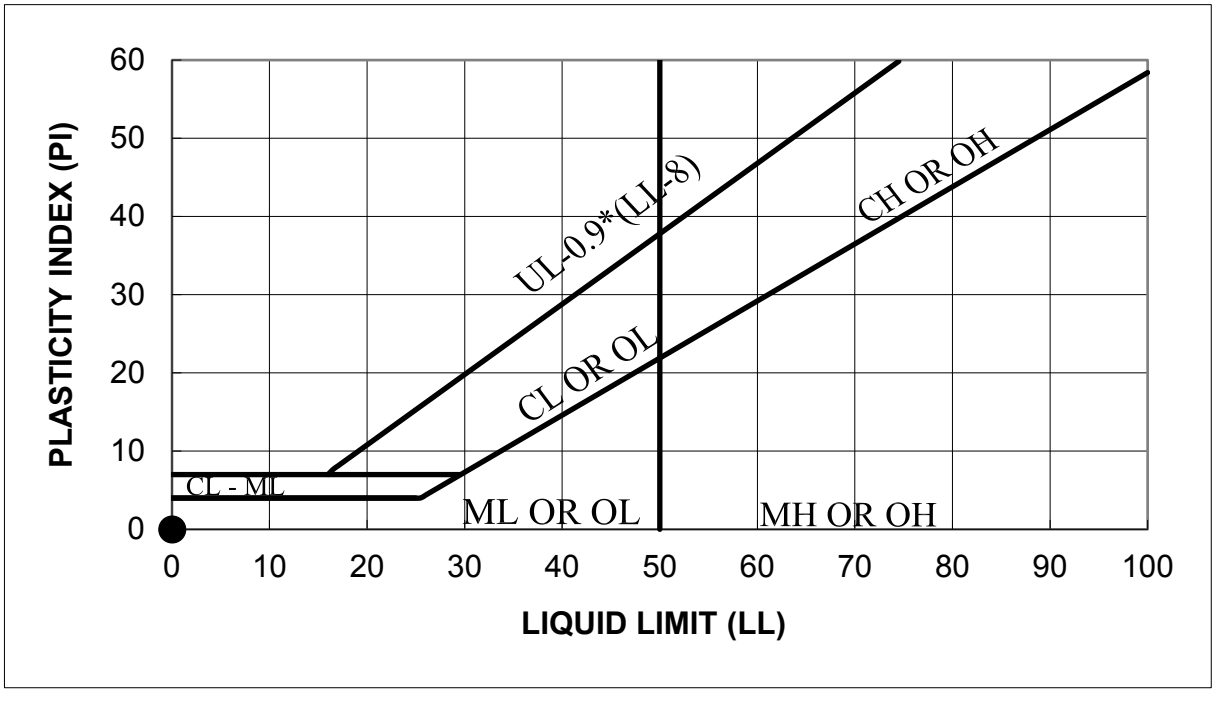
LIQUID AND PLASTIC LIMIT			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	Streambed	**Depth (Feet)**	Paige County near Cub Run
Lab Order No.	3384-64	**Date**	10/2/2014



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
POORLY GRADED SAND with gravel	NP	NP	NP	73.7	1.2	SP	8.0
			AASHTO Classification			A-1-b	

Test Method: ASTM D 4318
Soil Classification by ASTM D2487 and AASHTO M 145

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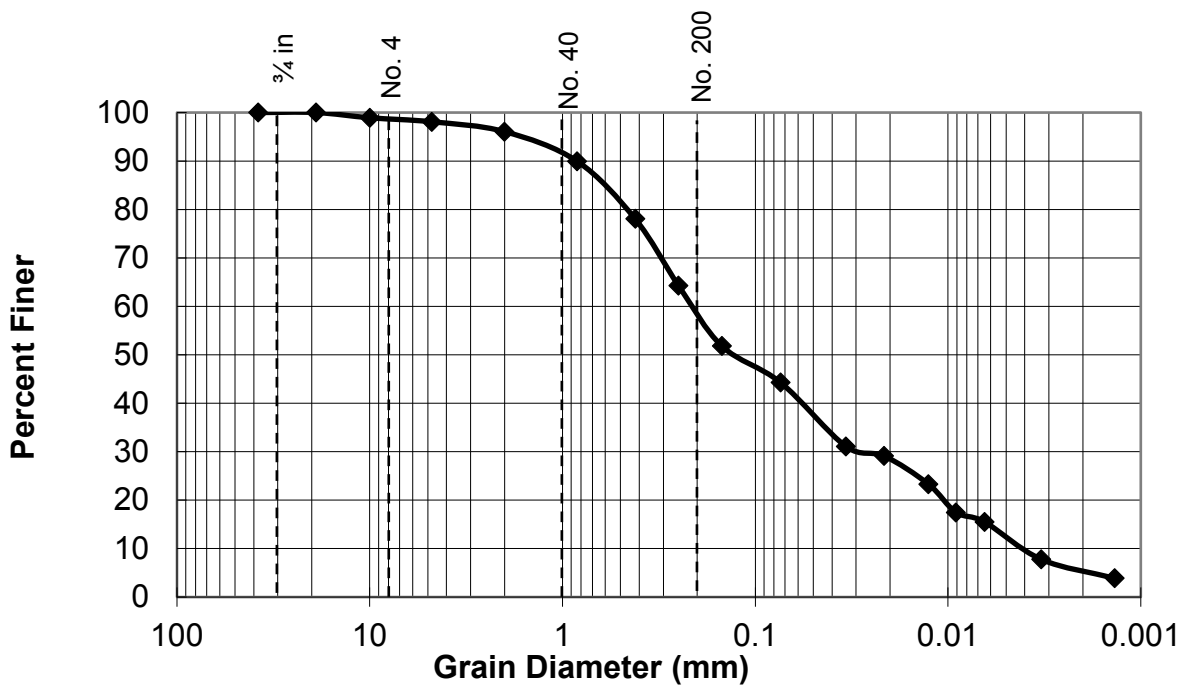
HYDROMETER ANALYSIS

Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	BR-1	**Depth (Feet)**	0.0'-5.0'
Lab Order No.	3384-1	**Date**	10/2/2014



SIEVE	% Passing
1 ½ "	**100.0**
3/4"	**100.0**
3/8"	**98.9**
#4	**98.1**
#10	**96.1**
#40	**78.1**
#100	**51.8**
#200	**44.3**
Pan	**--**

USCS Group Symbol	**SC**
USCS Group Name	**CLAYEY SAND**
Cu	**---**
Cc	**---**
LL	**23**
PI	**9**
Gravel	**1.9**
Sand	**53.8**
Silt	**39.1**
Clay	**5.2**
Fines	**44.3**
AASHTO Classification	**A-4**

Test Method: ASTM D 422
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____ Reviewed by _____

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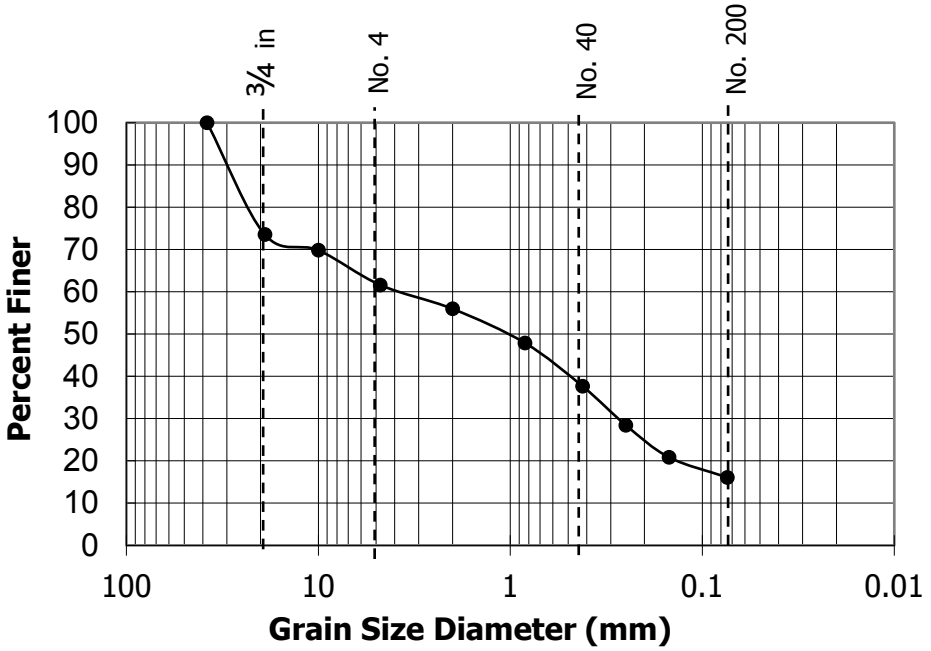
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	BR-4	**Depth (Feet)**	4.0'-6.0'
Lab Order No.	3384-14	**Date**	10/2/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**74**
3/8"	**70**
#4	**62**
#10	**56**
#20	**48**
#40	**38**
#60	**28**
#100	**21**
#200	**16**
Pan	**--**

USCS Group Symbol	**SC**
USCS Group Name	**CLAYEY SAND with gravel**
Cu	**---**
Cc	**---**
LL	**28**
PI	**7**
Gravel	**38.4**
Sand	**45.5**
Fines	**16.1**
AASHTO Classification	**A-2-4**
Color	**Gray**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by:_____

GeoConcepts Engineering, Inc.

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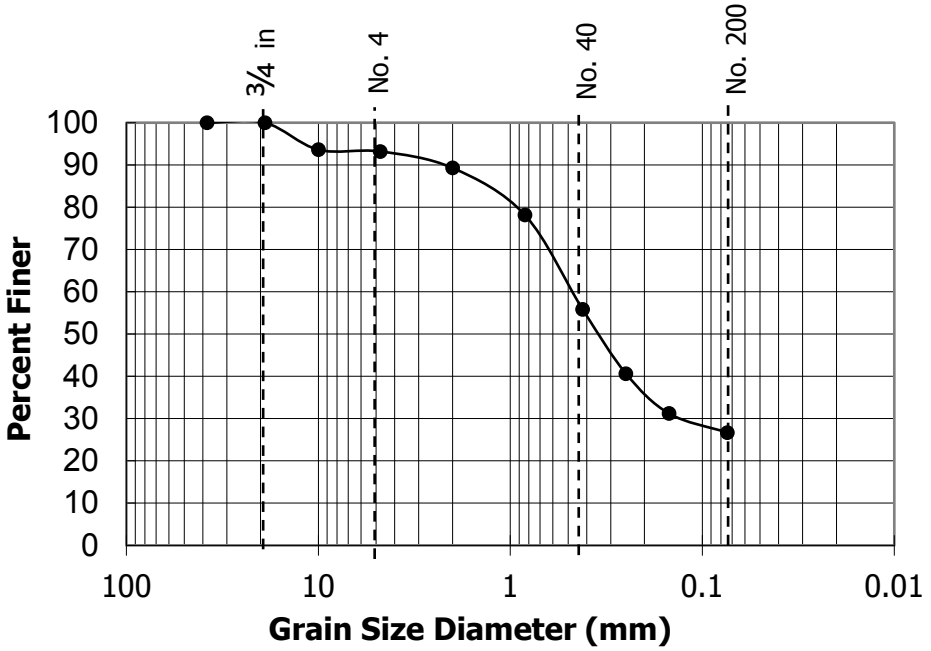
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	BR-7	**Depth (Feet)**	0.0'-2.0'
Lab Order No.	3384-25	**Date**	10/2/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**94**
#4	**93**
#10	**89**
#20	**78**
#40	**56**
#60	**41**
#100	**31**
#200	**27**
Pan	**--**

USCS Group Symbol	**SC**
USCS Group Name	**CLAYEY SAND**
Cu	**---**
Cc	**---**
LL	**36**
PI	**22**
Gravel	**6.8**
Sand	**66.5**
Fines	**26.7**
AASHTO Classification	**A-2-6**
Color	**Dark Brownish Gray**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by:_____

GeoConcepts Engineering, Inc.

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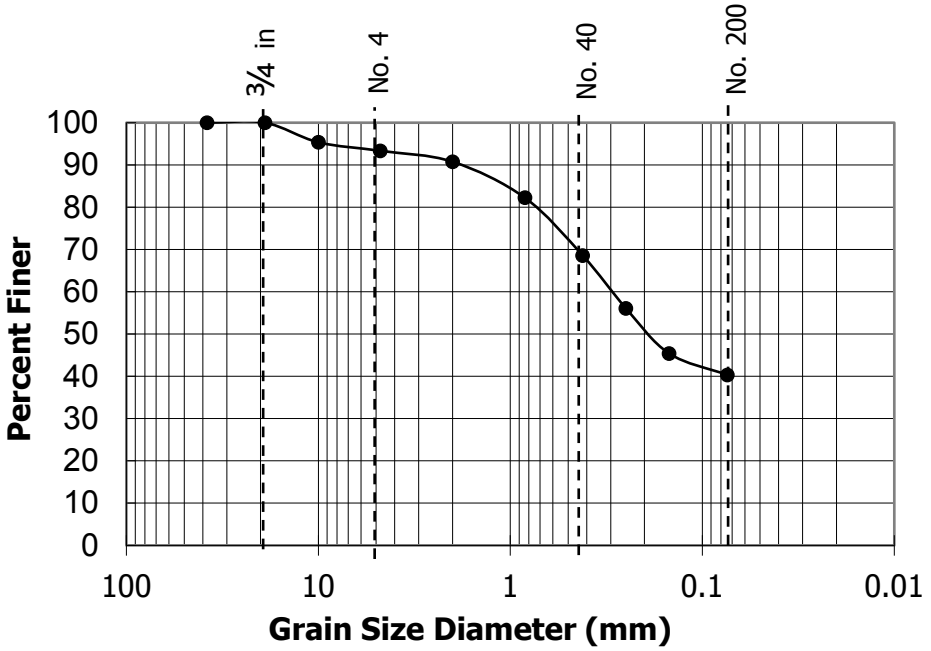
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	R-1	**Depth (Feet)**	3.0'-5.0'
Lab Order No.	3388-1	**Date**	10/2/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**95**
#4	**93**
#10	**91**
#20	**82**
#40	**69**
#60	**56**
#100	**45**
#200	**40**
Pan	**--**

USCS Group Symbol	**SC**
USCS Group Name	**CLAYEY SAND**
Cu	**---**
Cc	**---**
LL	**25**
PI	**12**
Gravel	**6.6**
Sand	**53.0**
Fines	**40.3**
AASHTO Classification	**A-6**
Color	**Dark Brownish Gray**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: Shawn Harris

GeoConcepts Engineering, Inc.

19955 Highland Vista Dr., Suite 170
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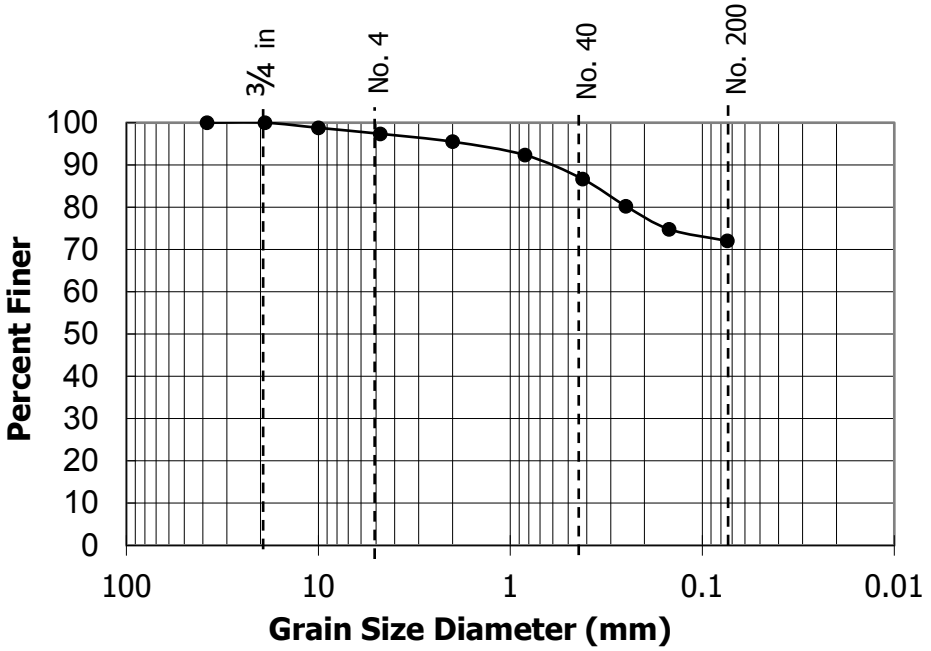
GRAIN SIZE ANALYSIS - ASTM D422			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	R-3	**Depth (Feet)**	1.0'-5.0'
Lab Order No.	3384-37	**Date**	10/2/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**99**
#4	**97**
#10	**95**
#20	**92**
#40	**87**
#60	**80**
#100	**75**
#200	**72**
Pan	**--**

USCS Group Symbol	**CH**
USCS Group Name	**Fat Clay with sand**
Cu	**---**
Cc	**---**
LL	**68**
PI	**46**
Gravel	**2.6**
Sand	**25.4**
Fines	**72.0**
AASHTO Classification	**A-7-6**
Color	**Brown**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: Shan Harris

GeoConcepts Engineering, Inc.

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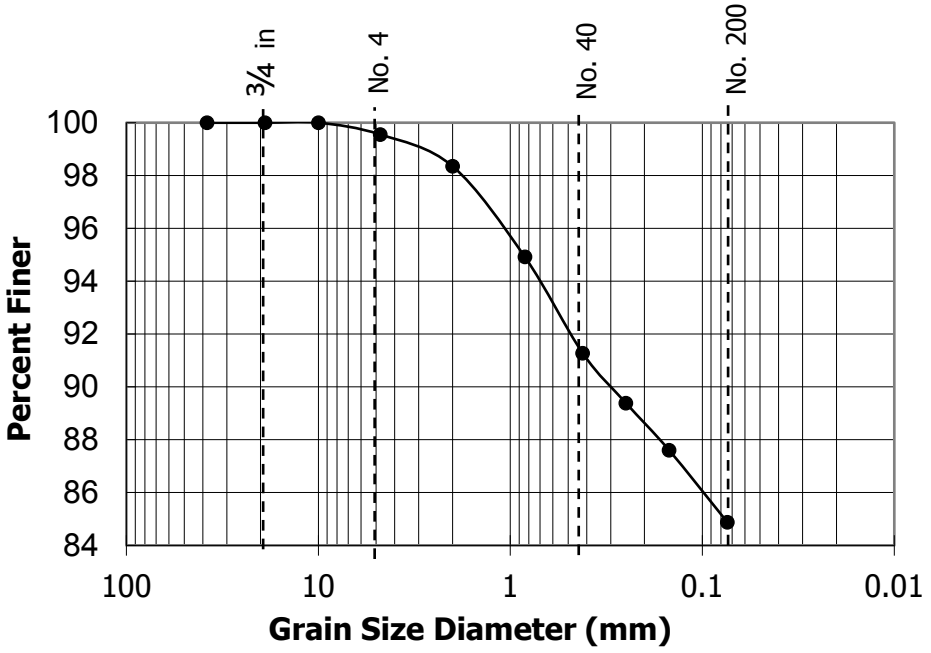
GRAIN SIZE ANALYSIS - ASTM D422

Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	SL-3	**Depth (Feet)**	8.0'-10.0'
Lab Order No.	3384-50	**Date**	10/2/2014



SIEVE	% Passing
1 ½ "	**100**
3/4"	**100**
3/8"	**100**
#4	**100**
#10	**98**
#20	**95**
#40	**91**
#60	**89**
#100	**88**
#200	**85**
Pan	**--**

USCS Group Symbol	**CH**
USCS Group Name	**Fat Clay with sand**
Cu	**---**
Cc	**---**
LL	**63**
PI	**34**
Gravel	**0.4**
Sand	**14.7**
Fines	**84.9**
AASHTO Classification	**A-7-6**
Color	**Orange Brown**

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Tested by:_____

Reviewed by: Shawn Harris

GeoConcepts Engineering, Inc.

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Ashburn, Virginia 20147
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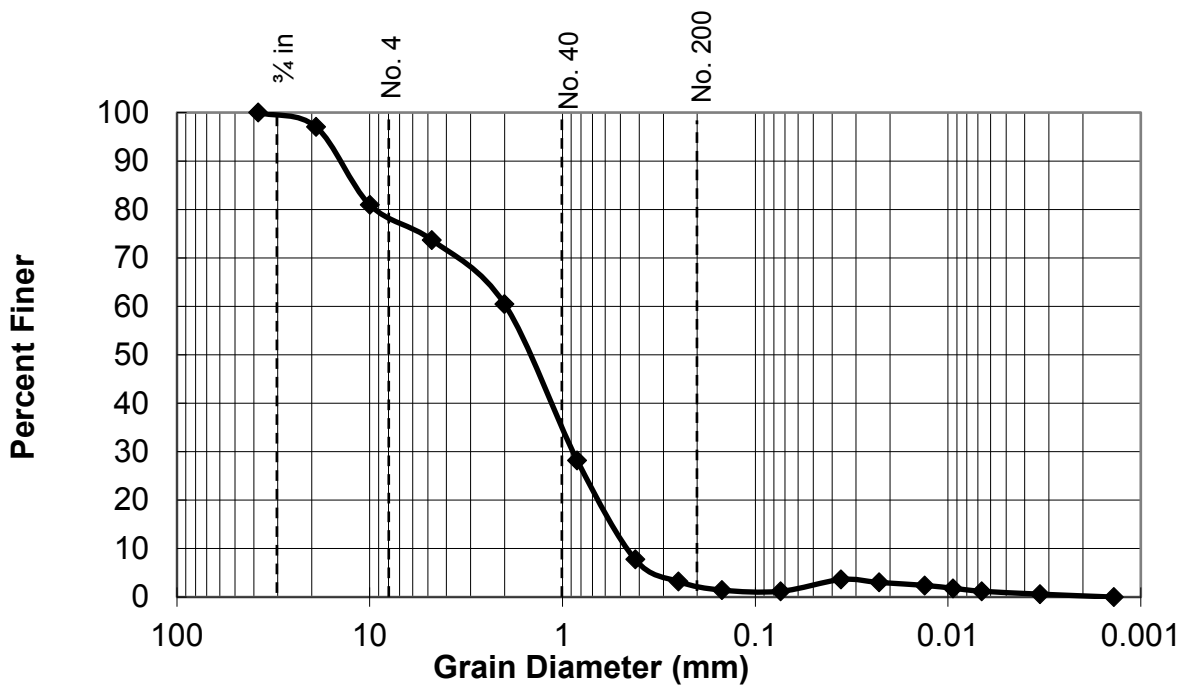
Fax (703) 726-8032

HYDROMETER ANALYSIS

Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	Streambed	**Depth (Feet)**	Paige County near Cub Run
Lab Order No.	3384-64	**Date**	10/2/2014



SIEVE	% Passing
1 ½ "	**100.0**
3/4"	**97.0**
3/8"	**81.0**
#4	**73.7**
#10	**60.5**
#40	**7.8**
#100	**1.4**
#200	**1.2**
Pan	**--**

USCS Group Symbol	**SP**
USCS Group Name	**POORLY GRADED SAND with gravel**
Cu	**4.3**
Cc	**0.9**
LL	**NP**
PI	**NP**
Gravel	**26.3**
Sand	**72.5**
Silt	**1.0**
Clay	**0.2**
Fines	**1.2**
AASHTO Classification	**A-2-4**

Test Method: ASTM D 422
Soil Classification by ASTM D2487 and AASHTO M 145

Tested by _____ Reviewed by _____

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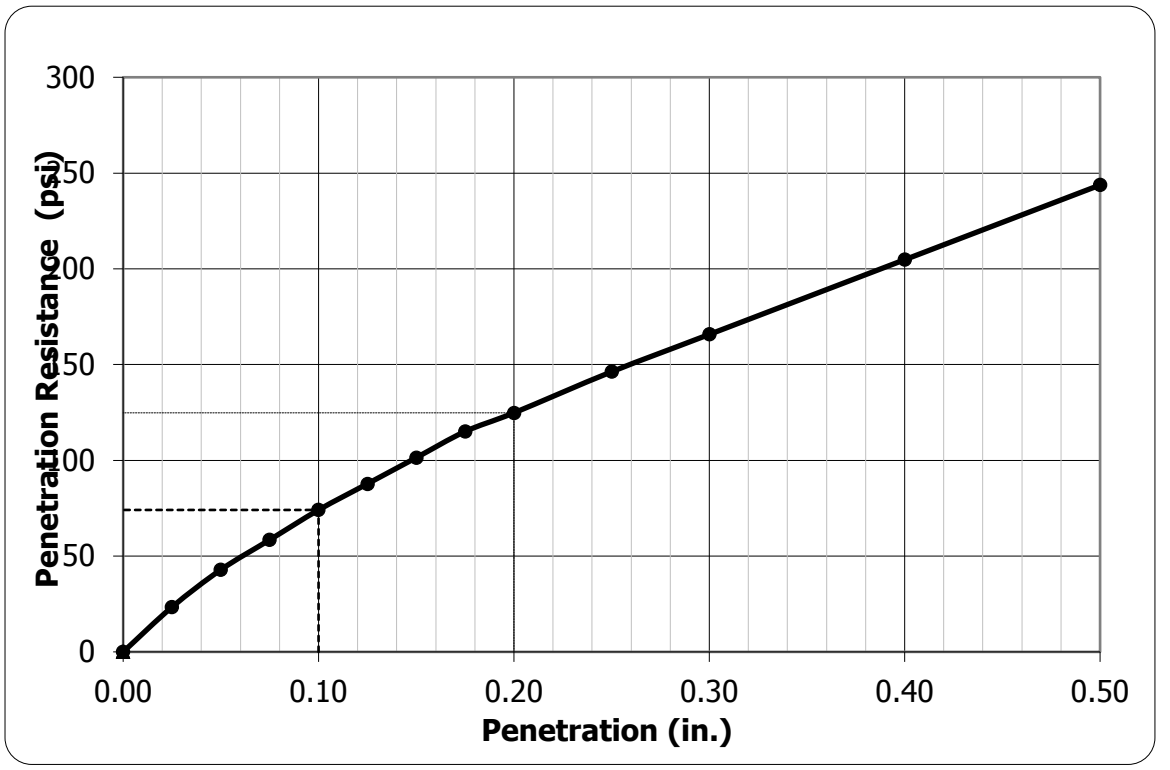
CALIFORNIA BEARING RATIO (CBR) TEST - VTM-008			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	R-1	**Depth (Feet)**	3.0'-5.0'
Lab Order No.	3388-1	**Date**	10/2/2014



Molded	
Dry Density (pcf)	**127.7**
Moisture (%)	**9.0**
Percent of Max. Density (%)	**99.8**

Soaked	
Dry Density (pcf)	**127.5**
Moisture (%)	**10.3**
Percentage of Max. Density (%)	**99.6**

CBR (%)	
0.1 in.	**7.4**
0.2 in.	**8.3**

Linearity Correction	**0.000**
Surcharge (lbs)	**10**
Max Swell (%)	**0.2**

Material Description	CLAYEY SAND
USCS	**SC**
Max Density	**128**
Optimum Moisture (%)	**9**
LL	**25**
PI	**12**
Color	**Dark Brownish Gray**

Tested by: _____

Reviewed by: _____

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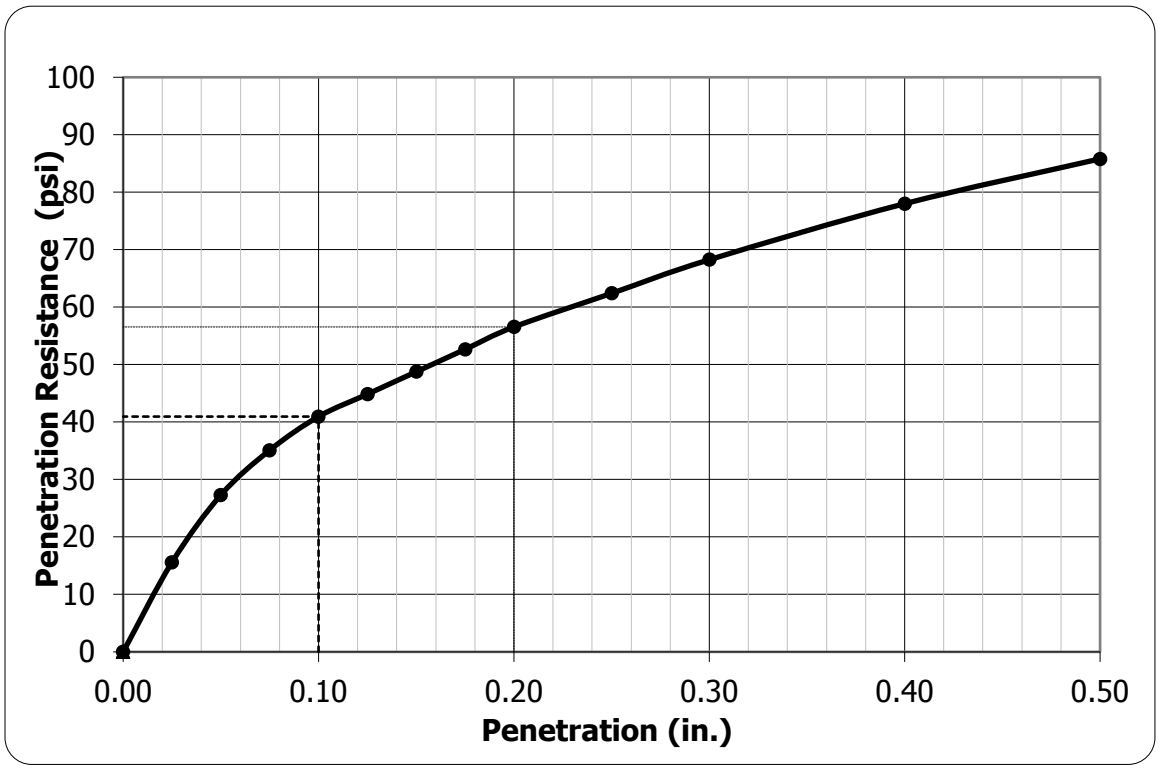
CALIFORNIA BEARING RATIO (CBR) TEST - VTM-008			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	R-3	**Depth (Feet)**	1.0'-5.0'
Lab Order No.	3384-37	**Date**	10/2/2014



Molded	
Dry Density (pcf)	**109.9**
Moisture (%)	**16.1**
Percent of Max. Density (%)	**99.9**

Soaked	
Dry Density (pcf)	**105.9**
Moisture (%)	**22.4**
Percentage of Max. Density (%)	**96.2**

CBR (%)	
0.1 in.	**4.1**
0.2 in.	**3.8**

Linearity Correction	**0.000**
Surcharge (lbs)	**10**
Max Swell (%)	**3.8**

Material Description	Fat Clay with sand
USCS	**CH**
Max Density	**110**
Optimum Moisture (%)	**16**
LL	**68**
PI	**46**
Color	**Brown**

Tested by: _____

Reviewed by: _____

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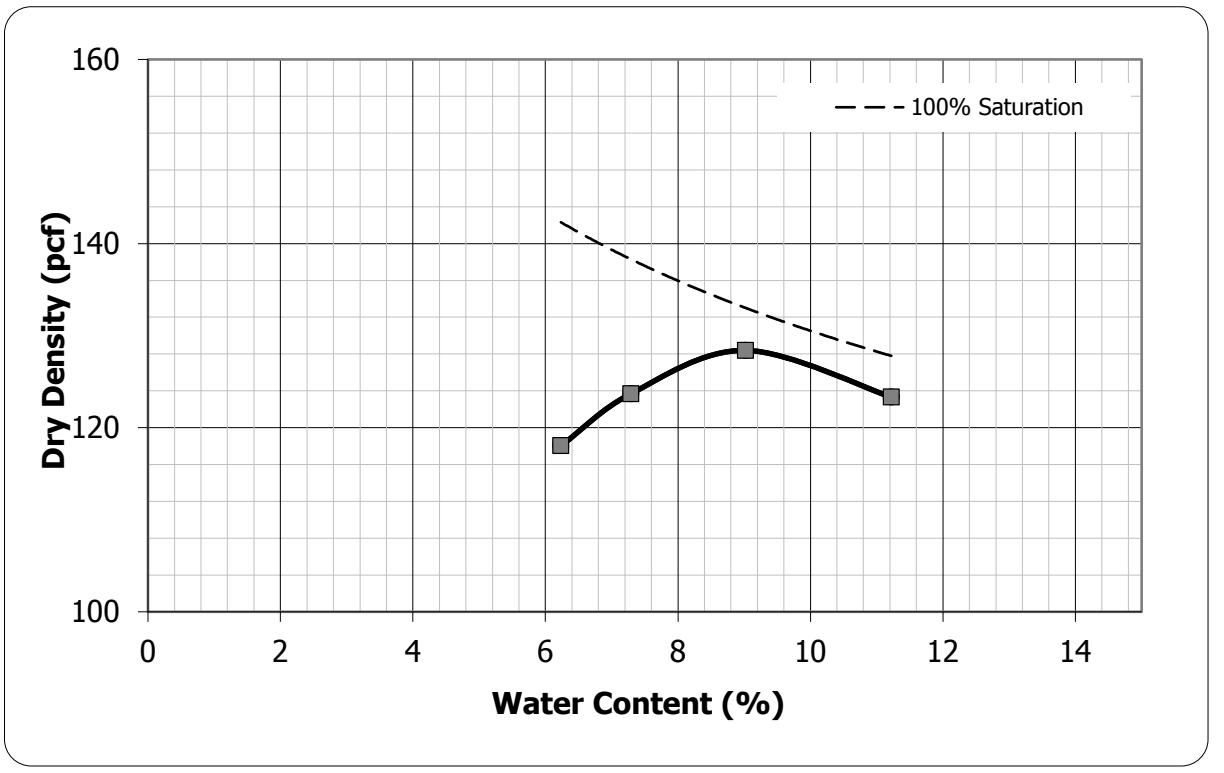
MOISTURE DENSITY RELATIONSHIP - VTM-001			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	R-1	**Depth (Feet)**	3.0'-5.0'
Lab Order No.	3388-1	**Date**	10/2/2014



TEST RESULTS	**Before Correc.**		**After Correc.**					
Maximum Dry Density (pcf)	128		--		**Color**			
Optimum Moisture Content (%)	9		--		Dark Brownish Gray			
Material	**Classification**		**Nat. Moist. (%)**	**Sp. G. (Assumed)**	**LL**	**PI**	**% > # 4**	**% < #200**
CLAYEY SAND	USCS	AASHTO	9.4	2.65	25	12	6.6	40.3
	SC	A-6						

Tested by _____

Reviewed by _____

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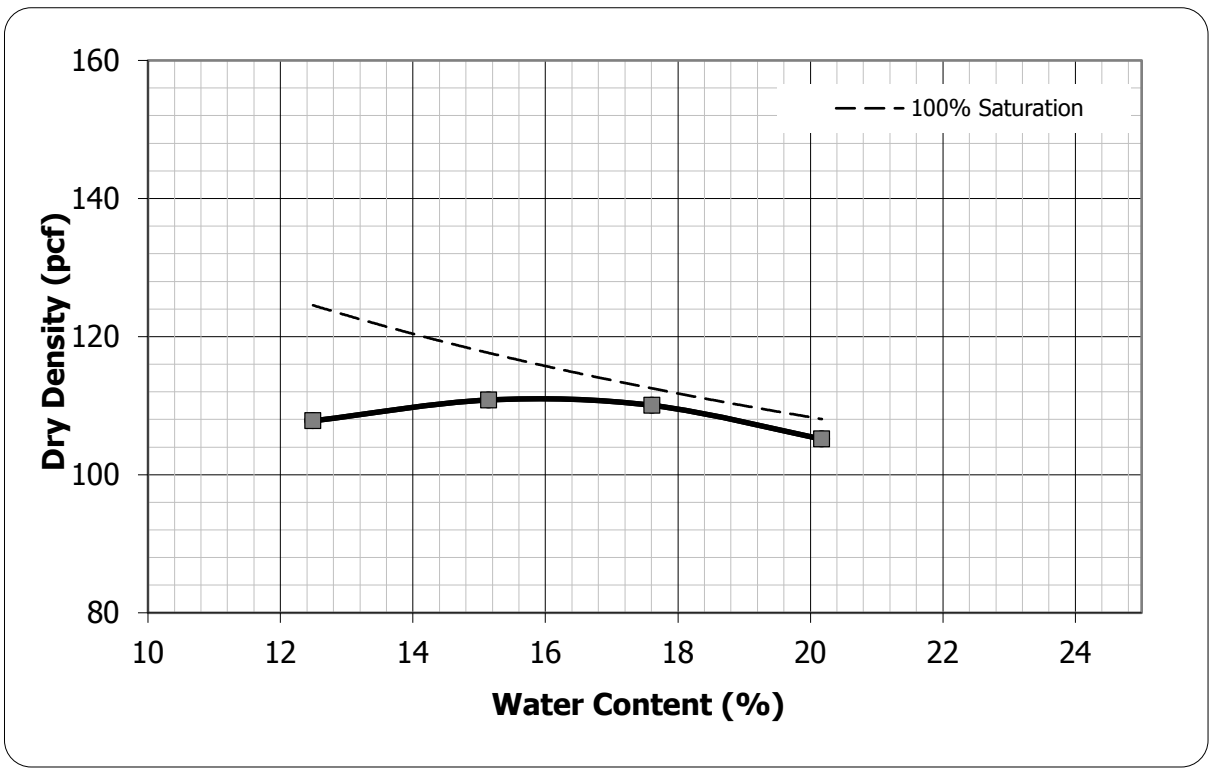
MOISTURE DENSITY RELATIONSHIP - VTM-001			
Project No.	13004.01	**Project Name**	Route 340 Bridge over Cub Run
Test Boring No.	R-3	**Depth (Feet)**	1.0'-5.0'
Lab Order No.	3384-37	**Date**	10/2/2014



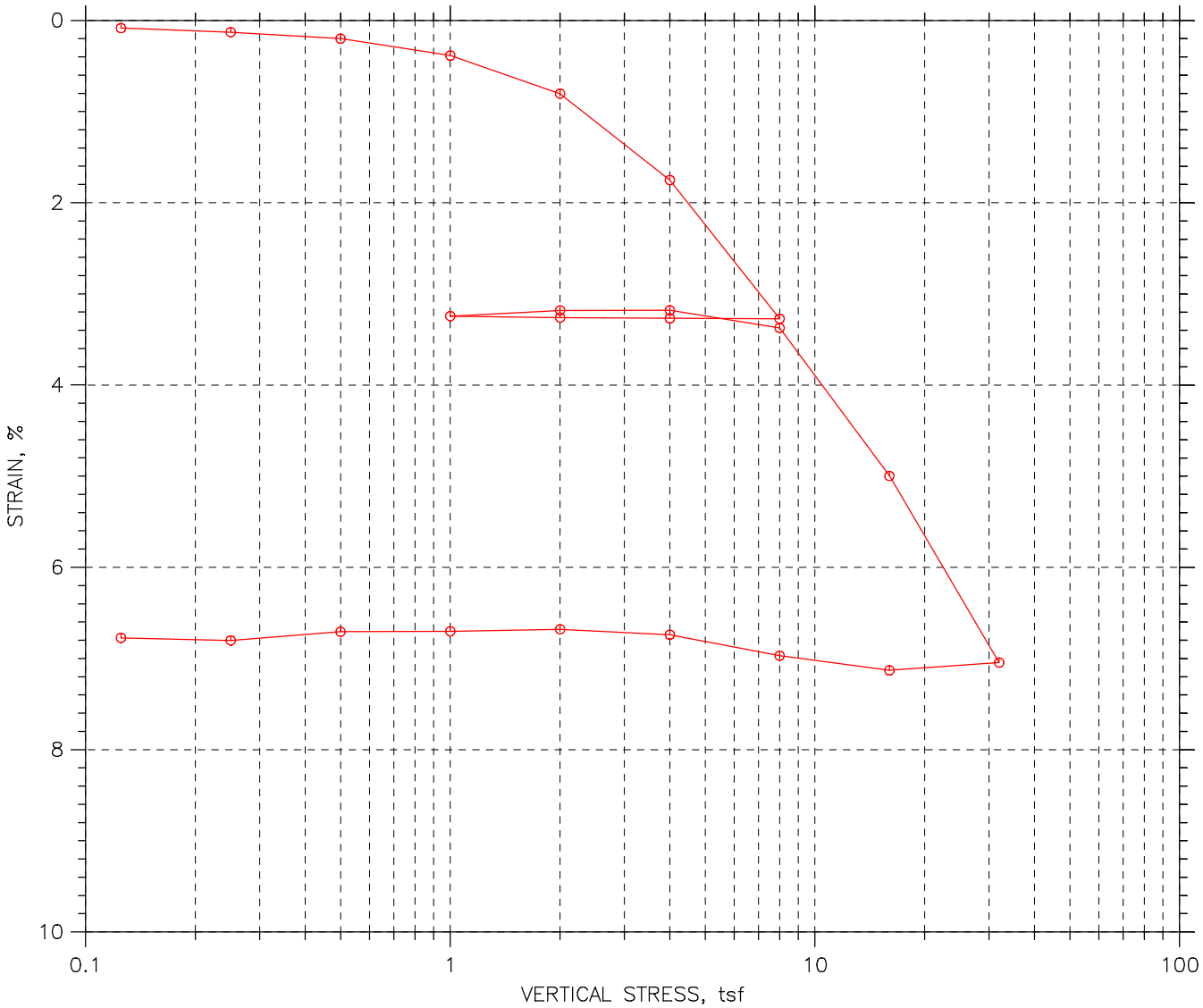
TEST RESULTS	Before Correc.		After Correc.					
Maximum Dry Density (pcf)	110		--		Color			
Optimum Moisture Content (%)	16		--		Brown			
Material	**Classification**		**Nat. Moist. (%)**	**Sp. G. (Assumed)**	**LL**	**PI**	**% > # 4**	**% < #200**
Fat Clay with sand	USCS	AASHTO	22.7	2.65	68	46	2.6	72.0
	CH	A-7-6						

Tested by _____

Reviewed by _____

CONSOLIDATION TEST DATA

SUMMARY REPORT



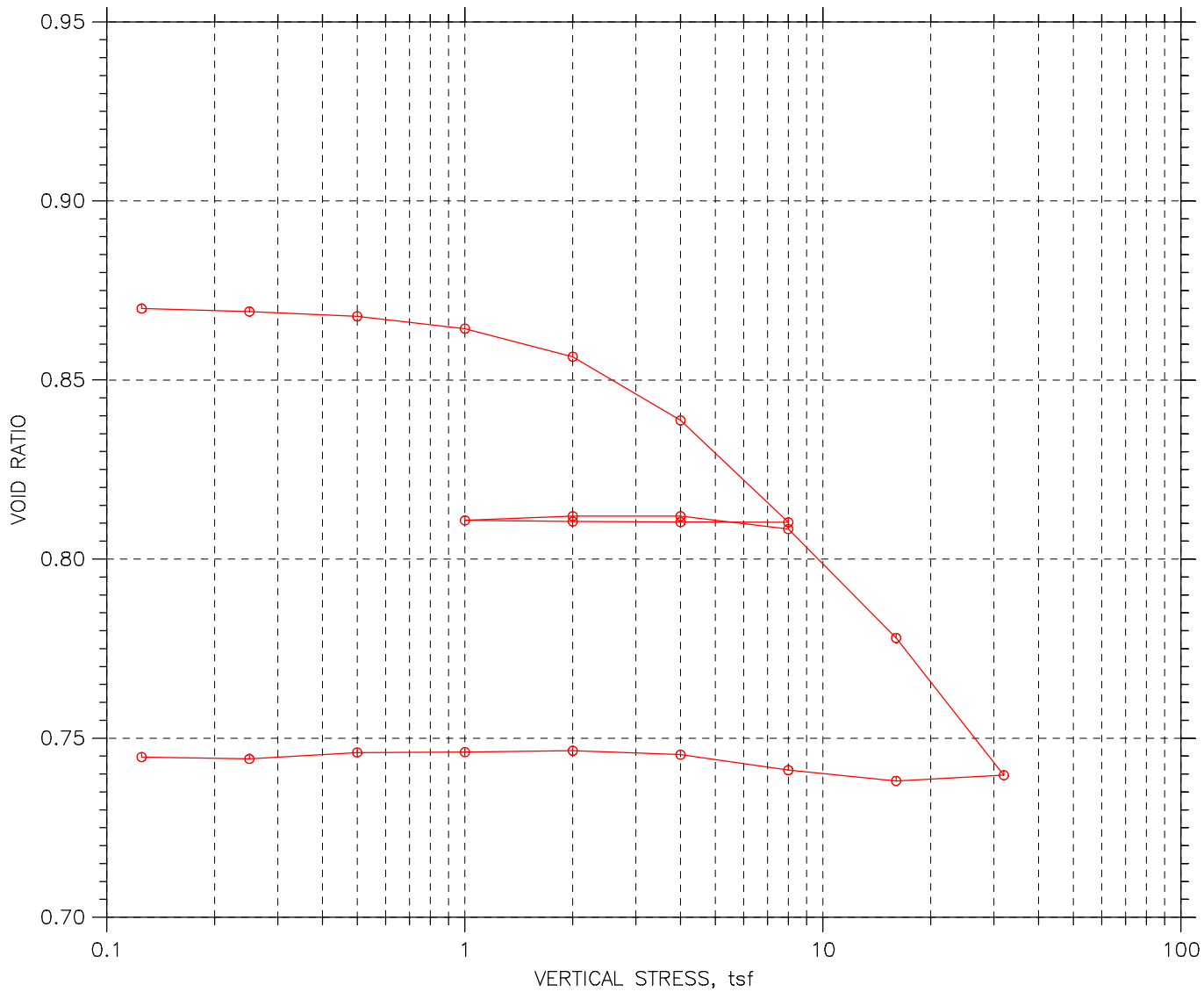
					Before Test	After Test
Overburden Pressure: 0.45 tsf				Water Content, %	29.94	28.53
Preconsolidation Pressure: 5.5 tsf				Dry Unit Weight, pcf	88.4	94.82
Compression Index: 0.11				Saturation, %	91.03	101.53
Diameter: 2.5 in		Height: 1 in		Void Ratio	0.87	0.74
LL: 51	PL: 27	PI: 24	GS: 2.65			

F&R SINCE 1881	Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
	Boring No.: SL-3	Tested By: AS	Checked By:
	Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
	Test No.:	Sample Type: ST	Elevation:
	Description: Orange-brown silt(visual ML)		
	Remarks: F&R Project # 75S0102		

Thu, 09-OCT-2014 10:38:39

CONSOLIDATION TEST DATA

SUMMARY REPORT



					Before Test	After Test
Overburden Pressure: 0.45 tsf				Water Content, %	29.94	28.53
Preconsolidation Pressure: 5.5 tsf				Dry Unit Weight, pcf	88.4	94.82
Compression Index: 0.11				Saturation, %	91.03	101.53
Diameter: 2.5 in		Height: 1 in		Void Ratio	0.87	0.74
LL: 51	PL: 27	PI: 24	GS: 2.65			

F&R SINCE 1881	Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
	Boring No.: SL-3	Tested By: AS	Checked By:
	Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
	Test No.:	Sample Type: ST	Elevation:
	Description: Orange-brown silt(visual ML)		
	Remarks: F&R Project # 75S0102		

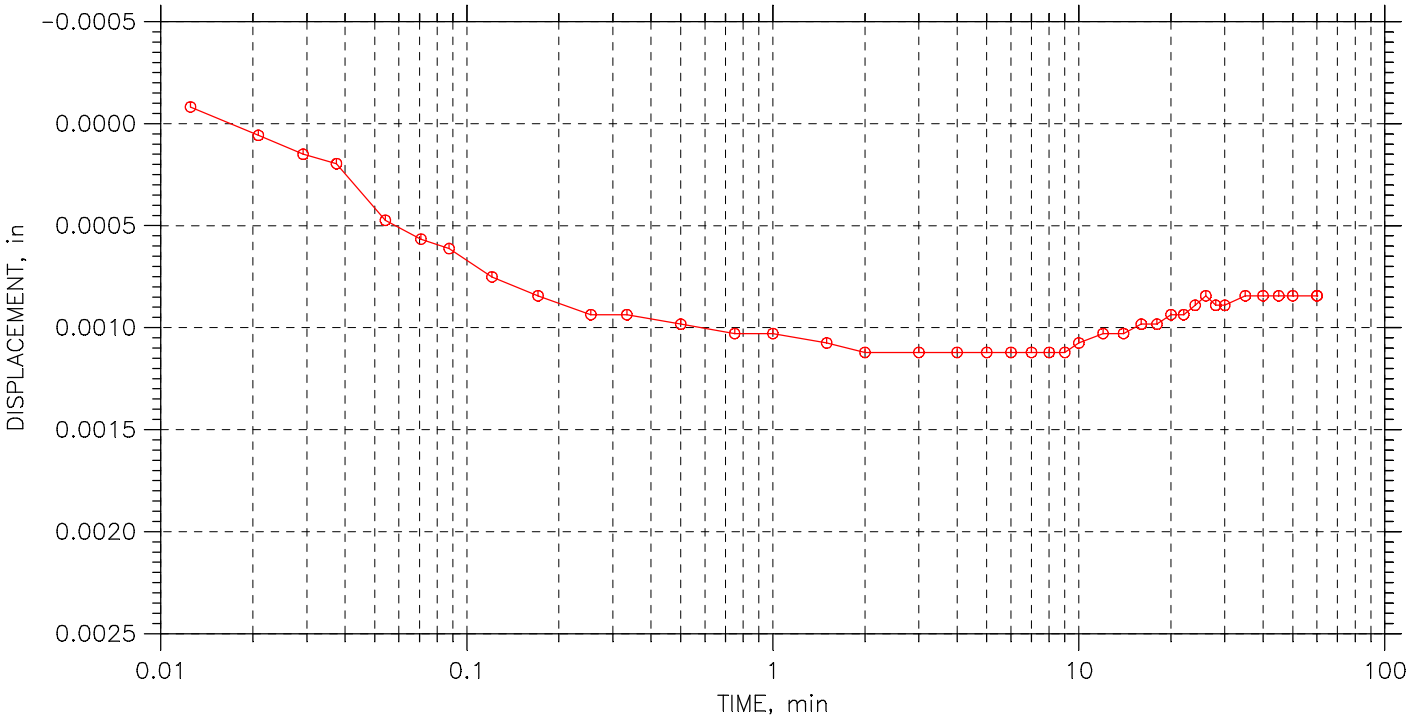
Thu, 09-OCT-2014 10:39:14

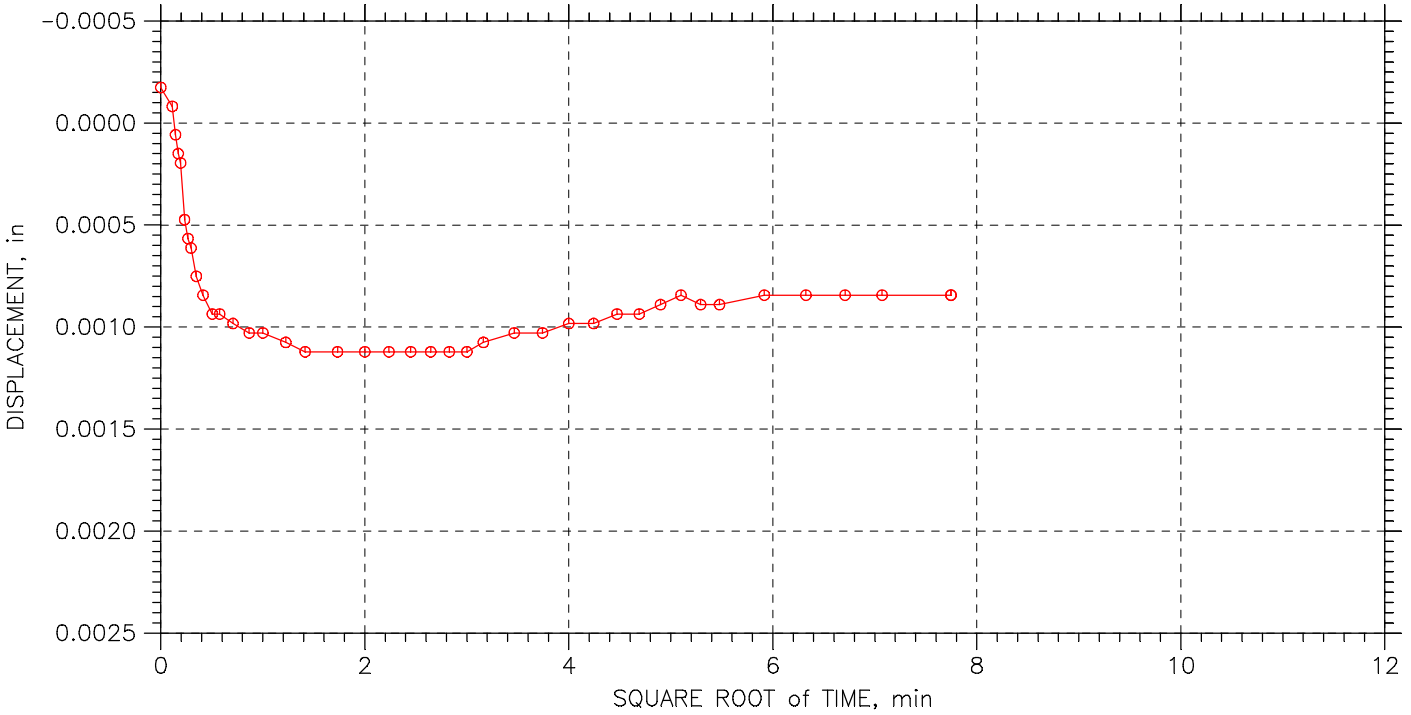
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 1 of 23

Stress: 0.125 tsf





Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
Boring No.: SL-3	Tested By: AS	Checked By:
Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
Test No.:	Sample Type: ST	Elevation:
Description: Orange-brown silt(visual ML)		
Remarks: F&R Project # 75S0102		

F&R SINCE 1881

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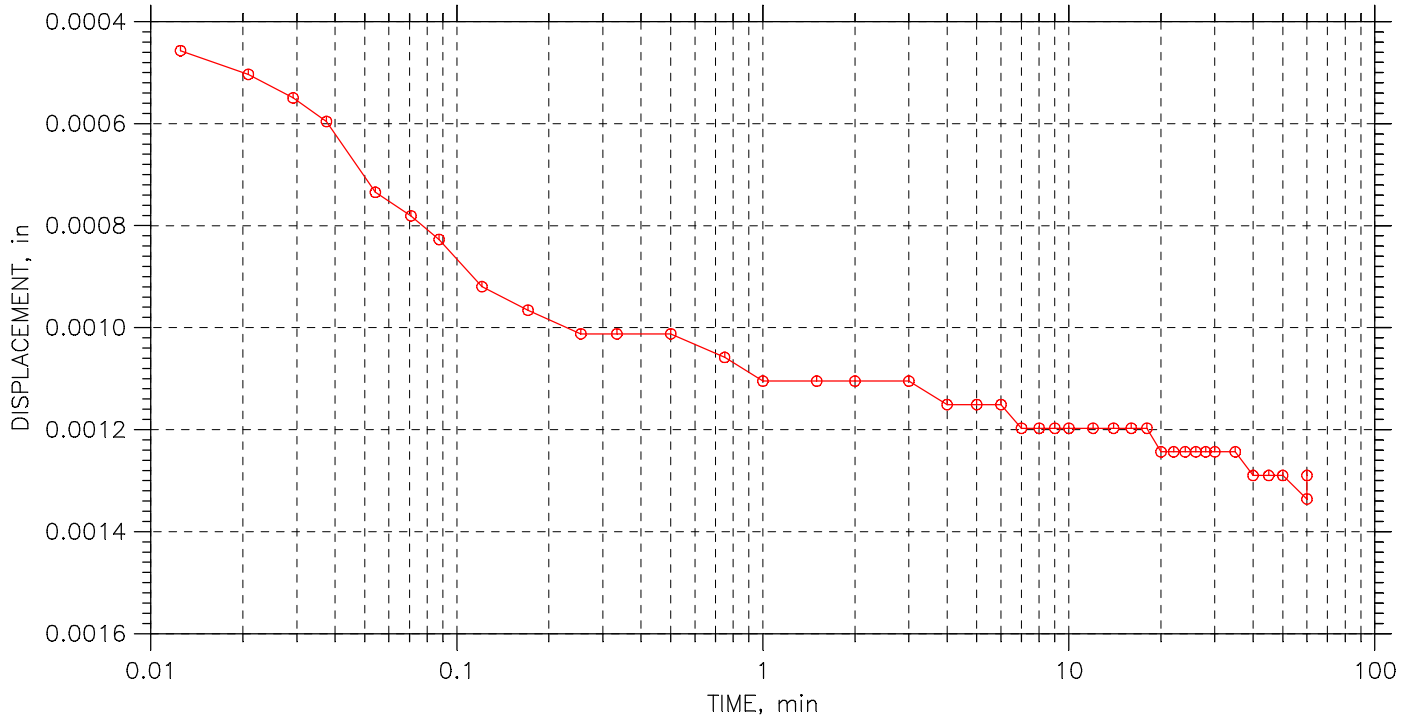
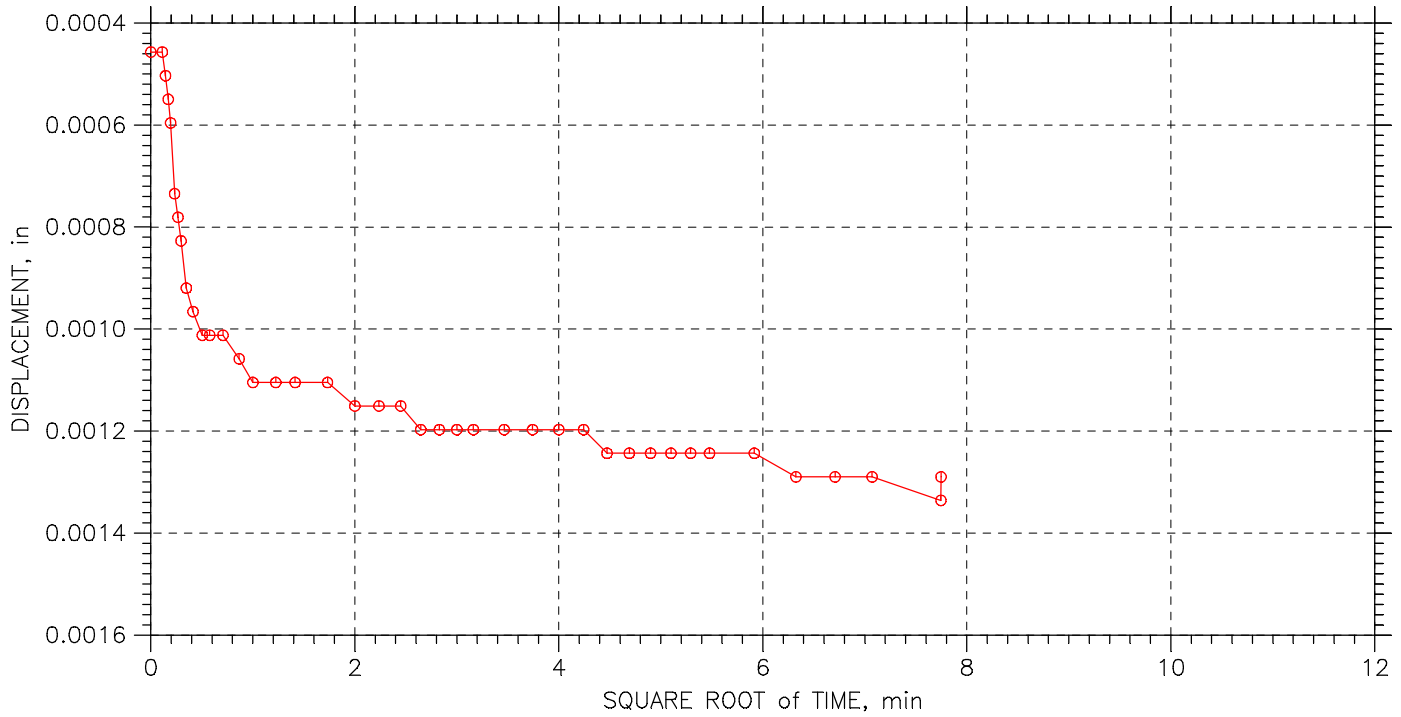
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 2 of 23

Stress: 0.25 tsf





	Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
	Boring No.: SL-3	Tested By: AS	Checked By:
	Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
	Test No.:	Sample Type: ST	Elevation:
	Description: Orange-brown silt(visual ML)		
	Remarks: F&R Project # 75S0102		

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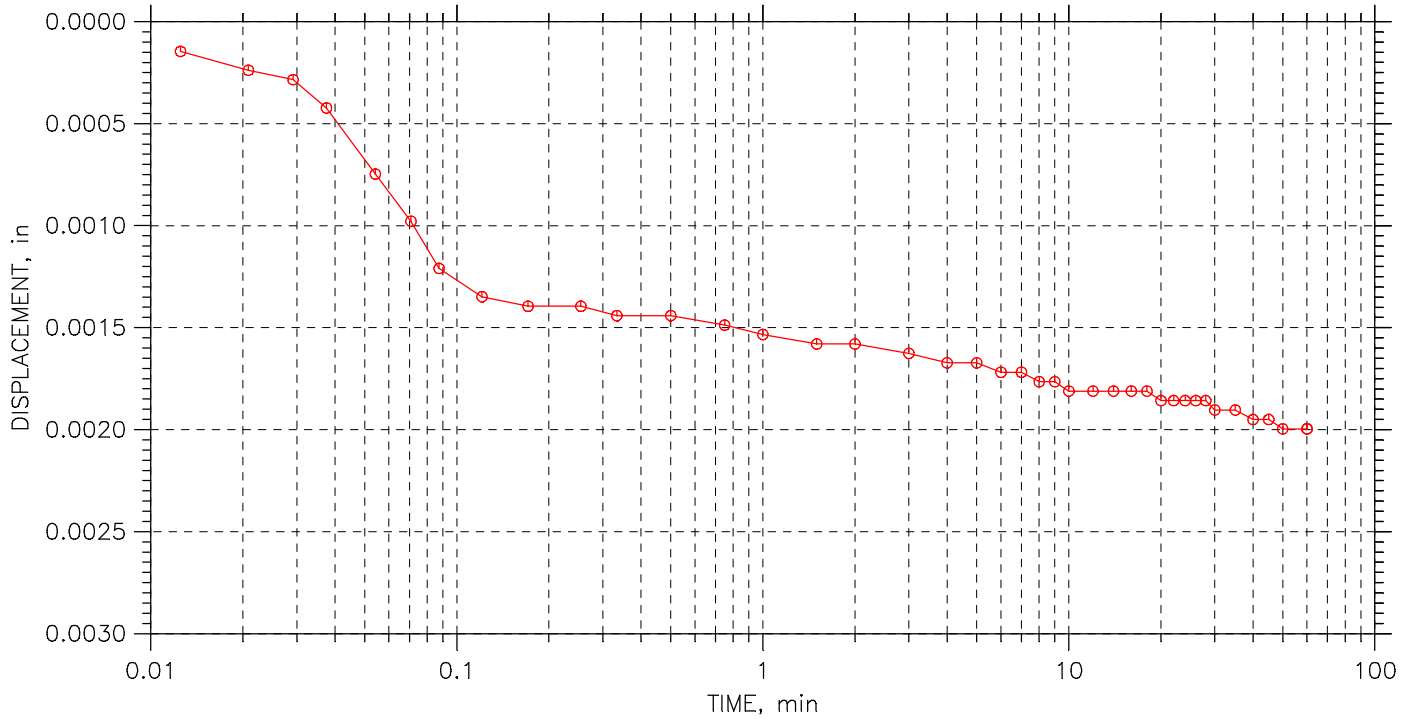
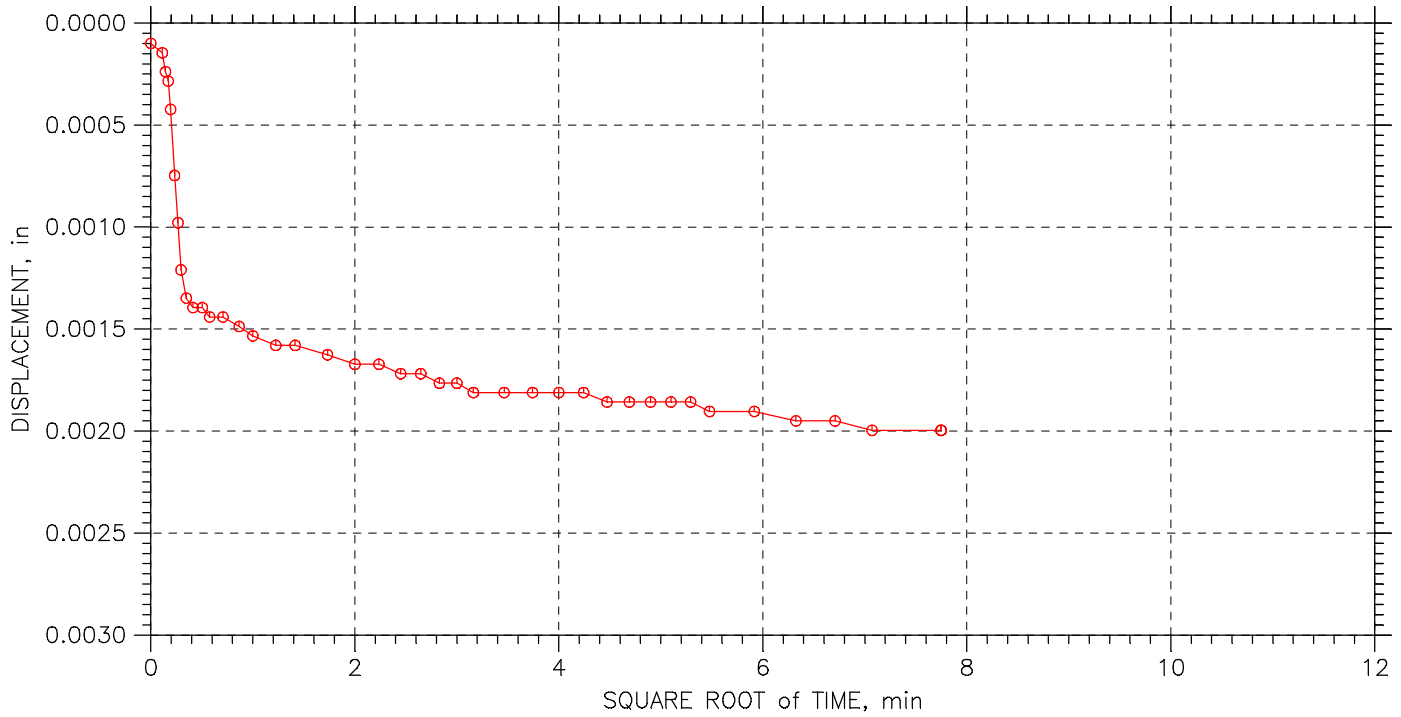
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 3 of 23

Stress: 0.5 tsf





Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
Boring No.: SL-3	Tested By: AS	Checked By:
Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
Test No.:	Sample Type: ST	Elevation:
Description: Orange-brown silt(visual ML)		
Remarks: F&R Project # 75S0102		

F&R SINCE 1881

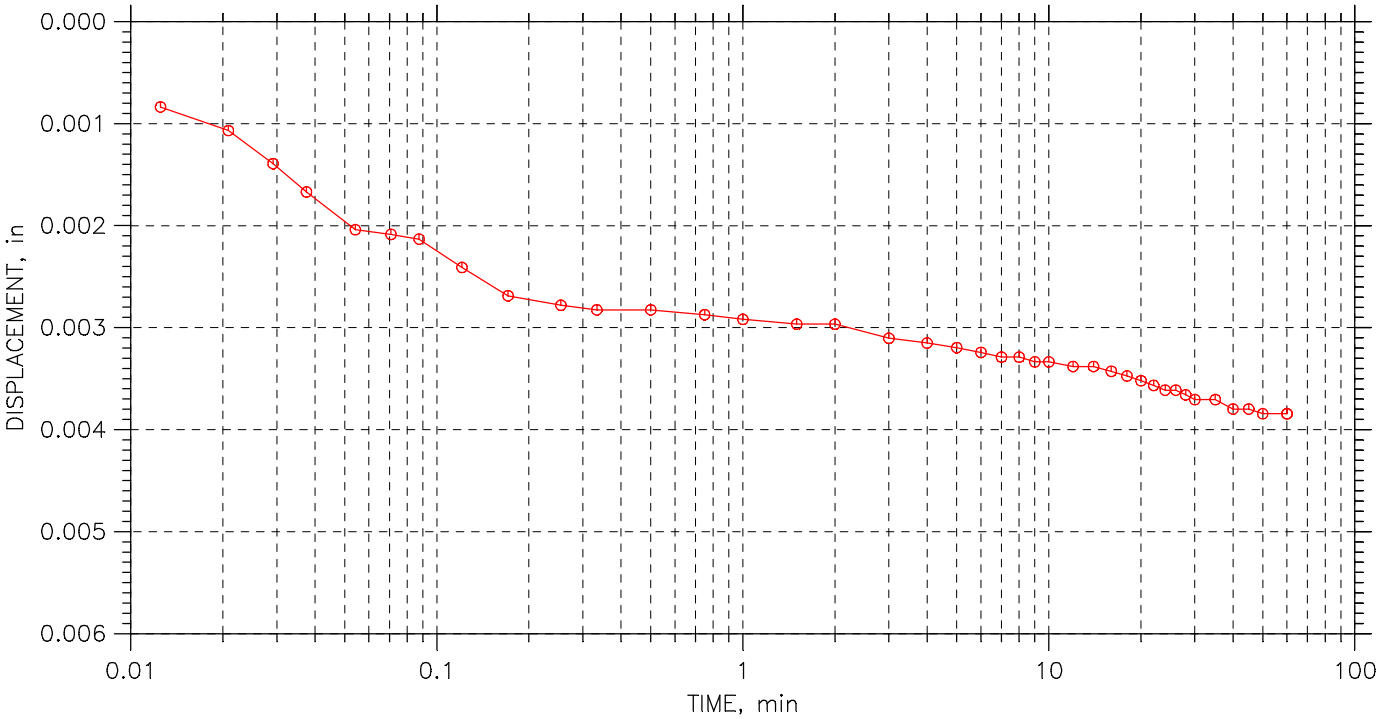
Thu, 09-OCT-2014 10:37:49

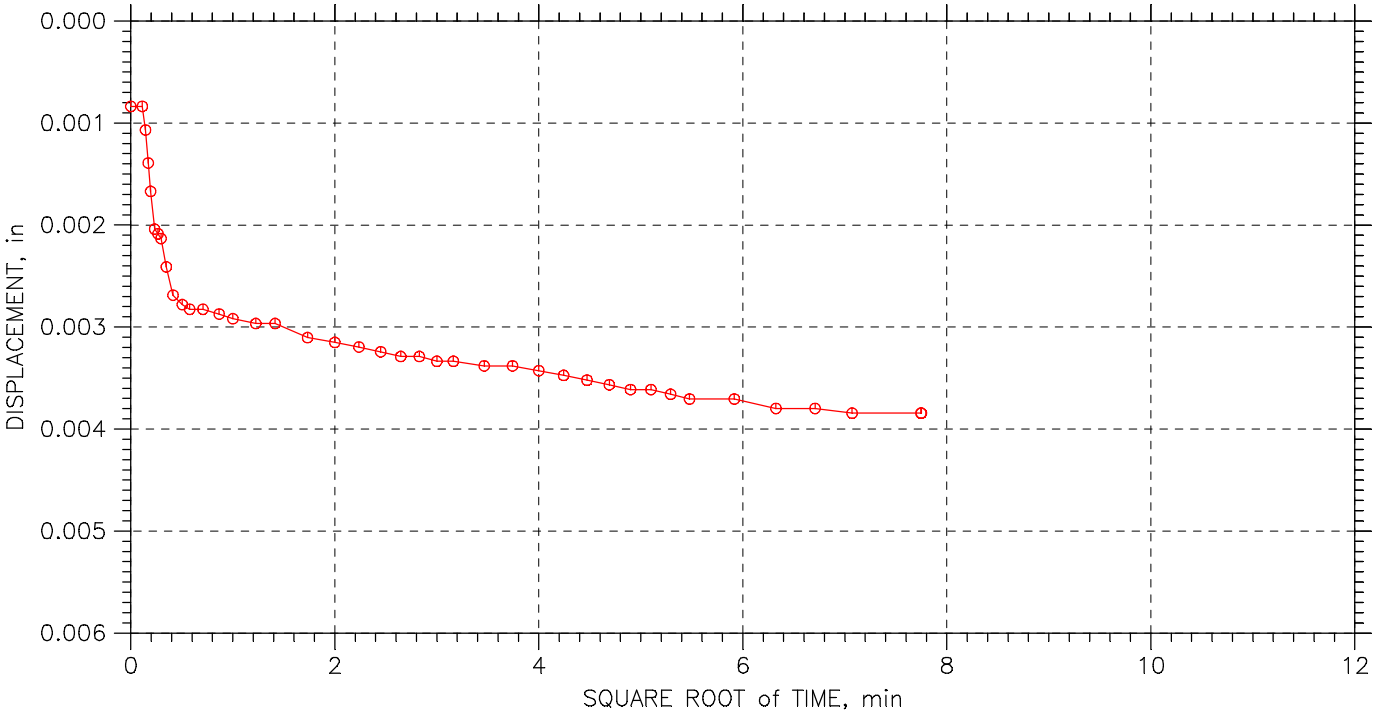
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 4 of 23

Stress: 1. tsf





	Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
	Boring No.: SL-3	Tested By: AS	Checked By:
	Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
	Test No.:	Sample Type: ST	Elevation:
	Description: Orange-brown silt(visual ML)		
	Remarks: F&R Project # 75S0102		

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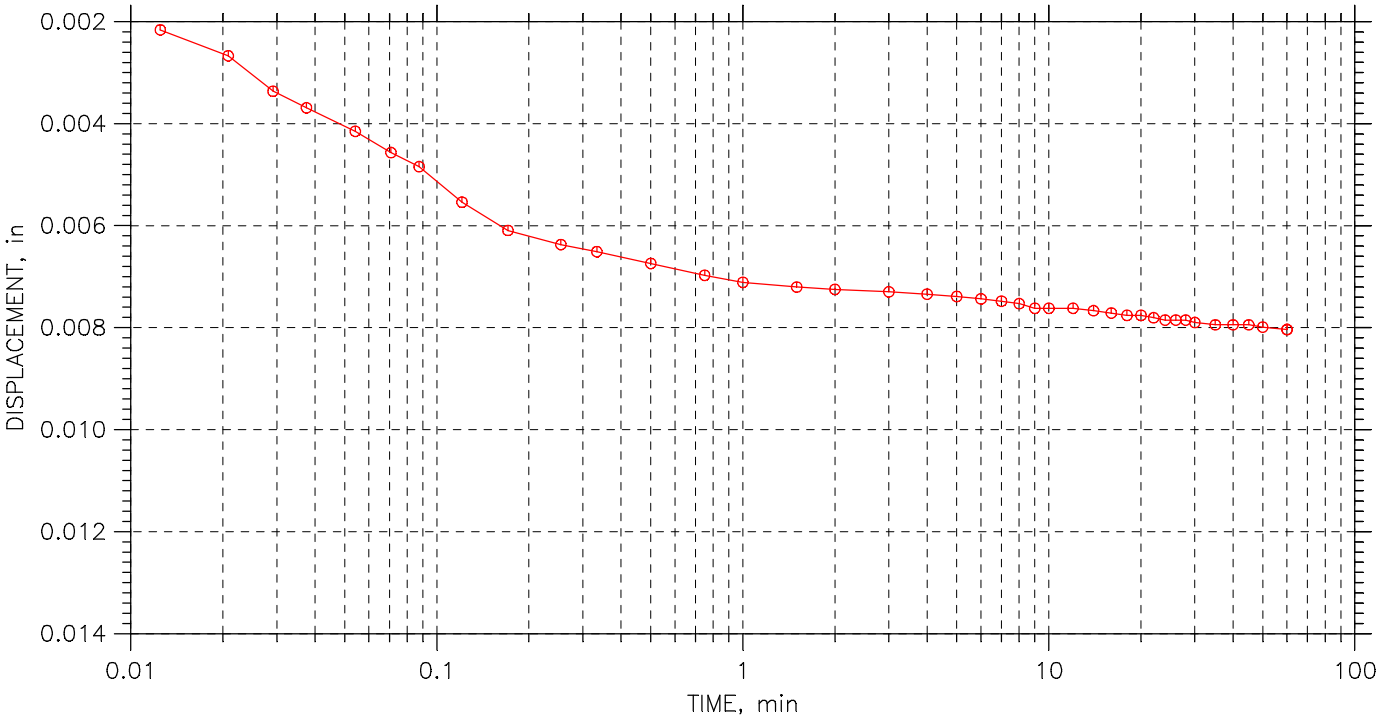
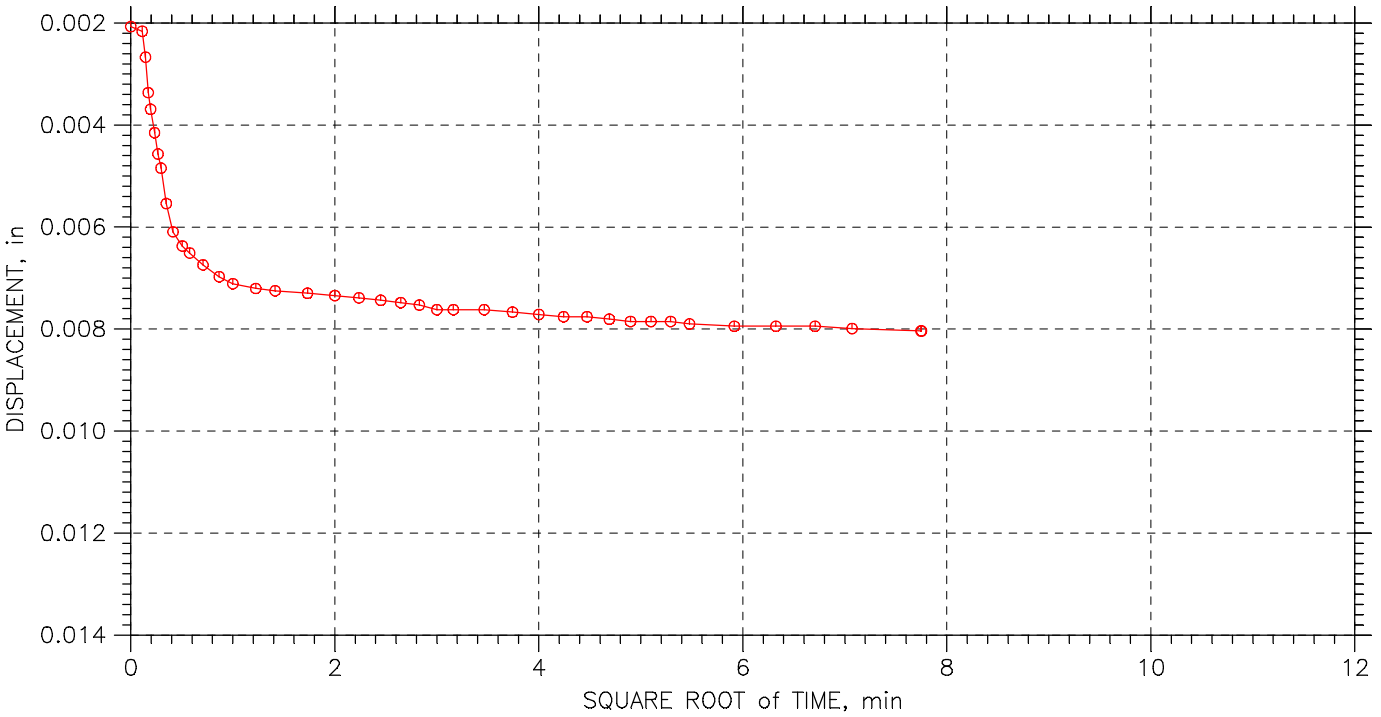
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 5 of 23

Stress: 2. tsf





Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
Boring No.: SL-3	Tested By: AS	Checked By:
Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
Test No.:	Sample Type: ST	Elevation:
Description: Orange-brown silt(visual ML)		
Remarks: F&R Project # 75S0102		

F&R SINCE 1881

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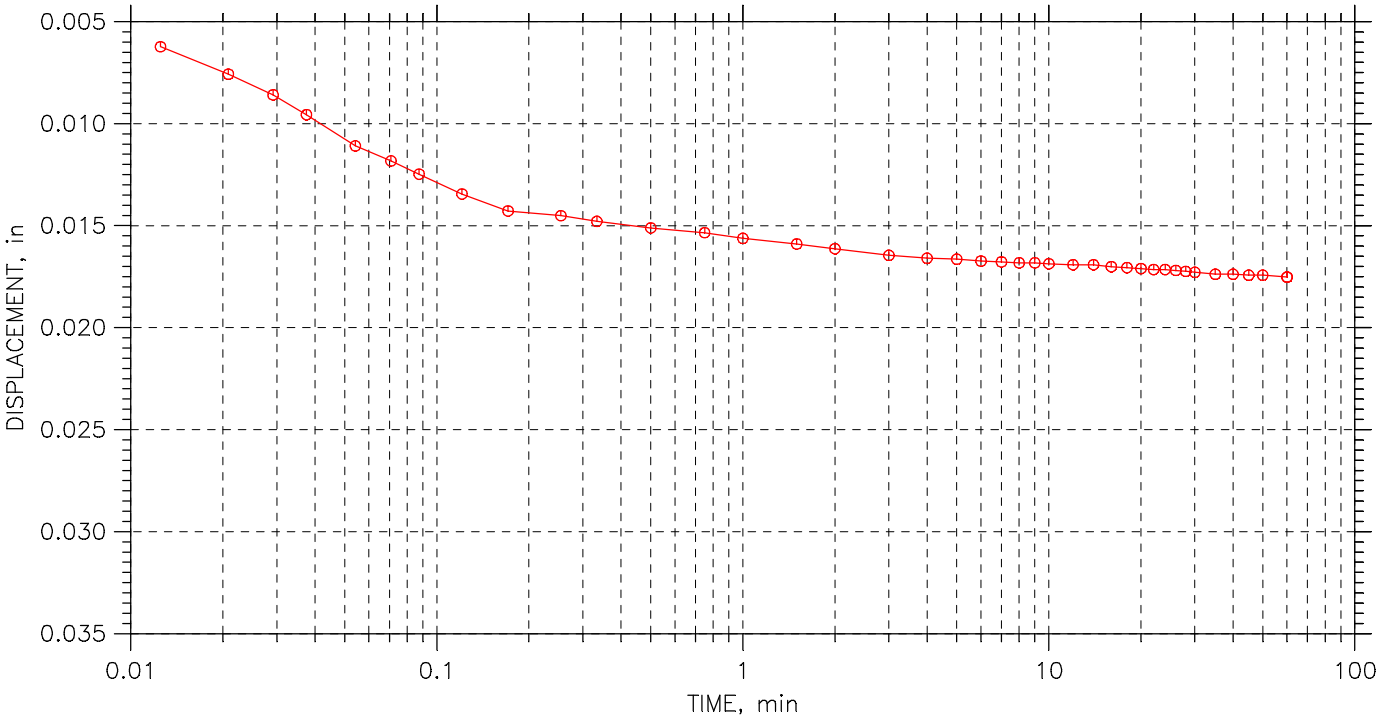
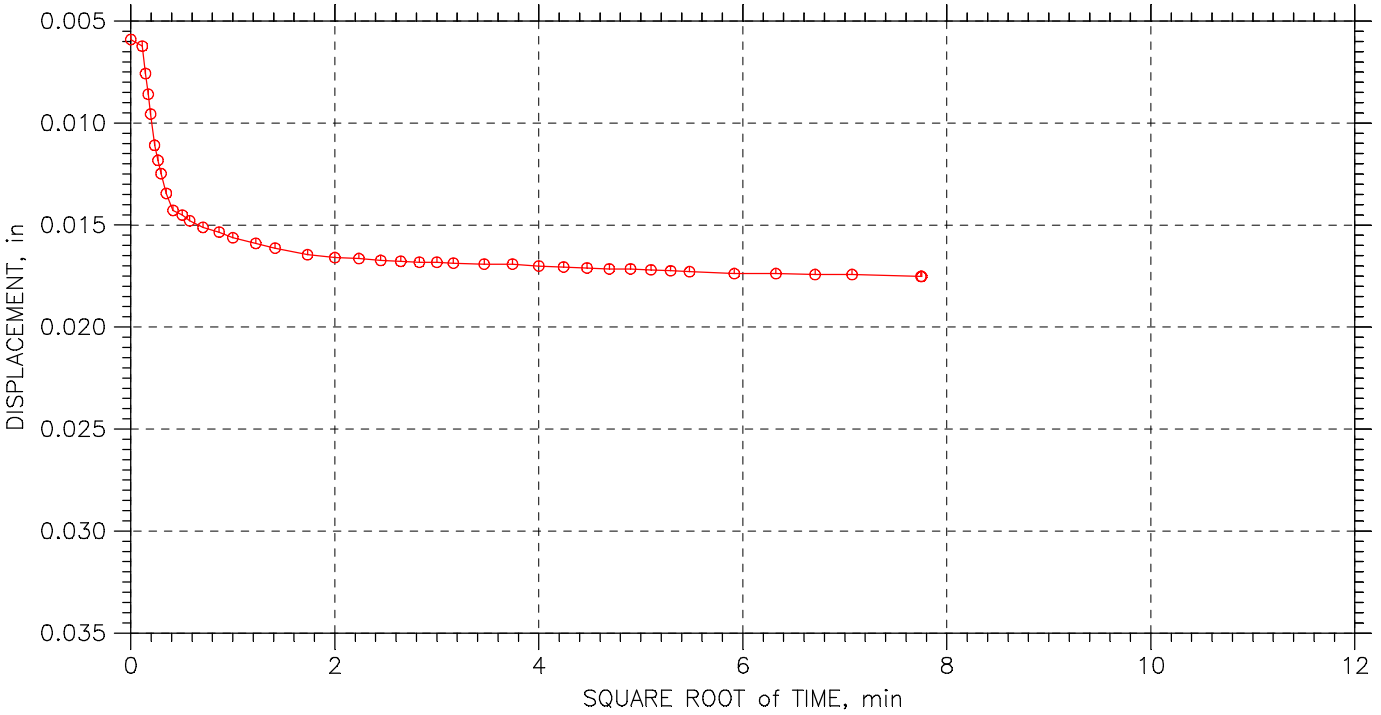
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 6 of 23

Stress: 4. tsf





	Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
	Boring No.: SL-3	Tested By: AS	Checked By:
	Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
	Test No.:	Sample Type: ST	Elevation:
	Description: Orange-brown silt(visual ML)		
	Remarks: F&R Project # 75S0102		

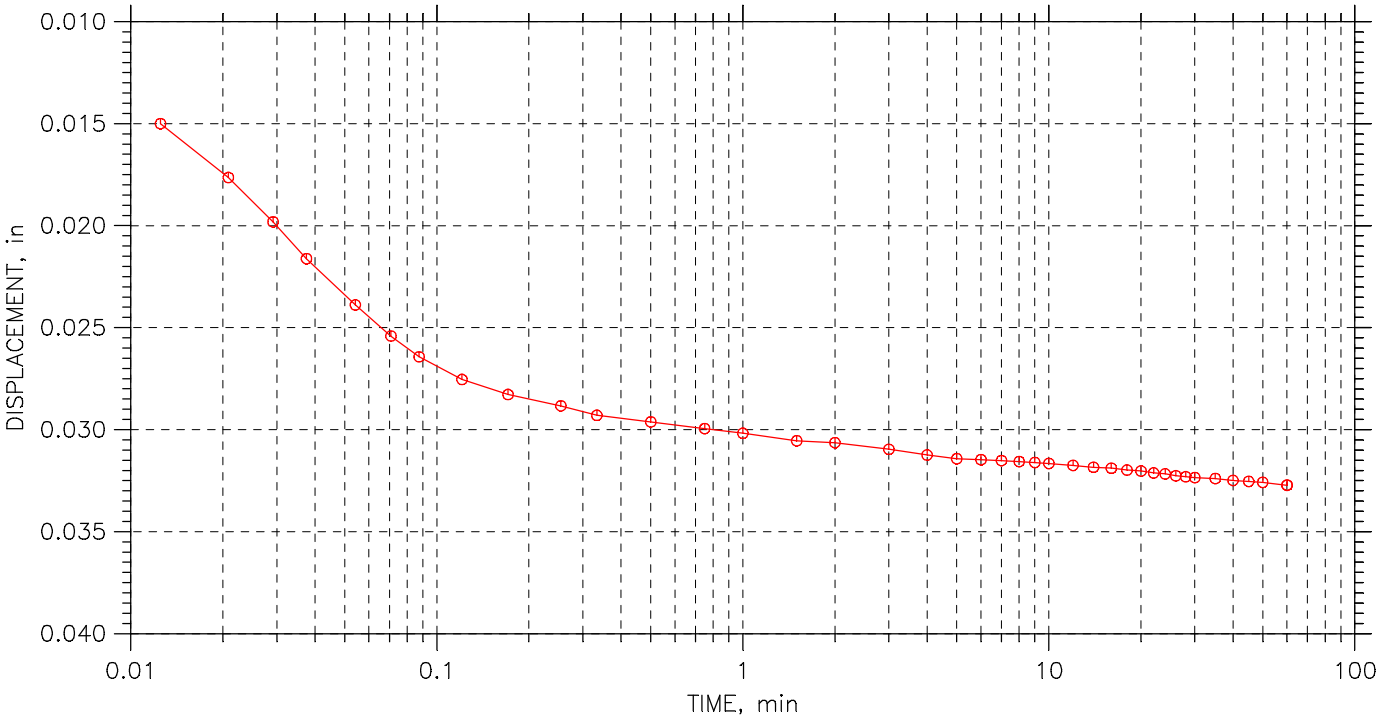
Thu, 09-OCT-2014 10:37:49

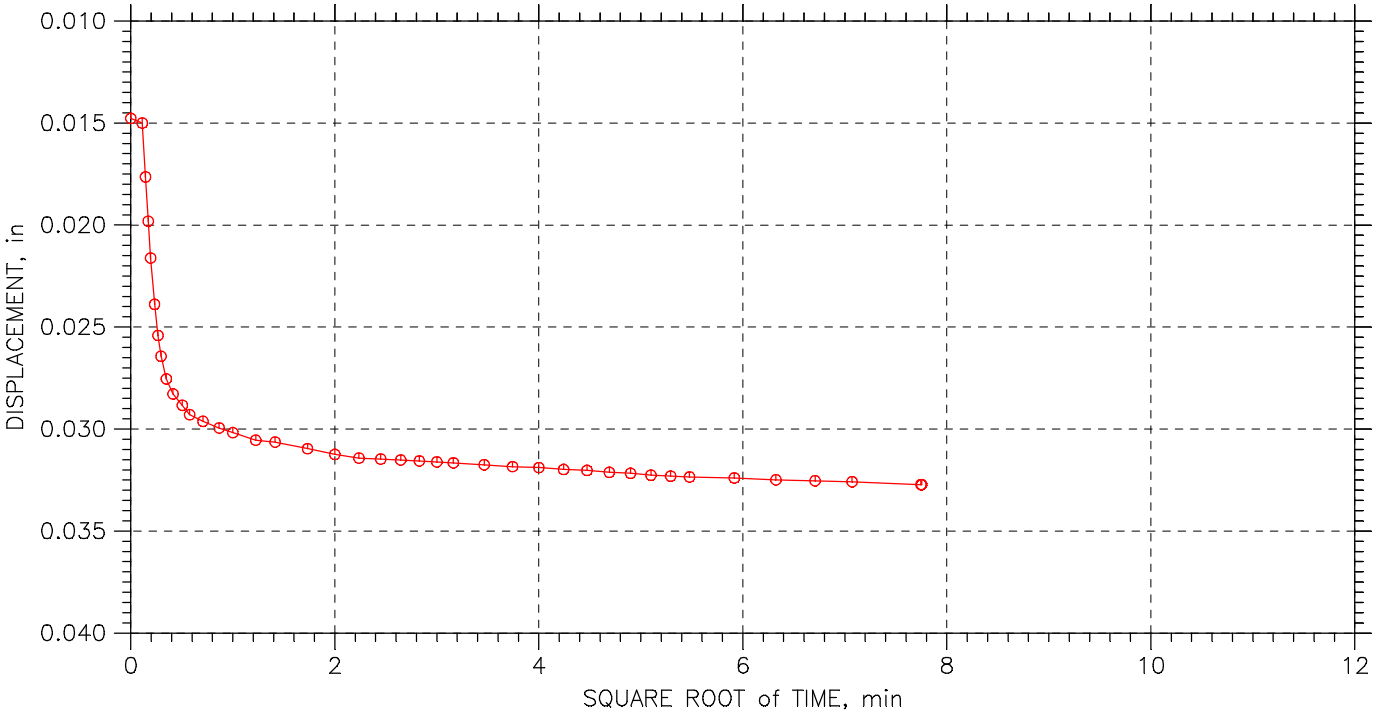
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 7 of 23

Stress: 8. tsf





	Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
	Boring No.: SL-3	Tested By: AS	Checked By:
	Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
	Test No.:	Sample Type: ST	Elevation:
	Description: Orange-brown silt(visual ML)		
	Remarks: F&R Project # 75S0102		

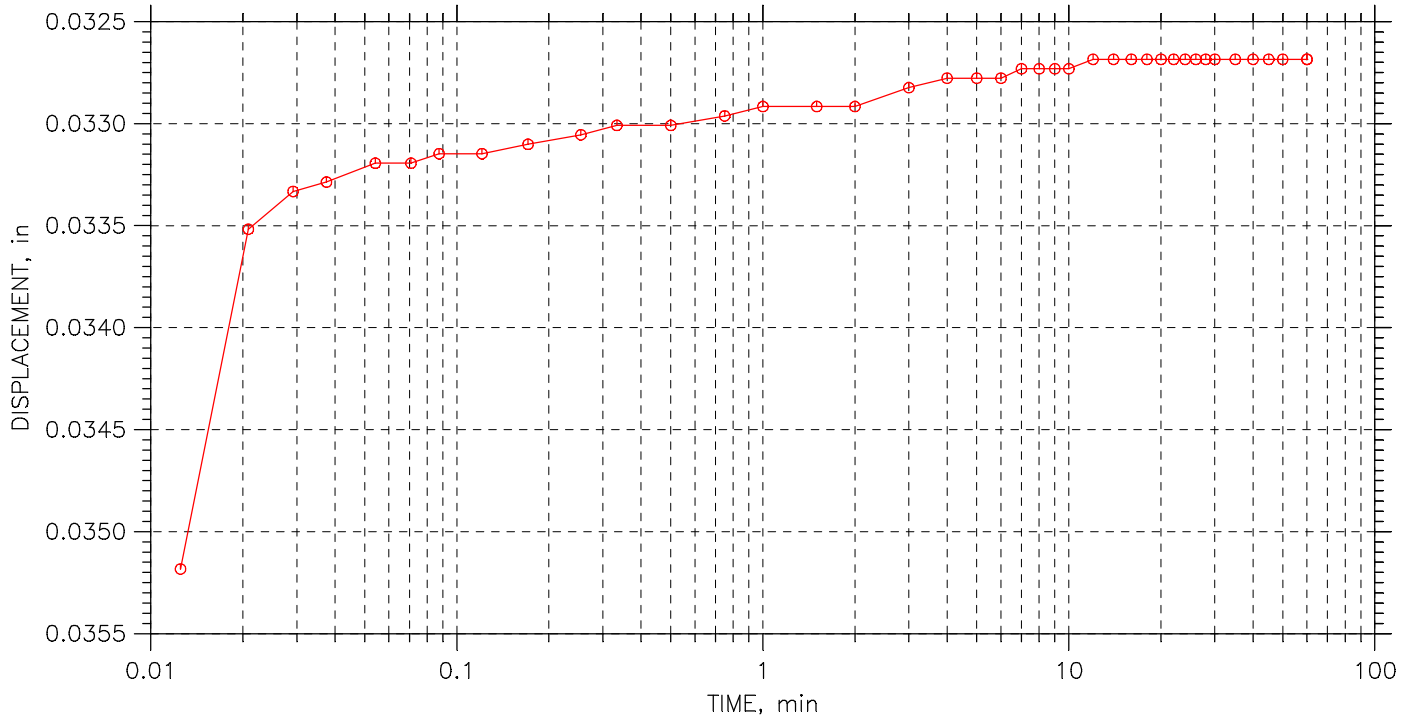
Thu, 09-OCT-2014 10:37:49

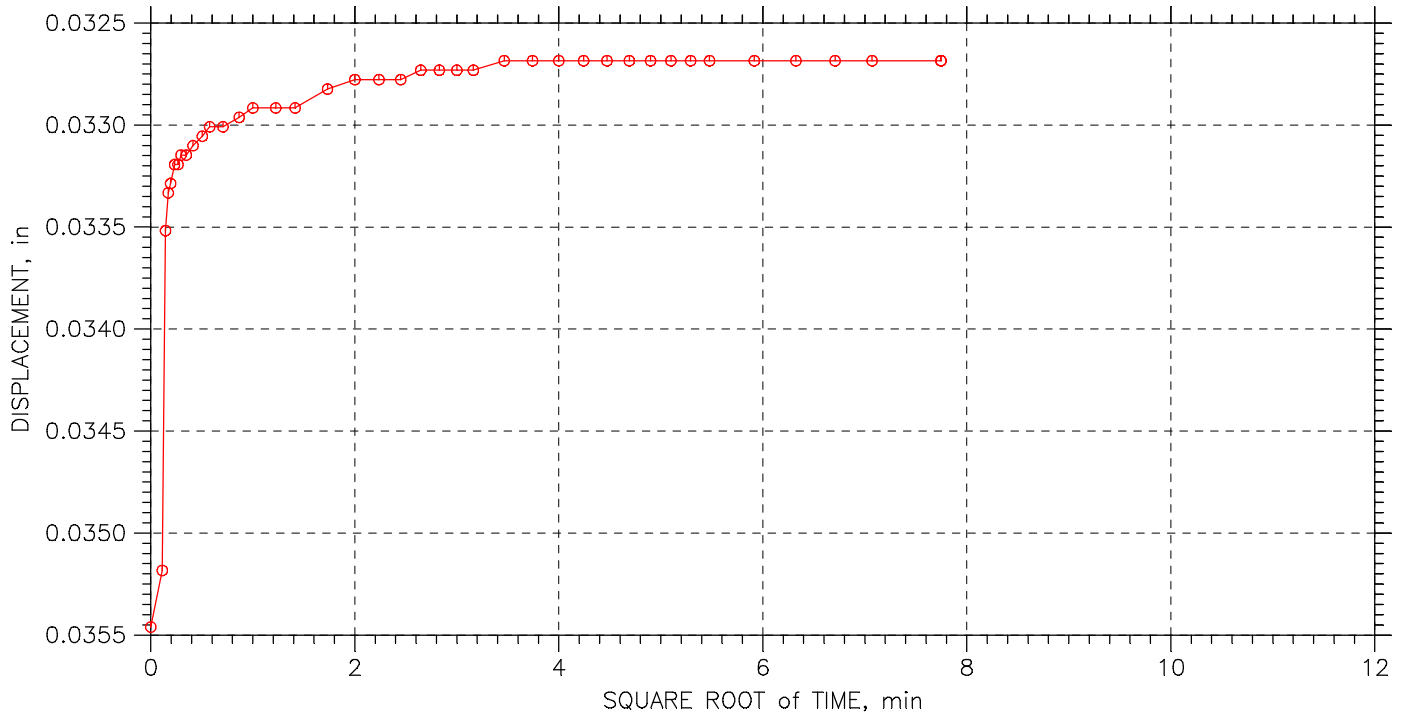
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 8 of 23

Stress: 4. tsf





Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
Boring No.: SL-3	Tested By: AS	Checked By:
Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
Test No.:	Sample Type: ST	Elevation:
Description: Orange-brown silt(visual ML)		
Remarks: F&R Project # 75S0102		

F&R SINCE 1881

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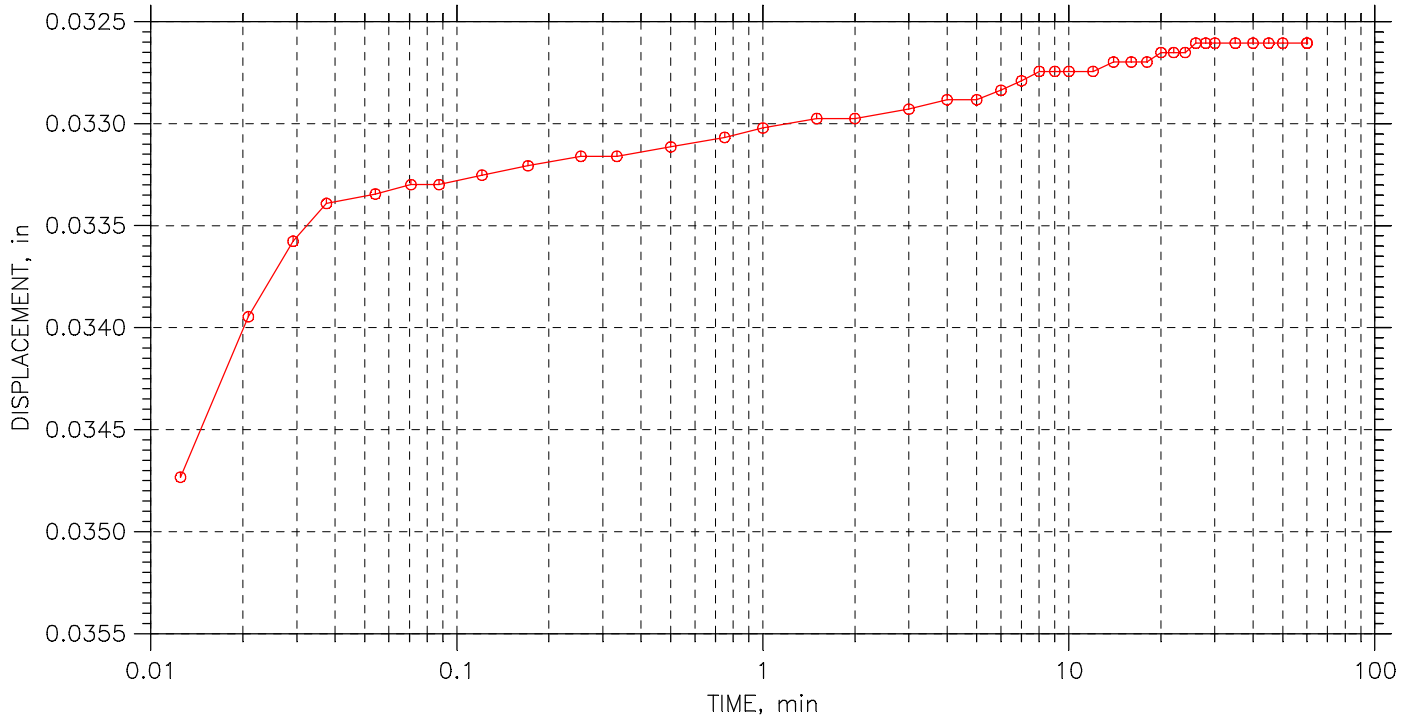
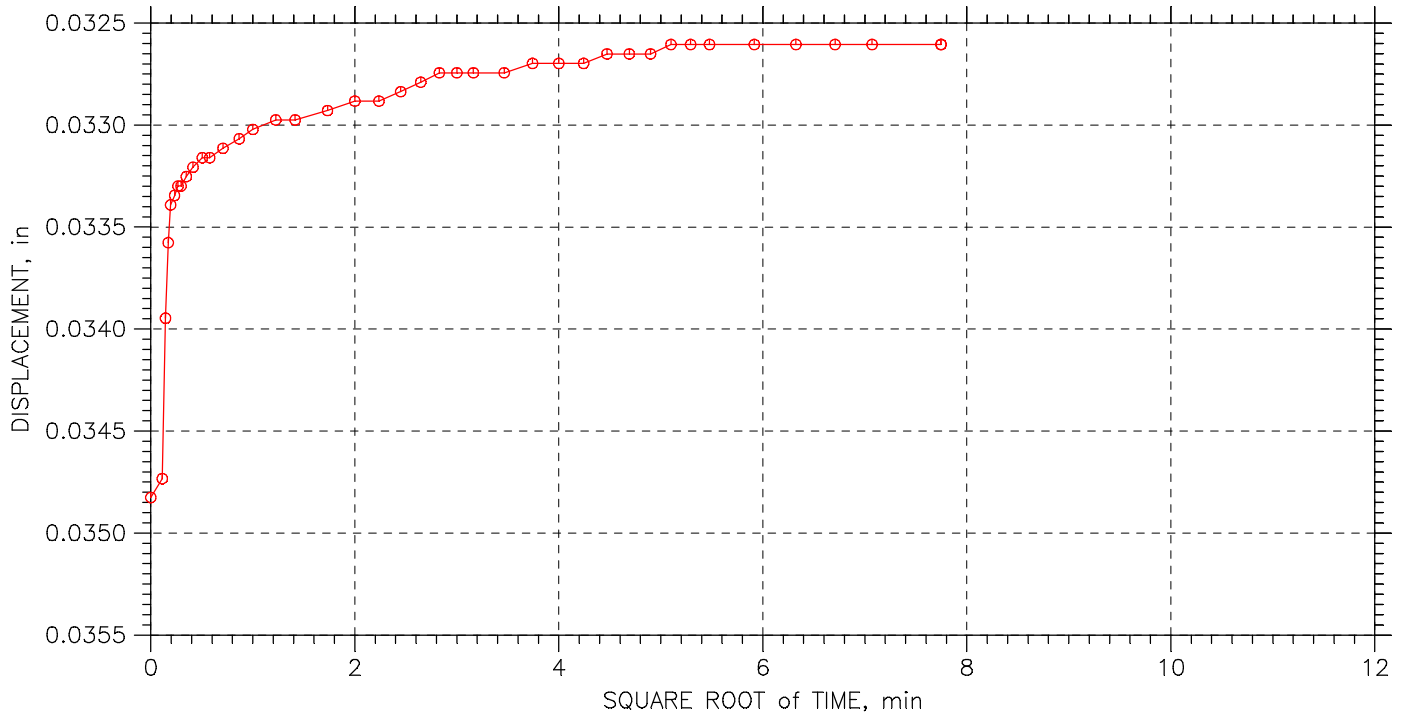
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 9 of 23

Stress: 2. tsf





Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
Boring No.: SL-3	Tested By: AS	Checked By:
Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
Test No.:	Sample Type: ST	Elevation:
Description: Orange-brown silt(visual ML)		
Remarks: F&R Project # 75S0102		

F&R SINCE 1881

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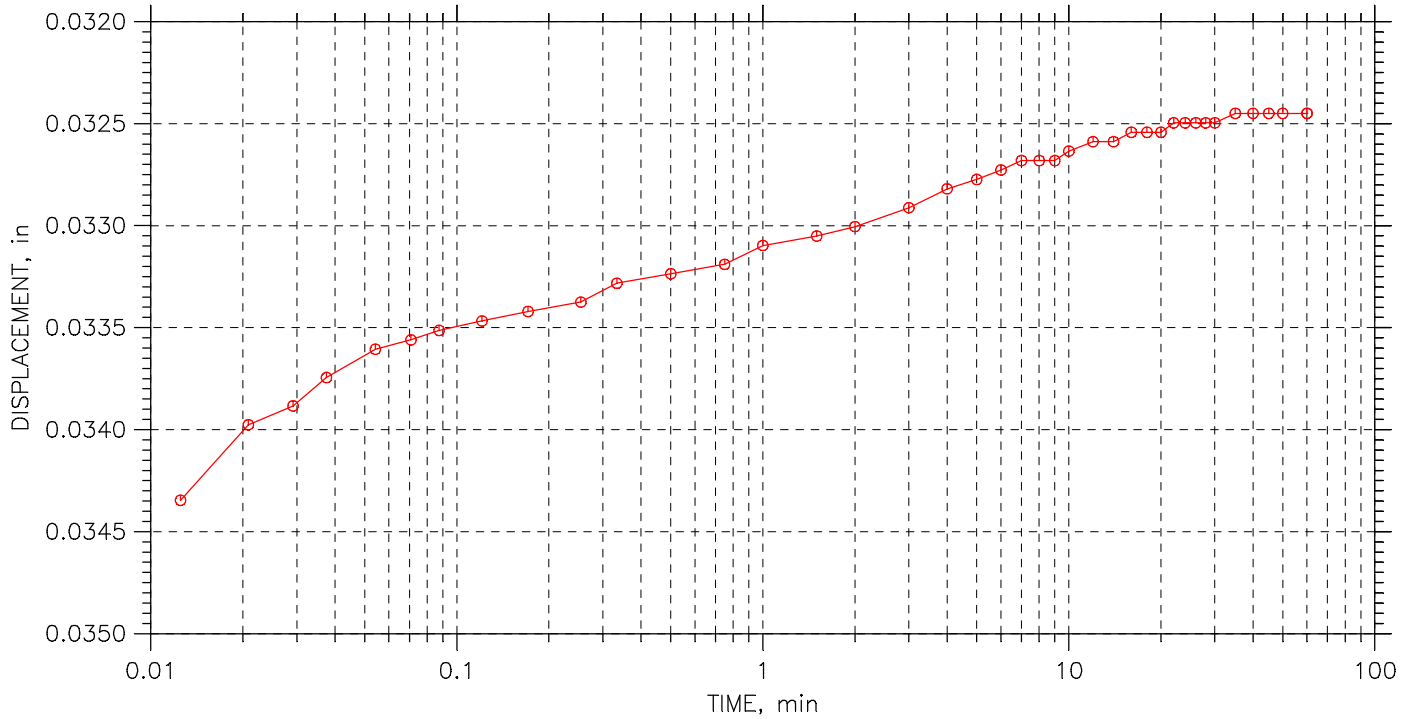
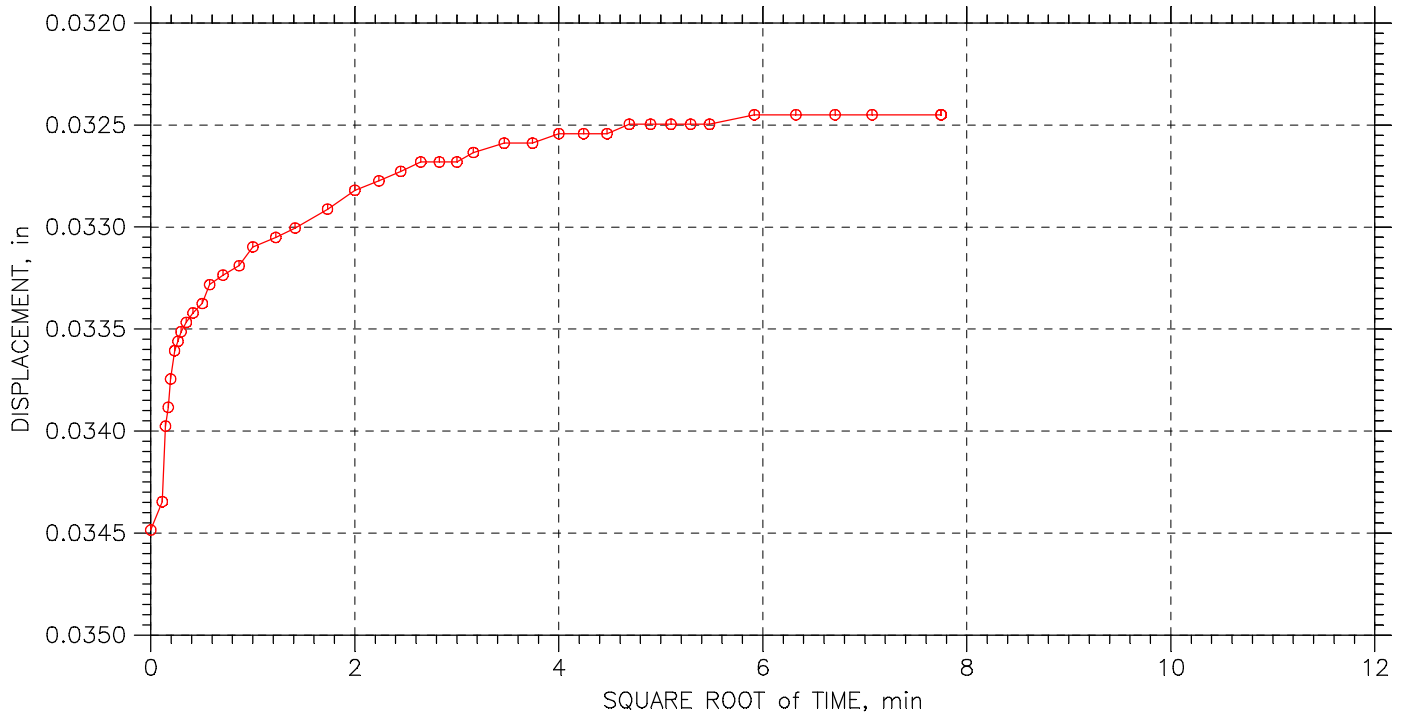
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 10 of 23

Stress: 1. tsf





Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
Boring No.: SL-3	Tested By: AS	Checked By:
Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
Test No.:	Sample Type: ST	Elevation:
Description: Orange-brown silt(visual ML)		
Remarks: F&R Project # 75S0102		

F&R SINCE 1881

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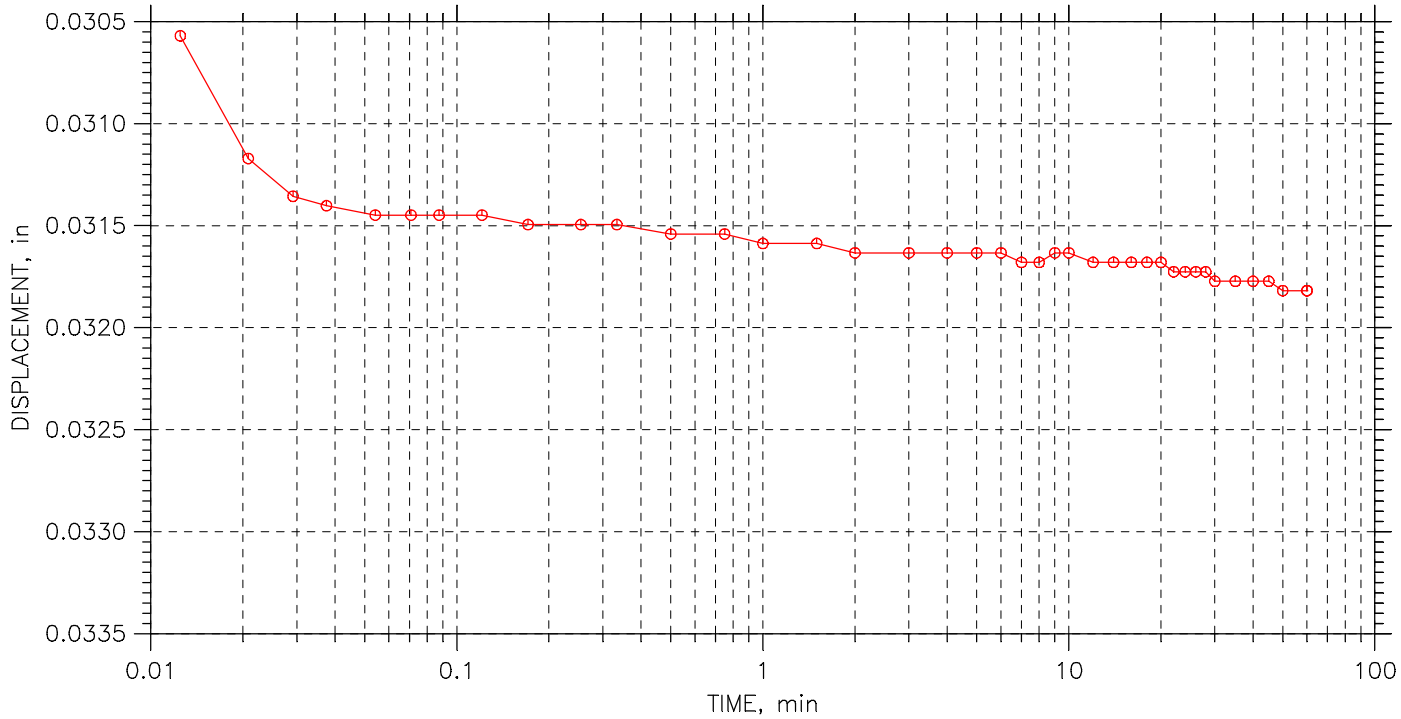
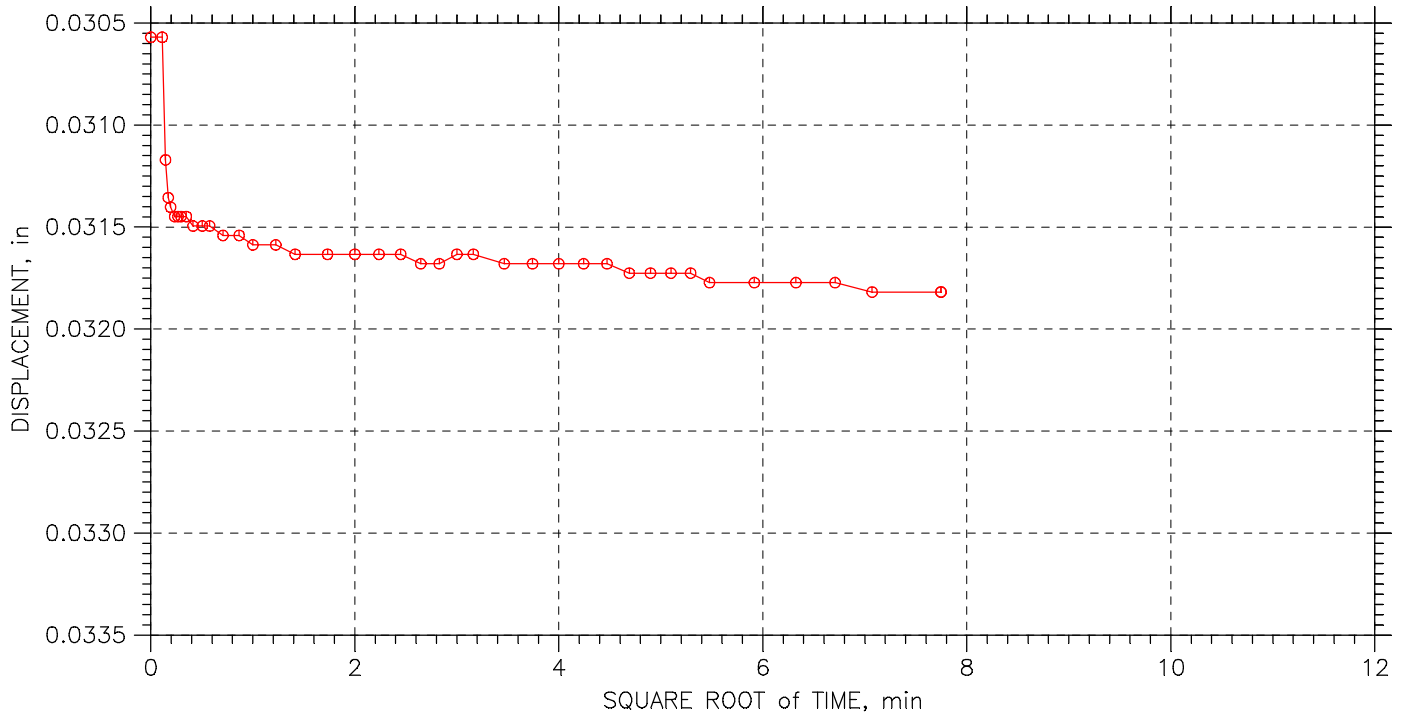
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 11 of 23

Stress: 2. tsf





Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
Boring No.: SL-3	Tested By: AS	Checked By:
Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
Test No.:	Sample Type: ST	Elevation:
Description: Orange-brown silt(visual ML)		
Remarks: F&R Project # 75S0102		

F&R SINCE 1881

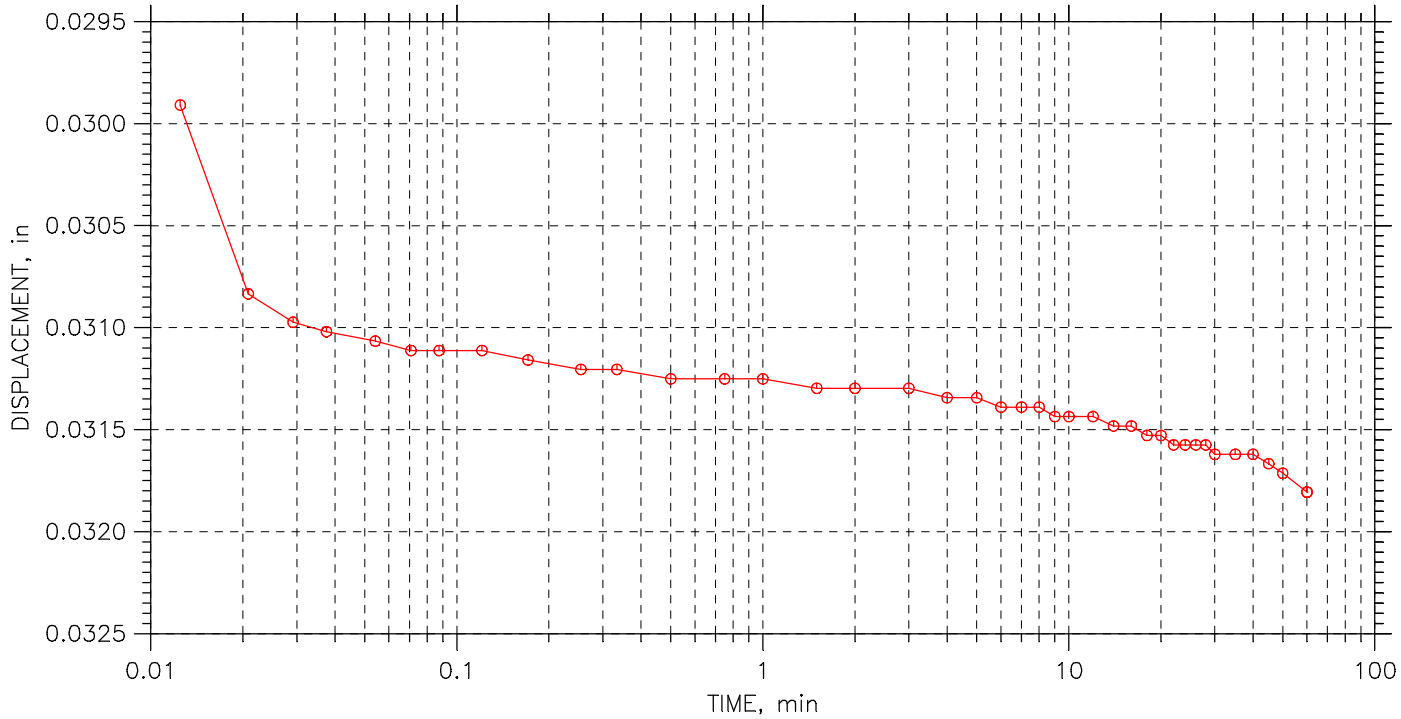
Thu, 09-OCT-2014 10:37:49

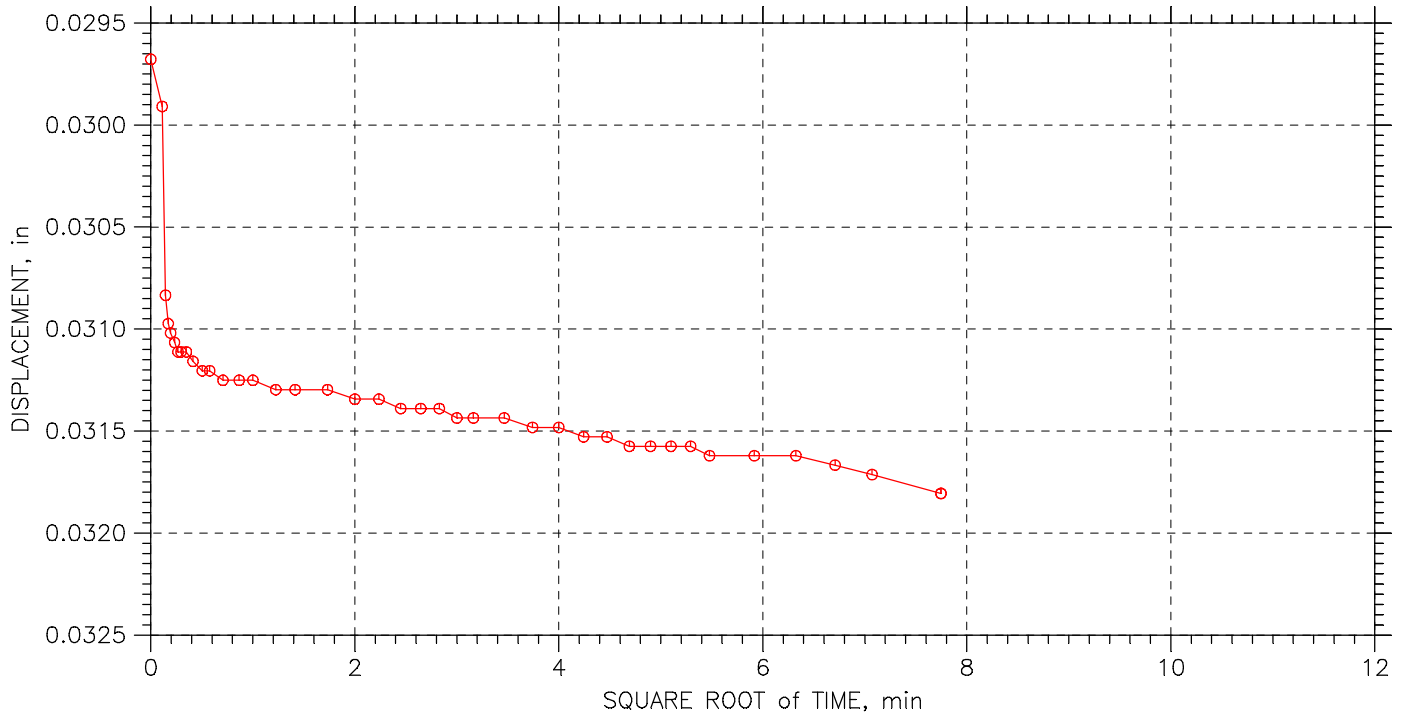
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 12 of 23

Stress: 4. tsf





	Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
	Boring No.: SL-3	Tested By: AS	Checked By:
	Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
	Test No.:	Sample Type: ST	Elevation:
	Description: Orange-brown silt(visual ML)		
	Remarks: F&R Project # 75S0102		

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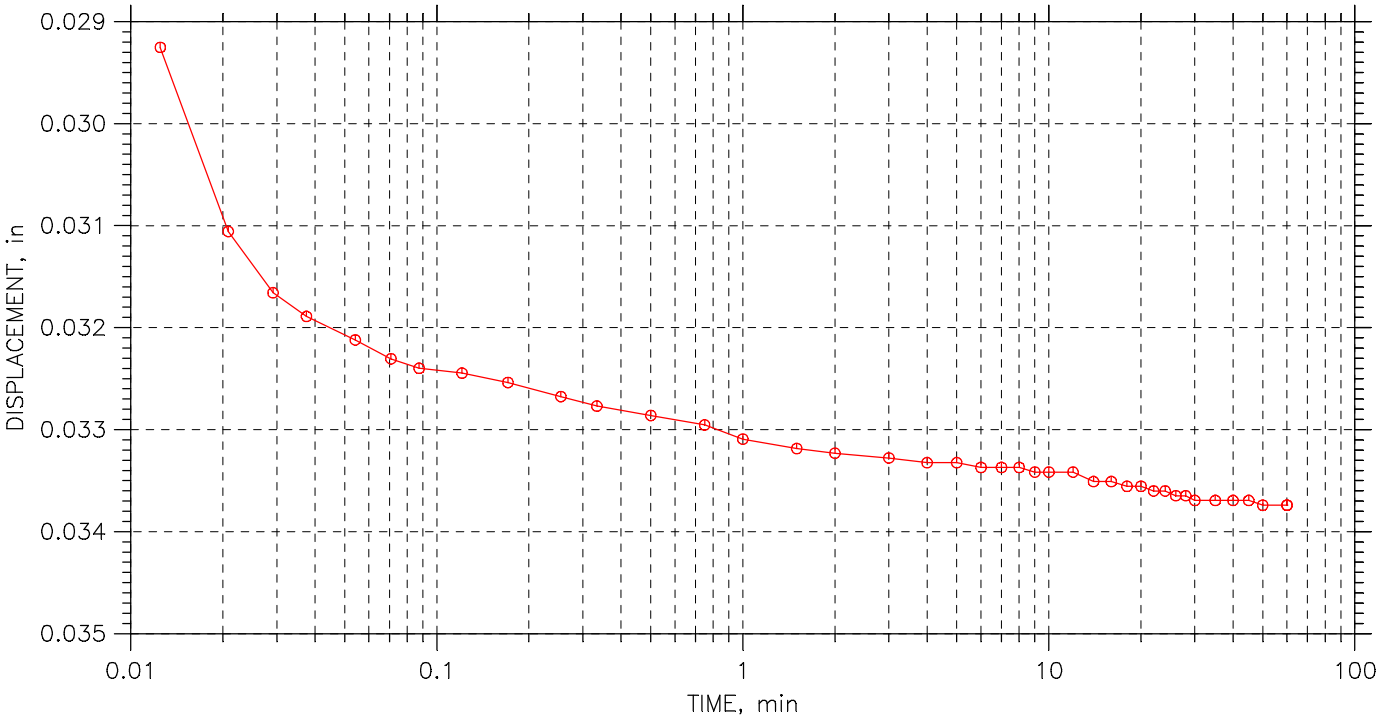
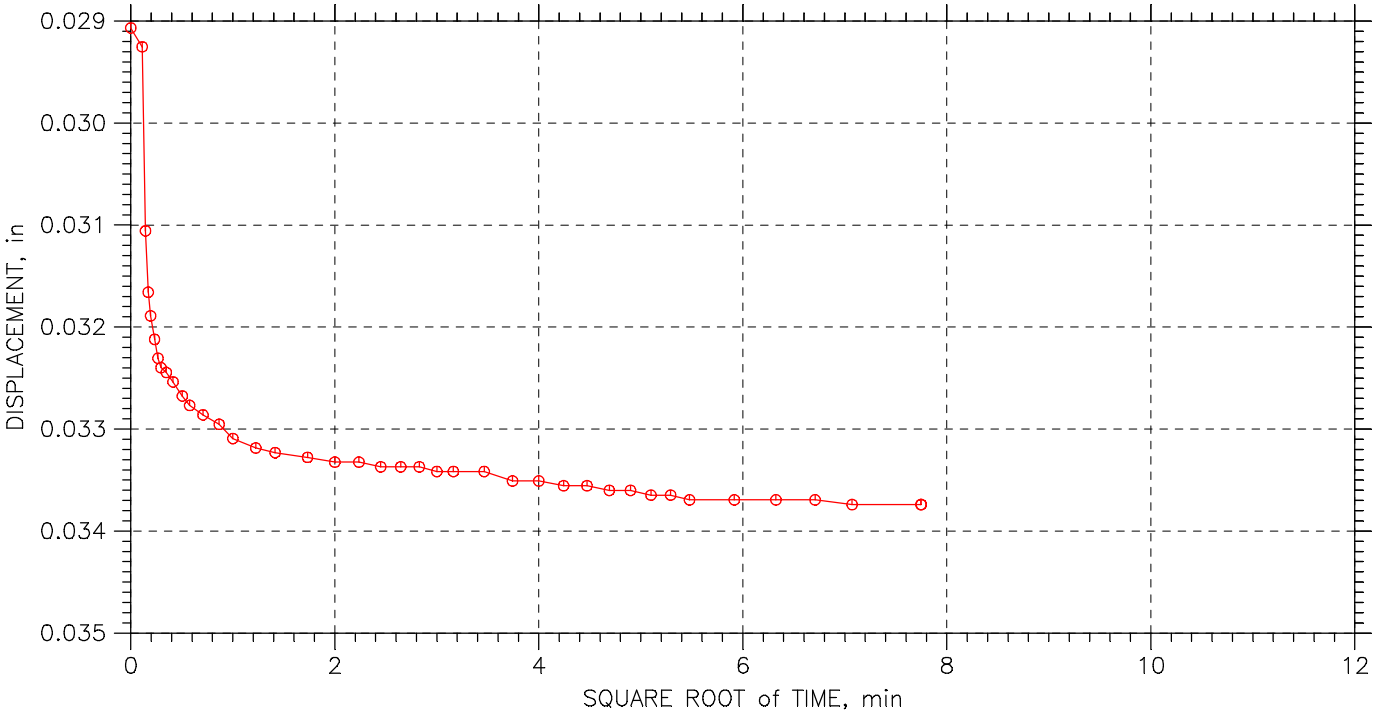
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 13 of 23

Stress: 8. tsf





Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
Boring No.: SL-3	Tested By: AS	Checked By:
Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
Test No.:	Sample Type: ST	Elevation:
Description: Orange-brown silt(visual ML)		
Remarks: F&R Project # 75S0102		

F&R SINCE 1881

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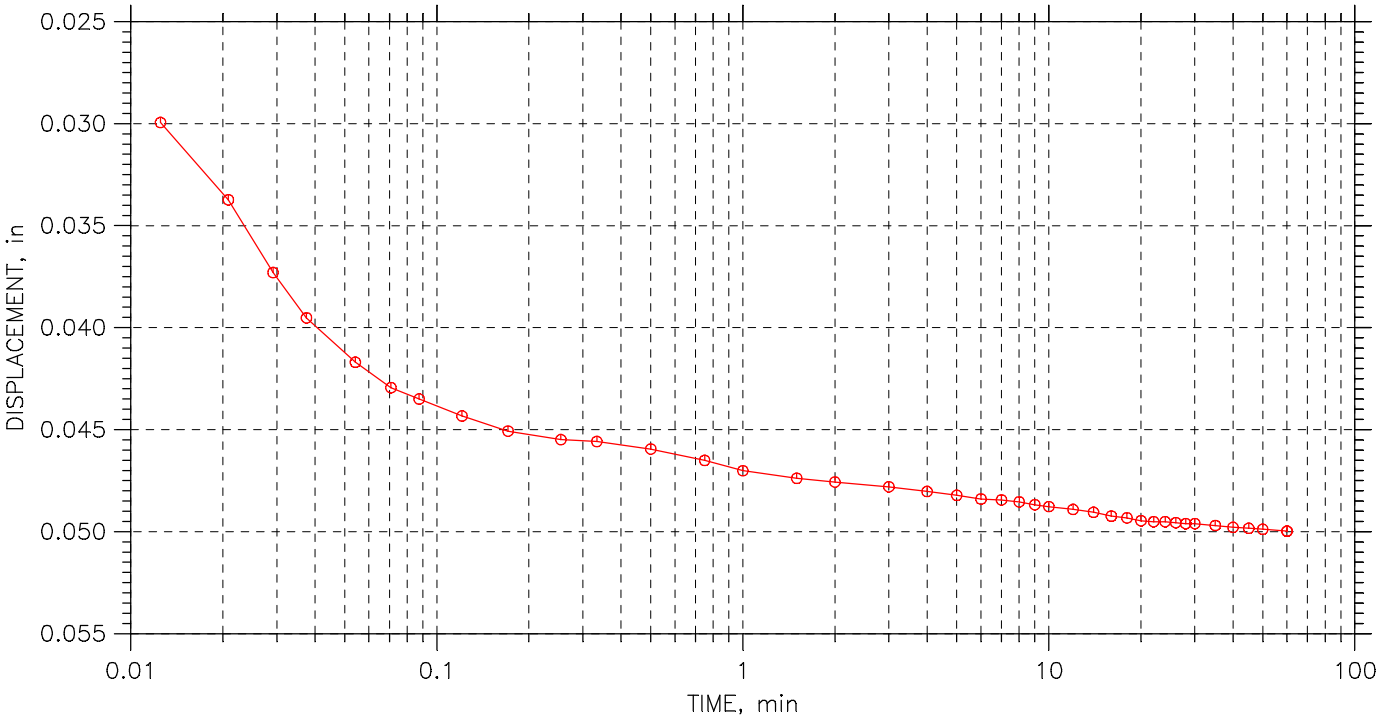
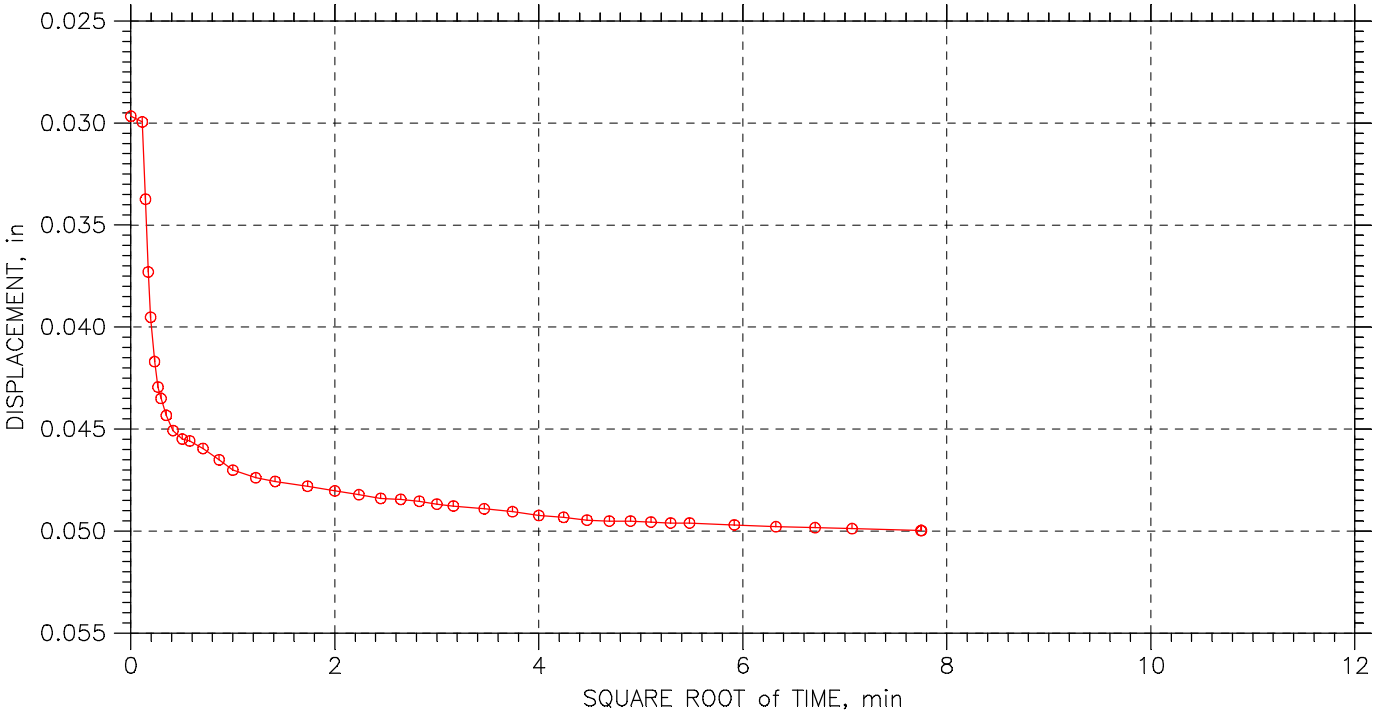
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 14 of 23

Stress: 16. tsf





	Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
	Boring No.: SL-3	Tested By: AS	Checked By:
	Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
	Test No.:	Sample Type: ST	Elevation:
	Description: Orange-brown silt(visual ML)		
	Remarks: F&R Project # 75S0102		

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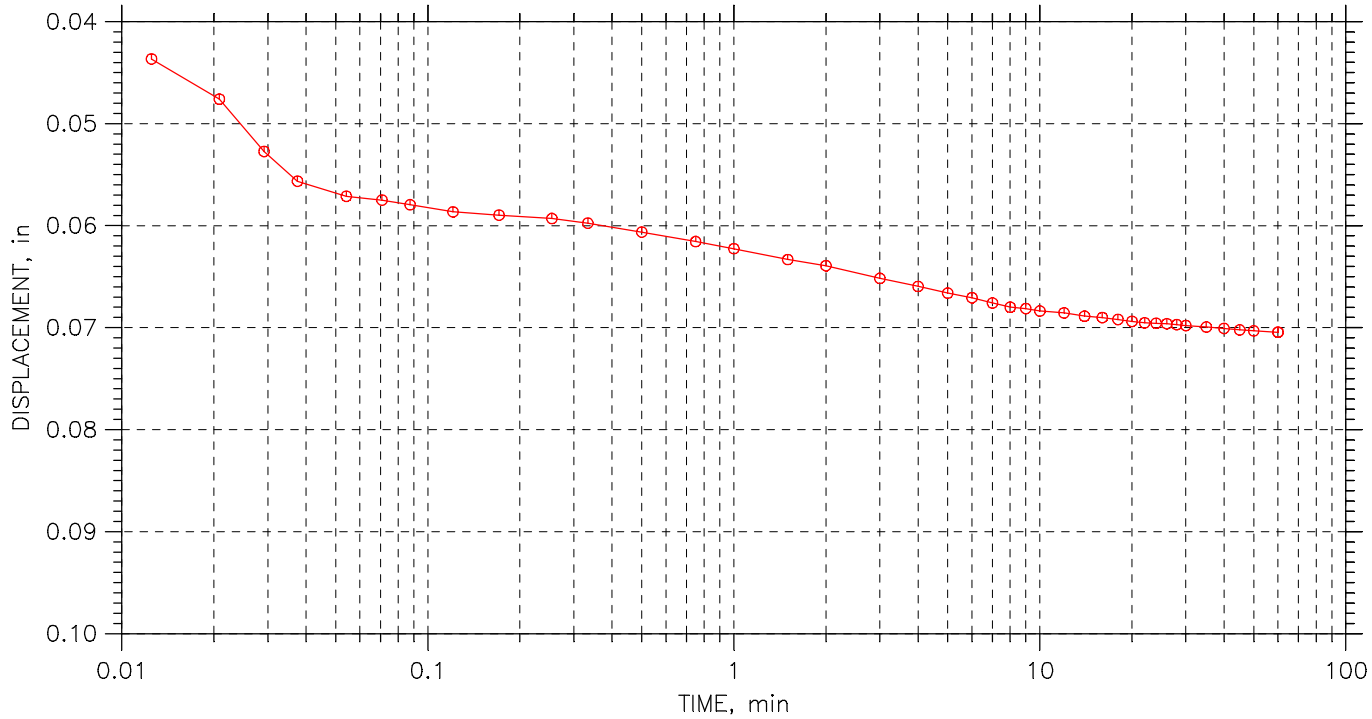
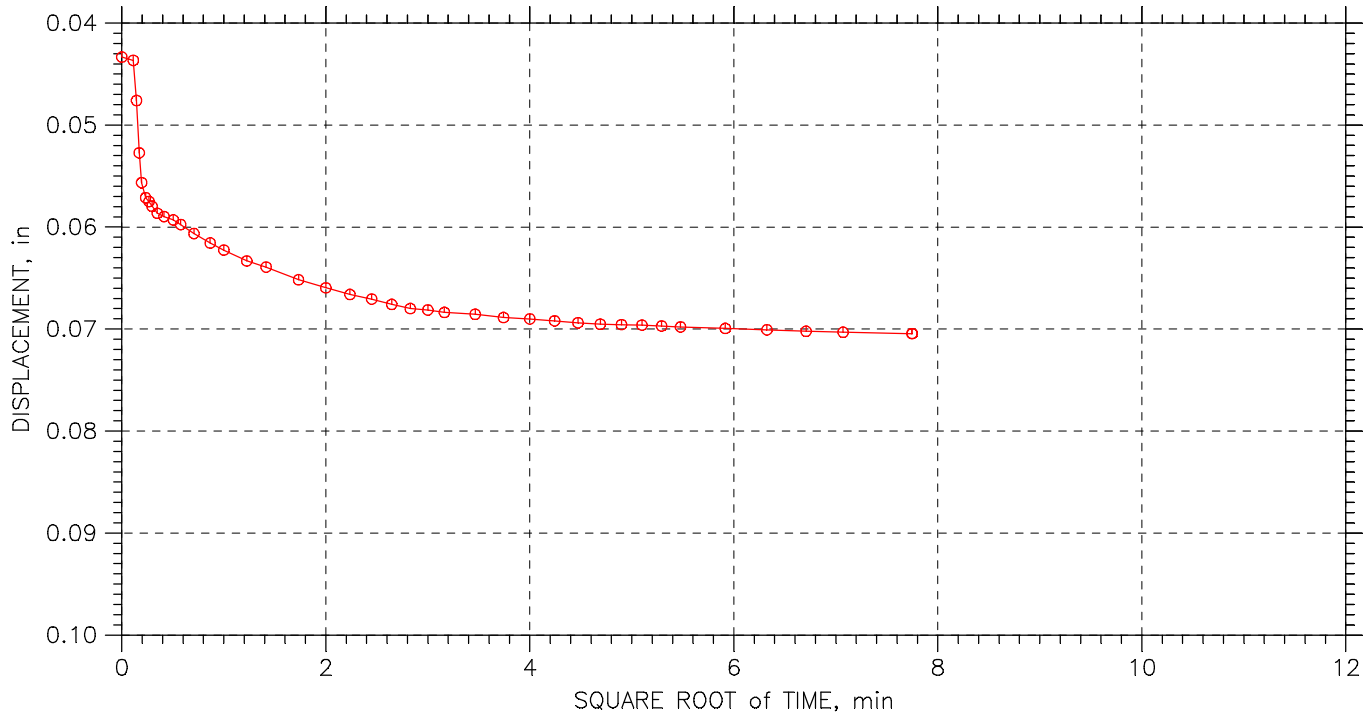
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 15 of 23

Stress: 32. tsf





Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
Boring No.: SL-3	Tested By: AS	Checked By:
Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
Test No.:	Sample Type: ST	Elevation:
Description: Orange-brown silt(visual ML)		
Remarks: F&R Project # 75S0102		

F&R SINCE 1881

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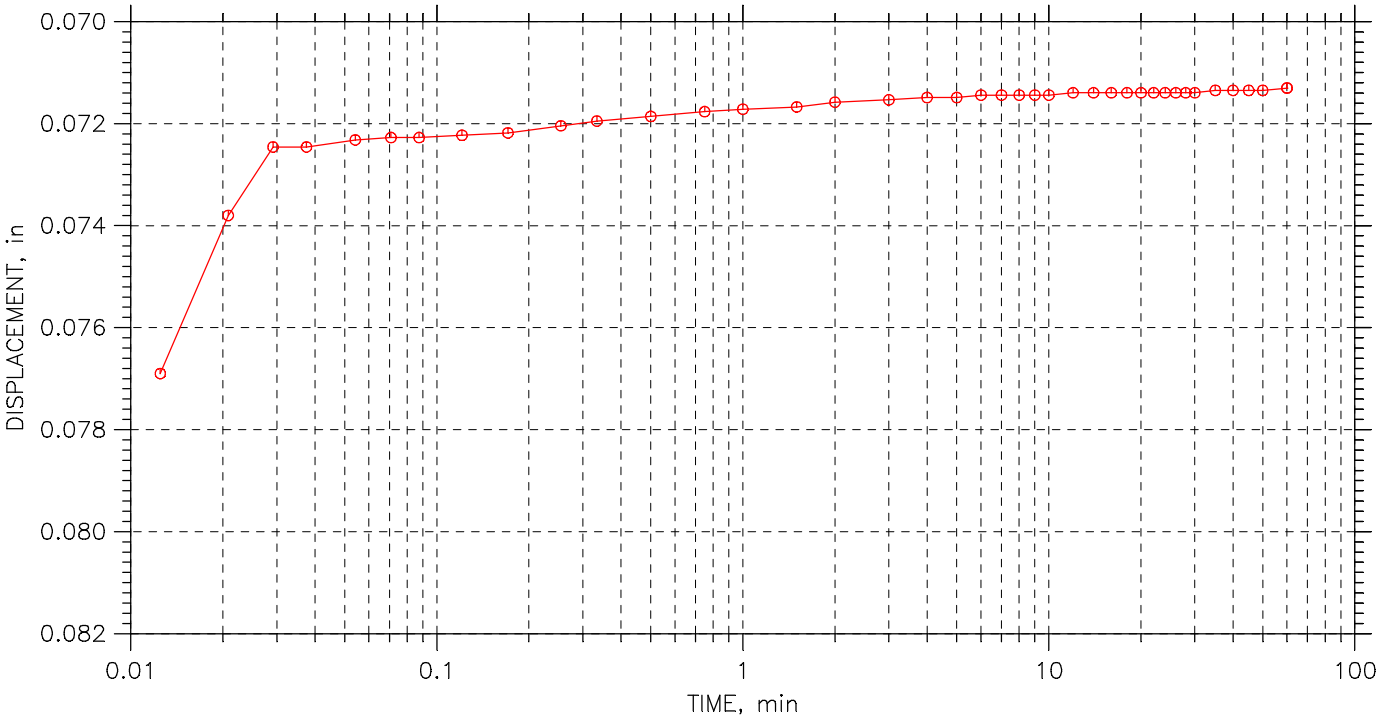
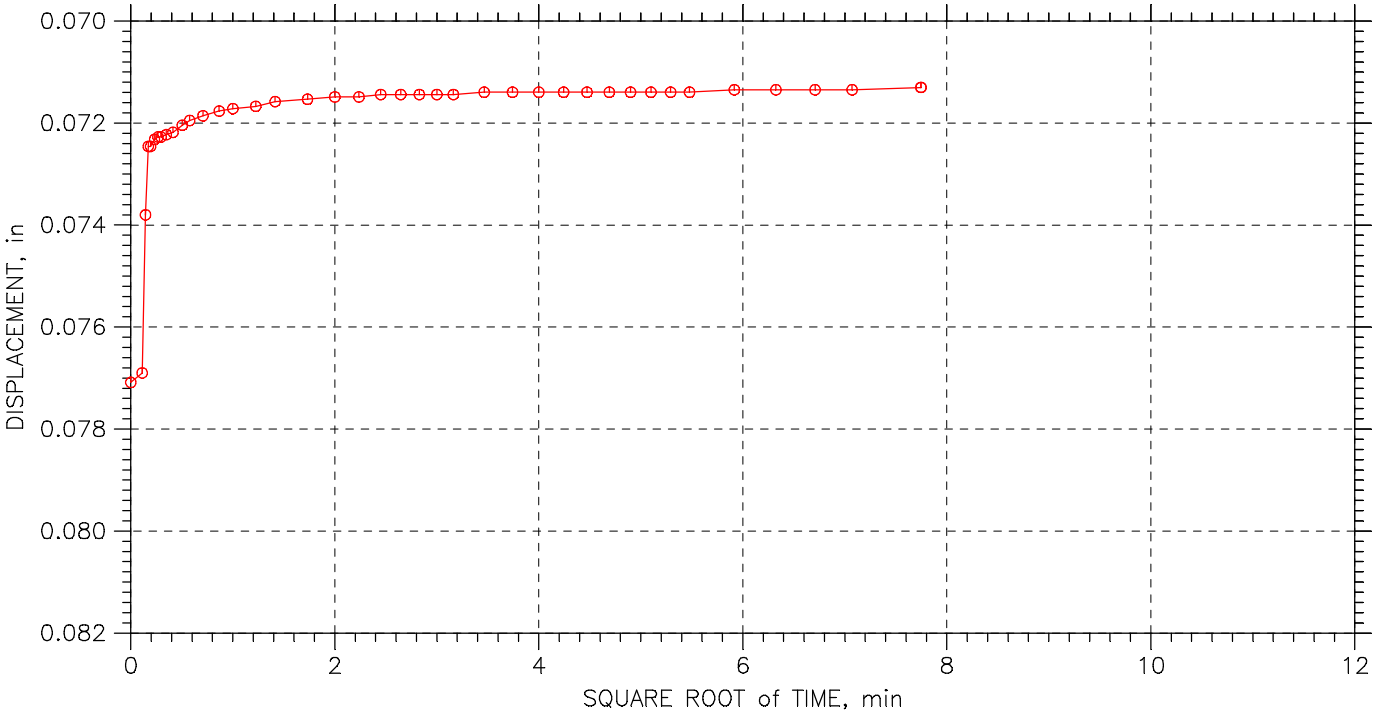
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 16 of 23

Stress: 16. tsf





	Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
	Boring No.: SL-3	Tested By: AS	Checked By:
	Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
	Test No.:	Sample Type: ST	Elevation:
	Description: Orange-brown silt(visual ML)		
	Remarks: F&R Project # 75S0102		

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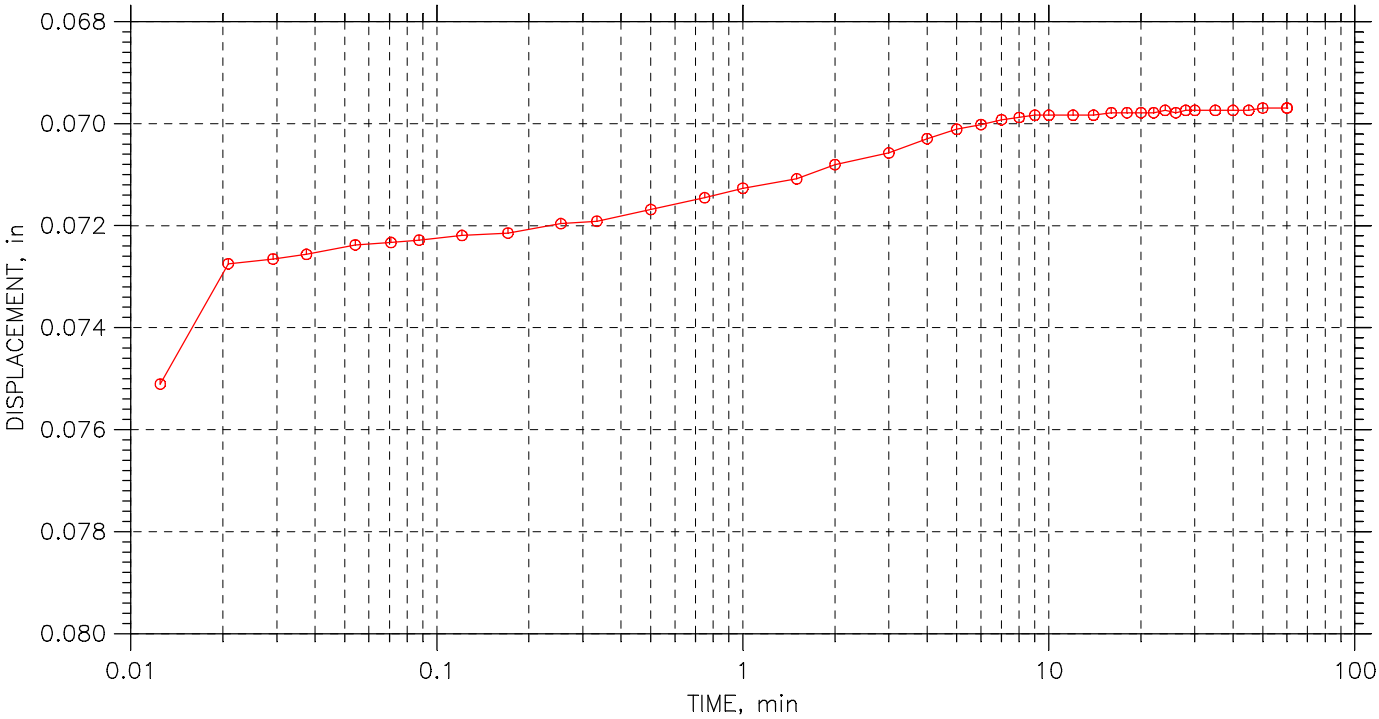
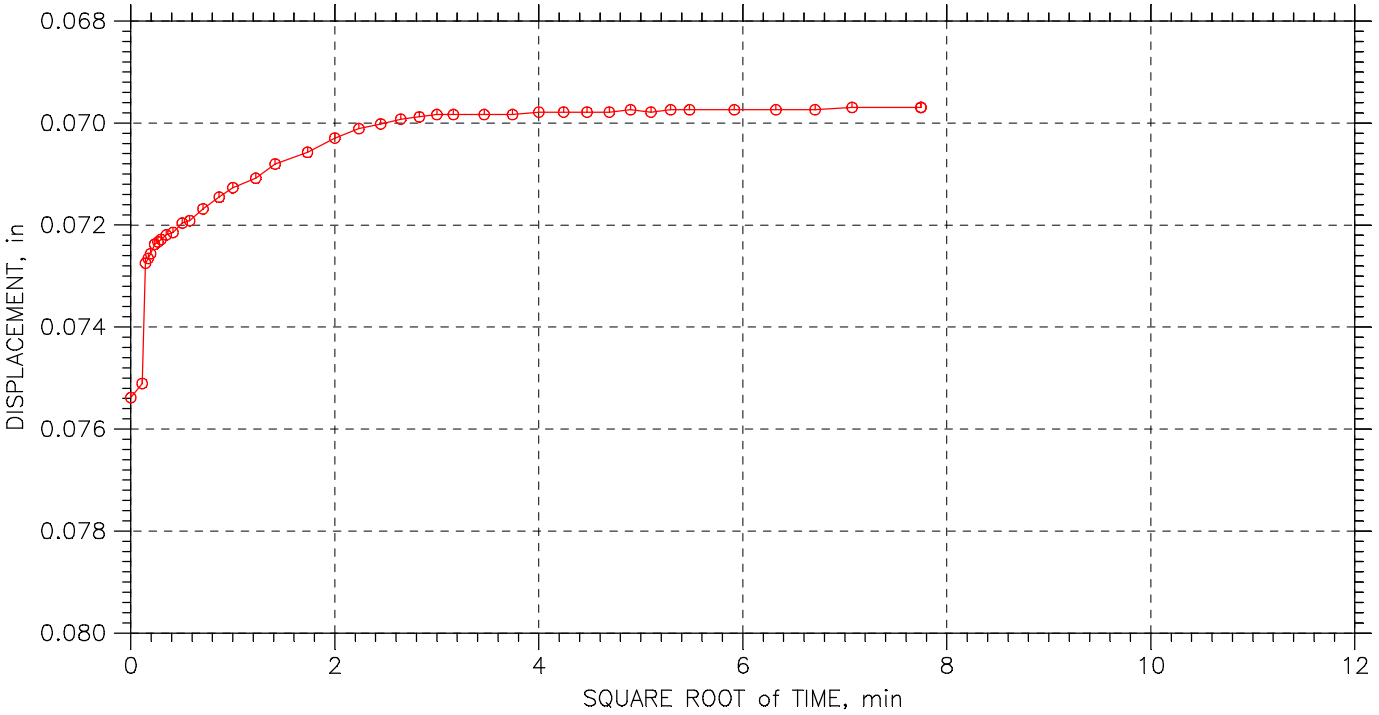
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 17 of 23

Stress: 8. tsf





F&R SINCE 1881	Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
	Boring No.: SL-3	Tested By: AS	Checked By:
	Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
	Test No.:	Sample Type: ST	Elevation:
	Description: Orange-brown silt(visual ML)		
	Remarks: F&R Project # 75S0102		

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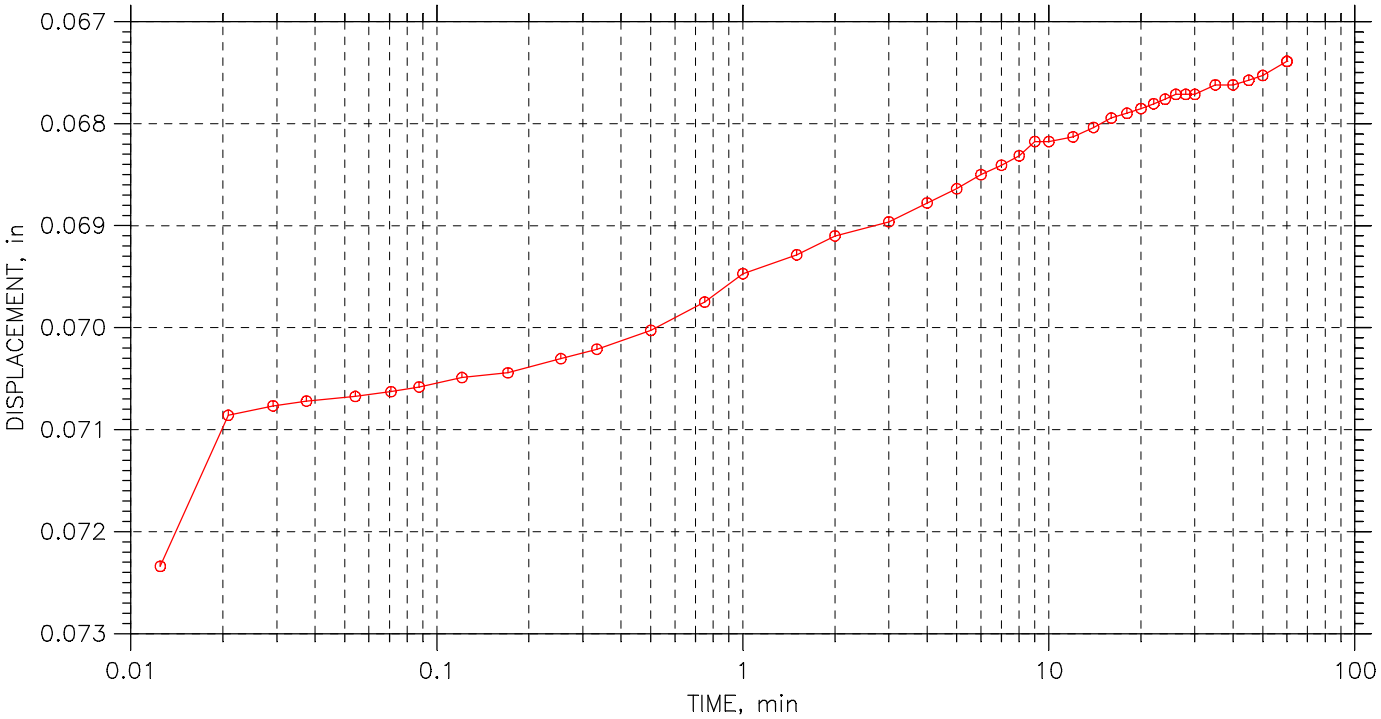
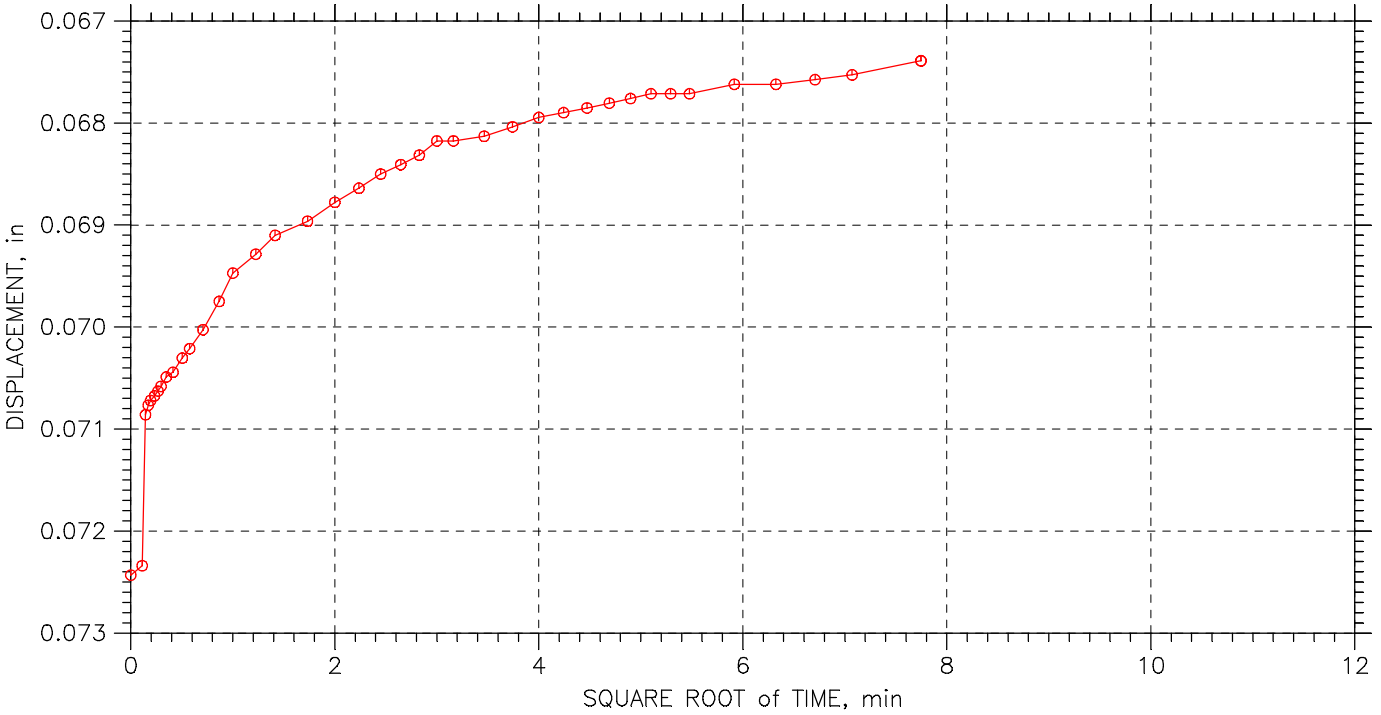
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 18 of 23

Stress: 4. tsf





	Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
	Boring No.: SL-3	Tested By: AS	Checked By:
	Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
	Test No.:	Sample Type: ST	Elevation:
	Description: Orange-brown silt(visual ML)		
	Remarks: F&R Project # 75S0102		

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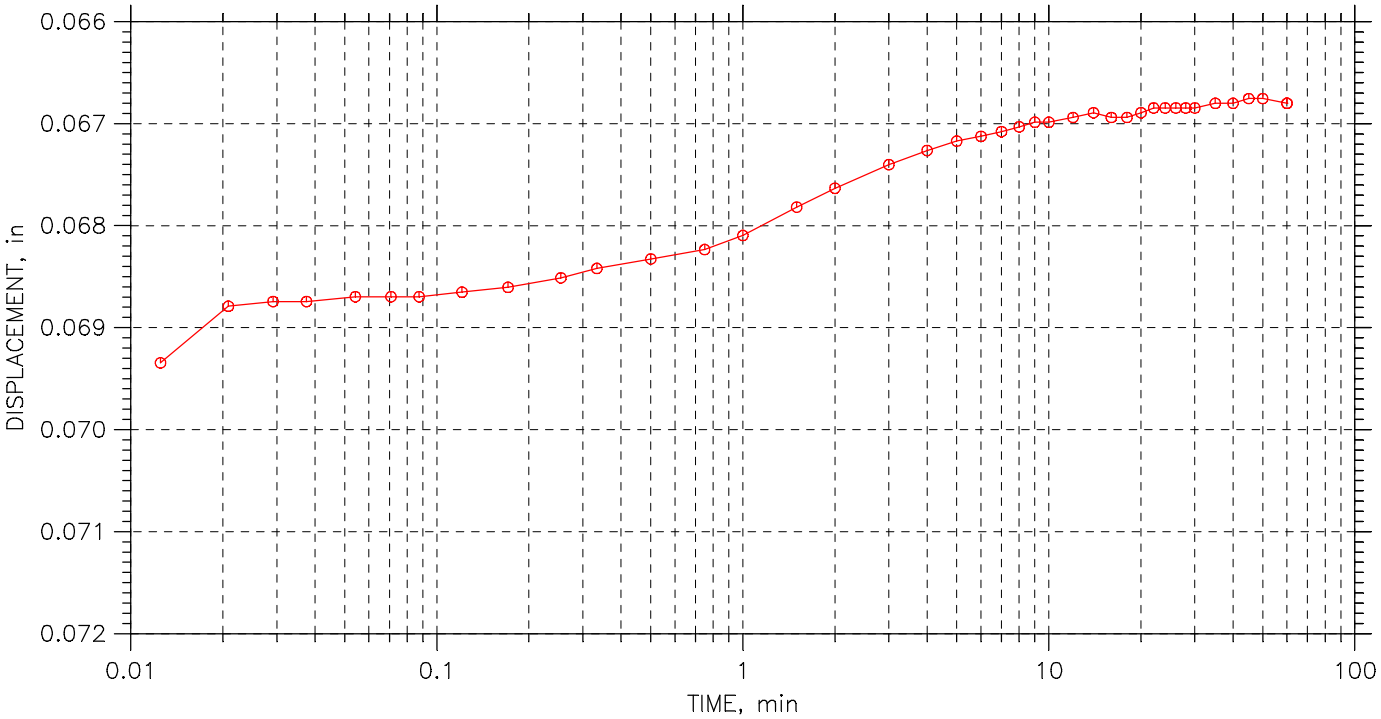
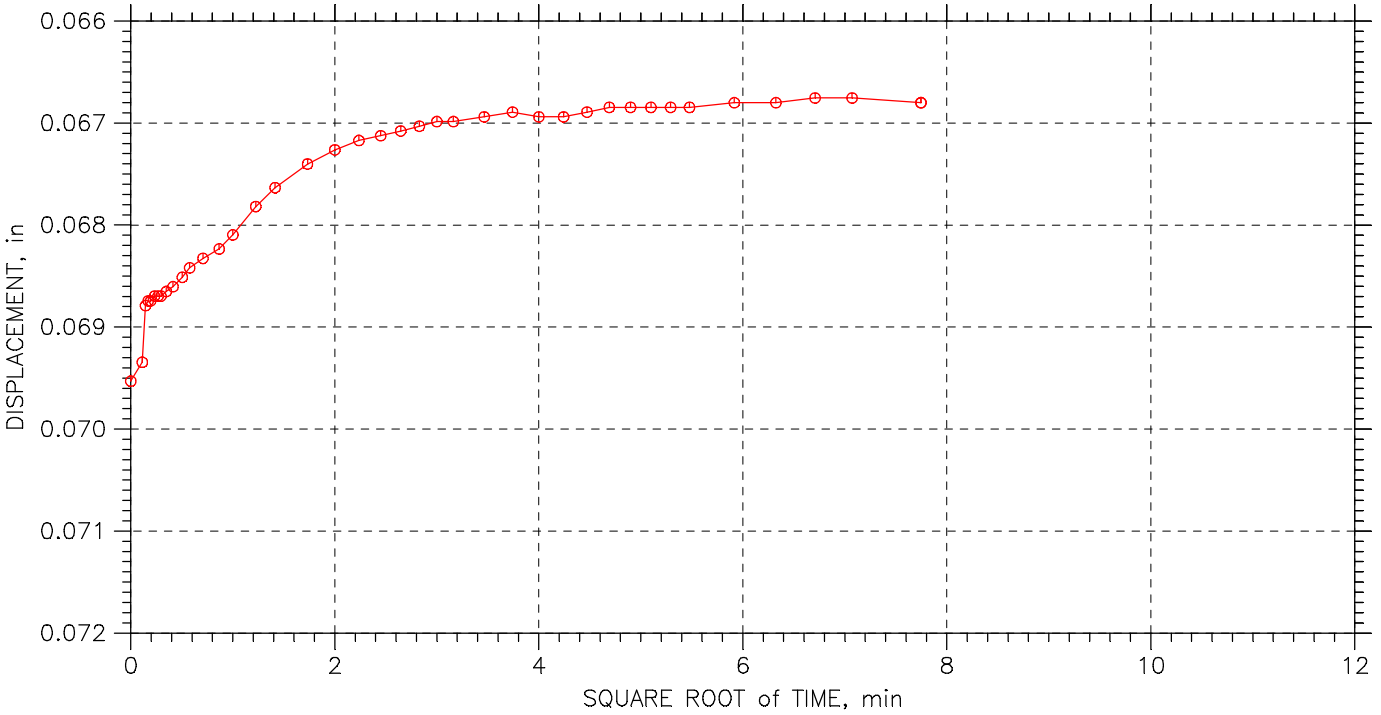
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 19 of 23

Stress: 2. tsf





F&R SINCE 1881	Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
	Boring No.: SL-3	Tested By: AS	Checked By:
	Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
	Test No.:	Sample Type: ST	Elevation:
	Description: Orange-brown silt(visual ML)		
	Remarks: F&R Project # 75S0102		

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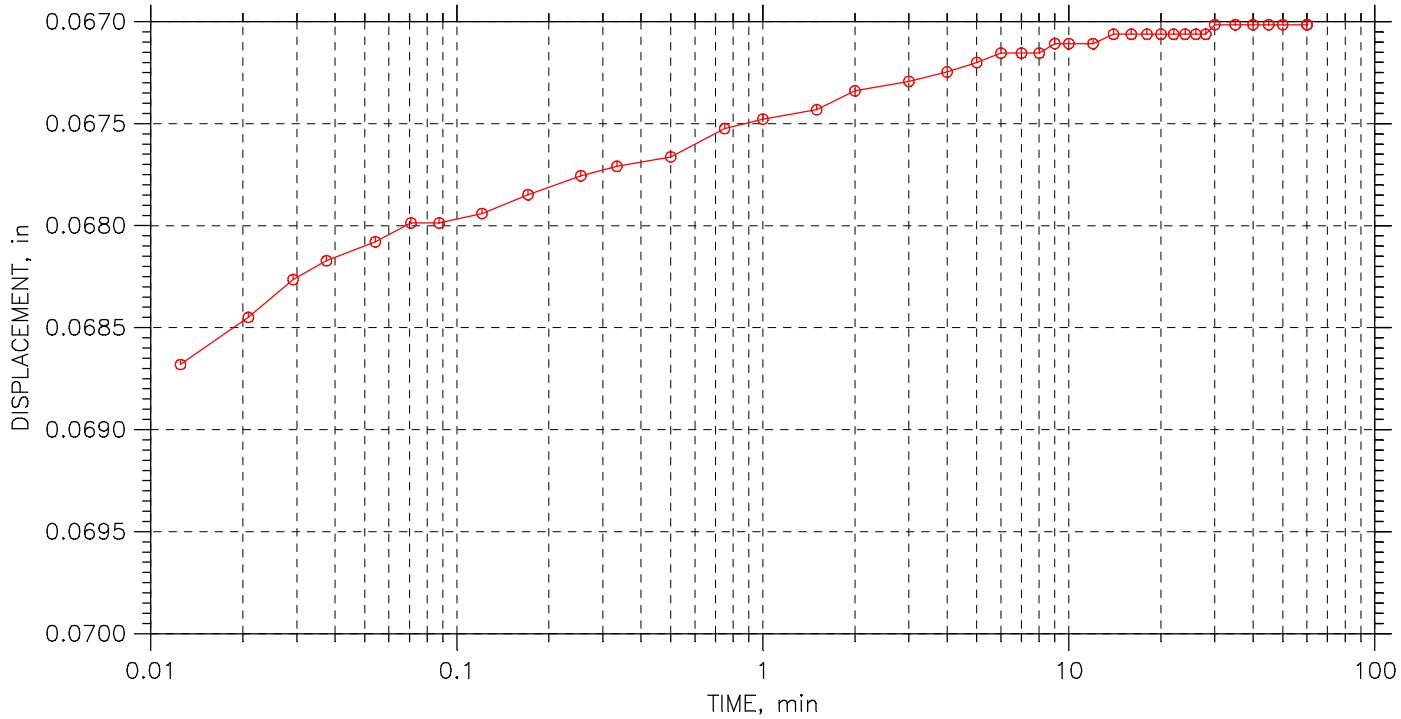
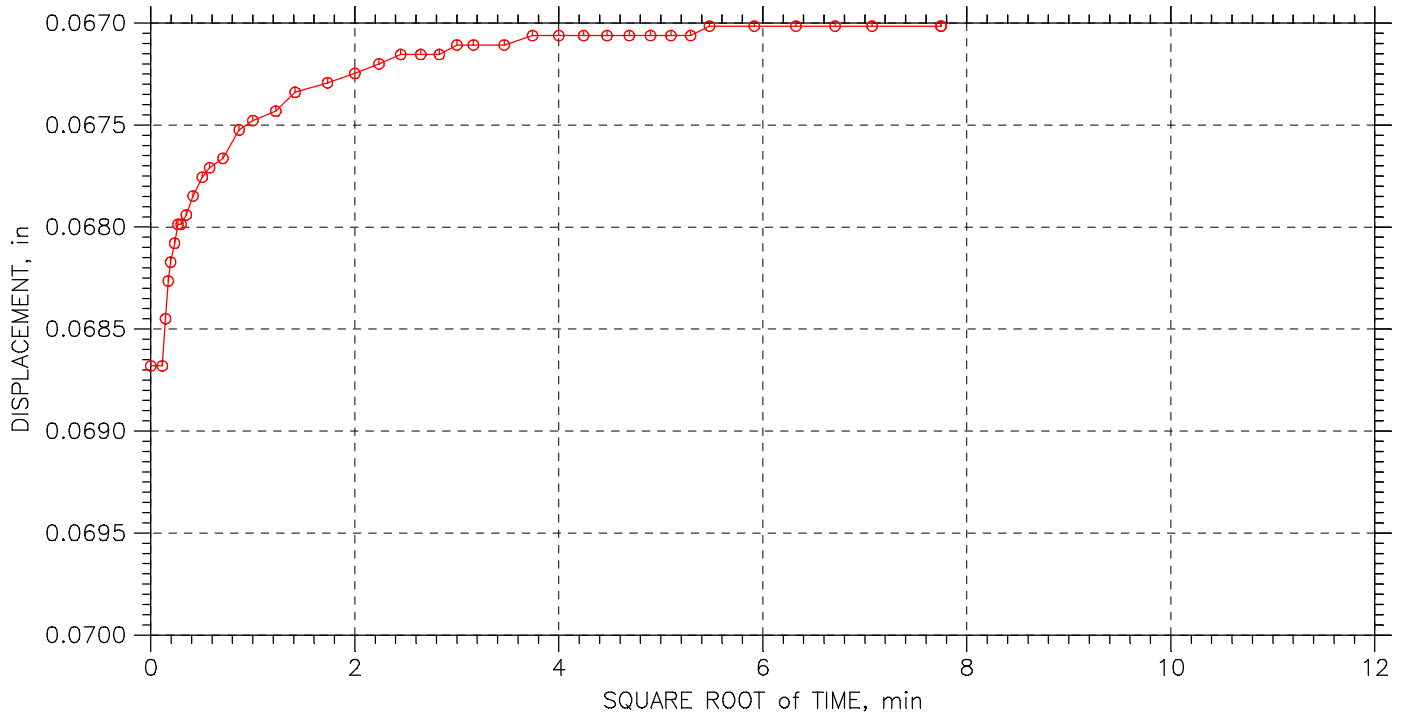
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 20 of 23

Stress: 1. tsf





Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
Boring No.: SL-3	Tested By: AS	Checked By:
Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
Test No.:	Sample Type: ST	Elevation:
Description: Orange-brown silt(visual ML)		
Remarks: F&R Project # 75S0102		

F&R SINCE 1881

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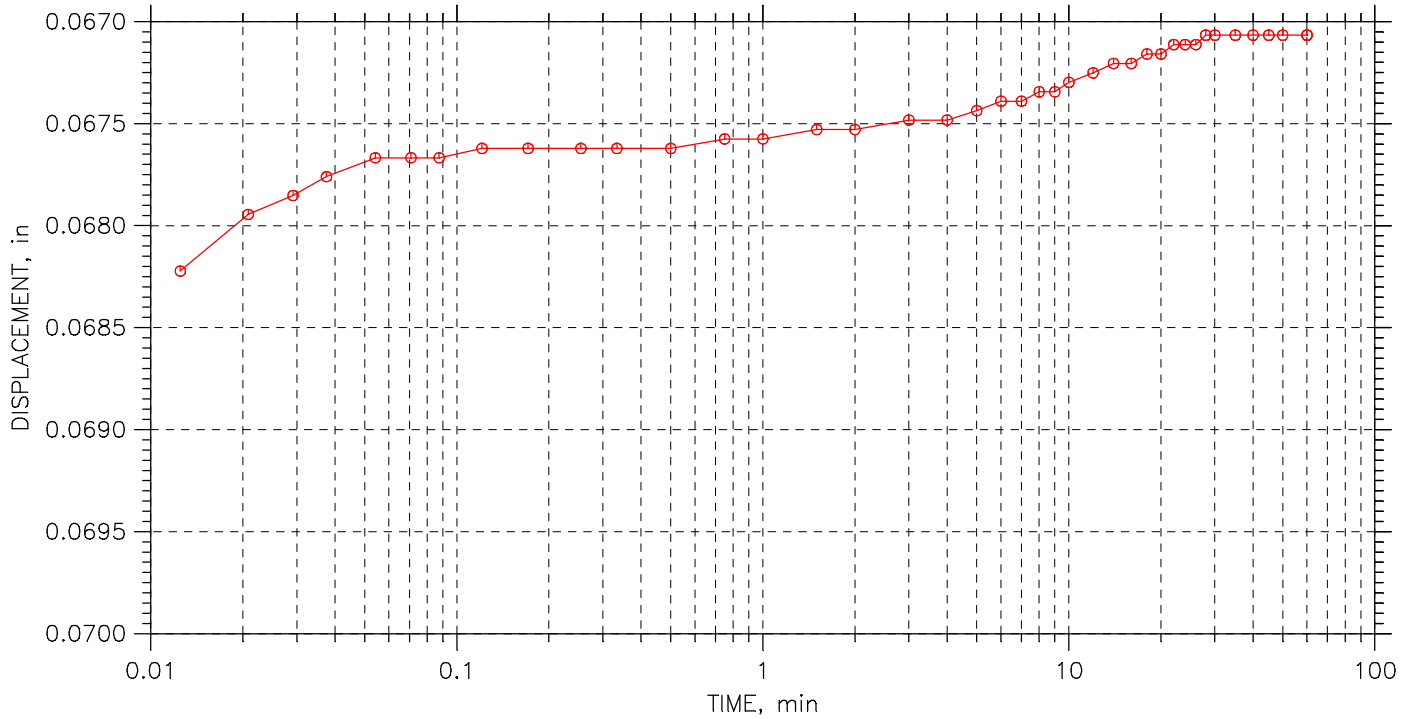
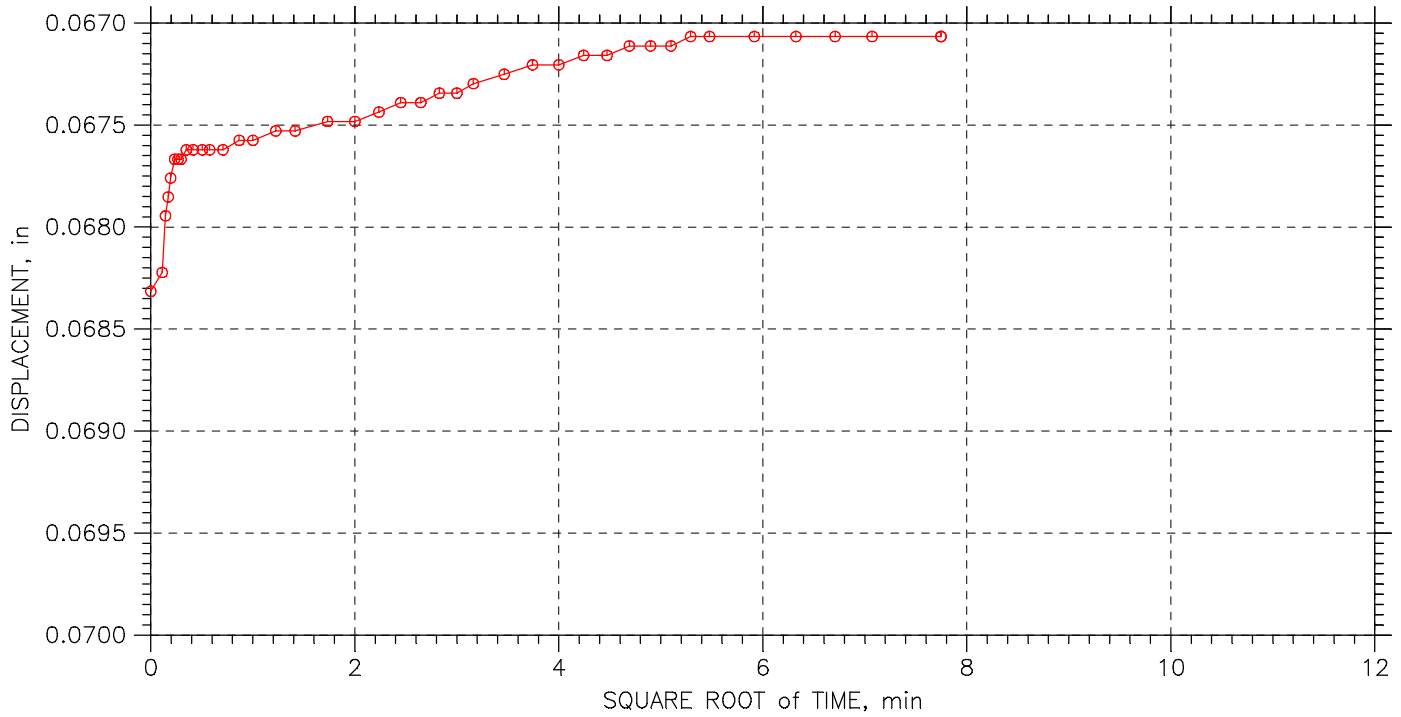
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 21 of 23

Stress: 0.5 tsf





Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
Boring No.: SL-3	Tested By: AS	Checked By:
Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
Test No.:	Sample Type: ST	Elevation:
Description: Orange-brown silt(visual ML)		
Remarks: F&R Project # 75S0102		

F&R SINCE 1881

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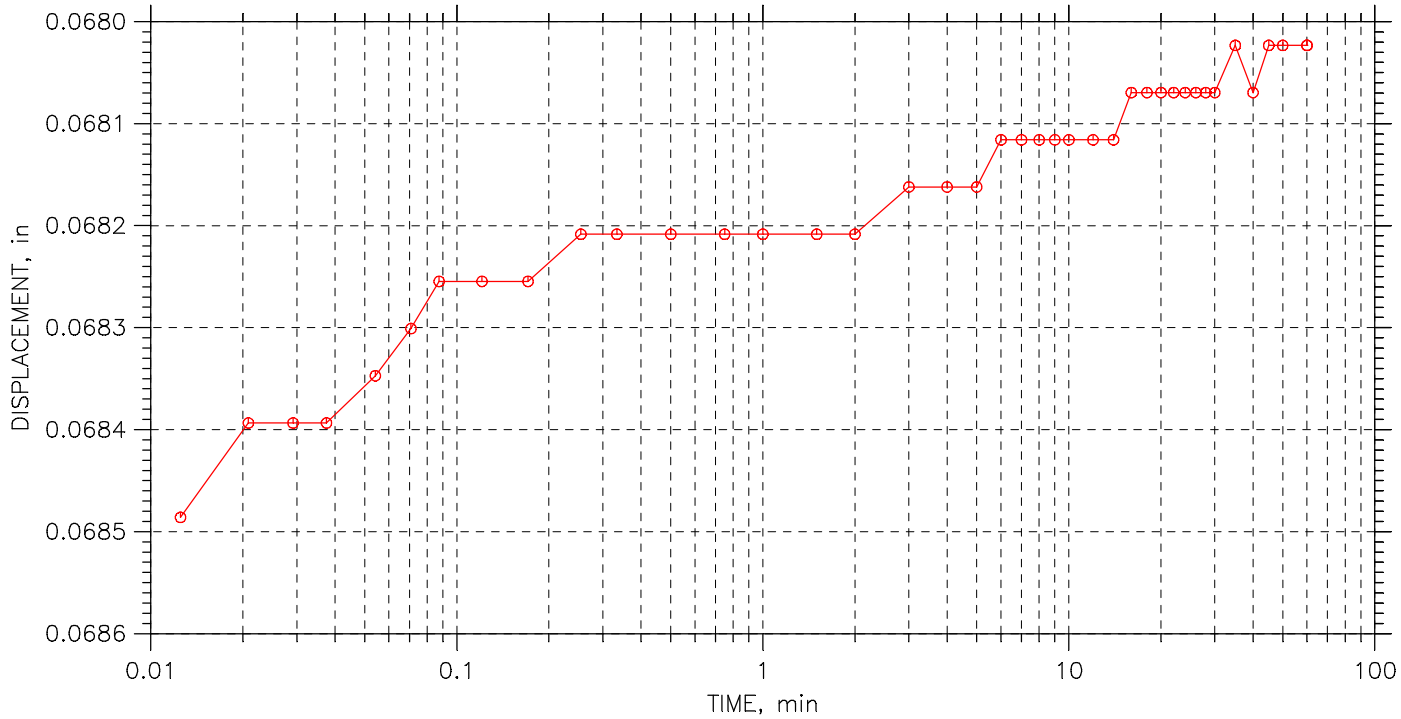
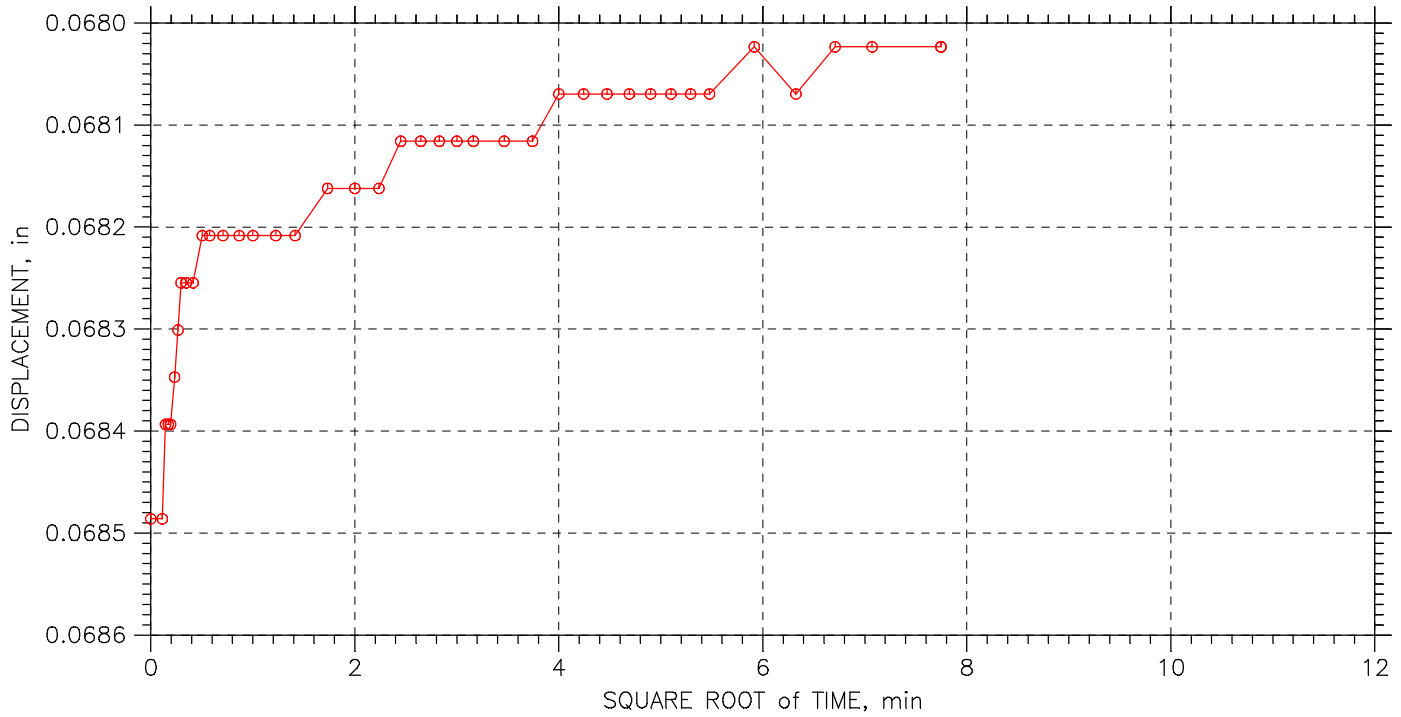
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 22 of 23

Stress: 0.25 tsf





Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
Boring No.: SL-3	Tested By: AS	Checked By:
Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
Test No.:	Sample Type: ST	Elevation:
Description: Orange-brown silt(visual ML)		
Remarks: F&R Project # 75S0102		

F&R SINCE 1881

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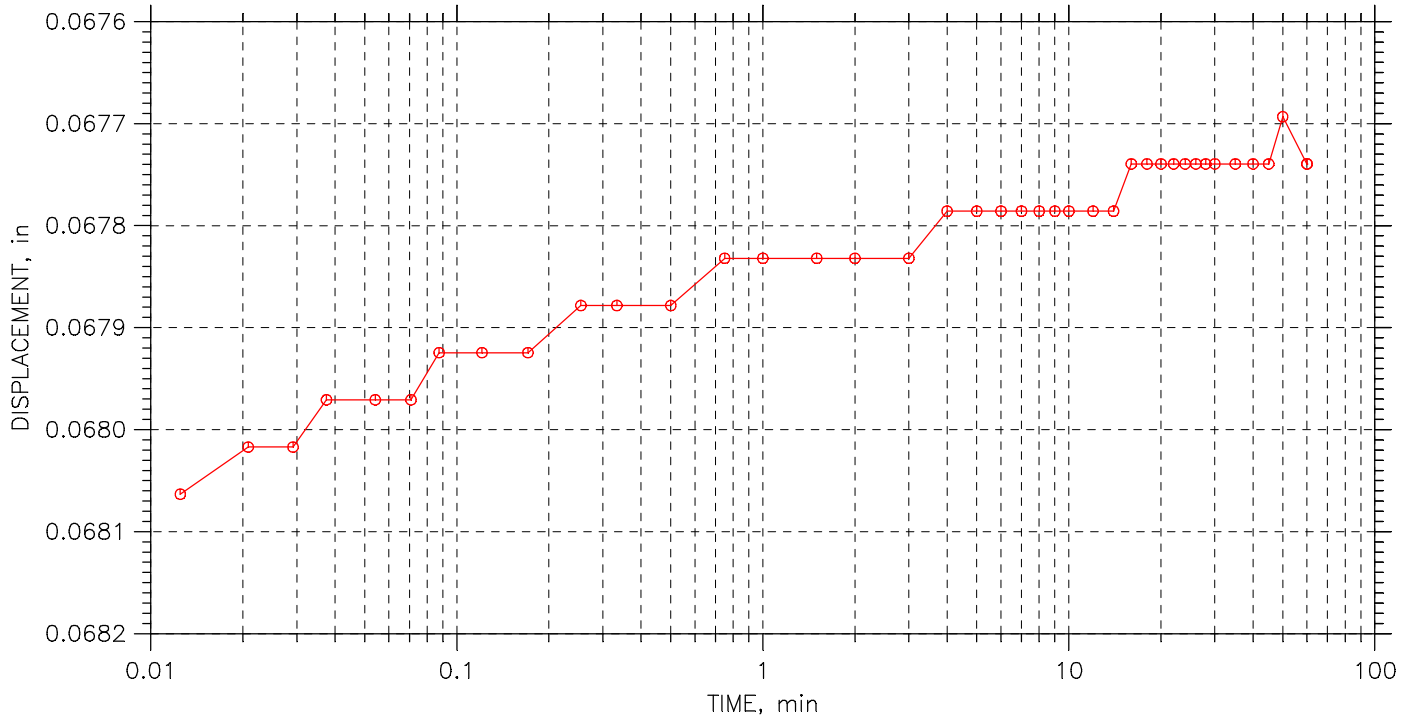
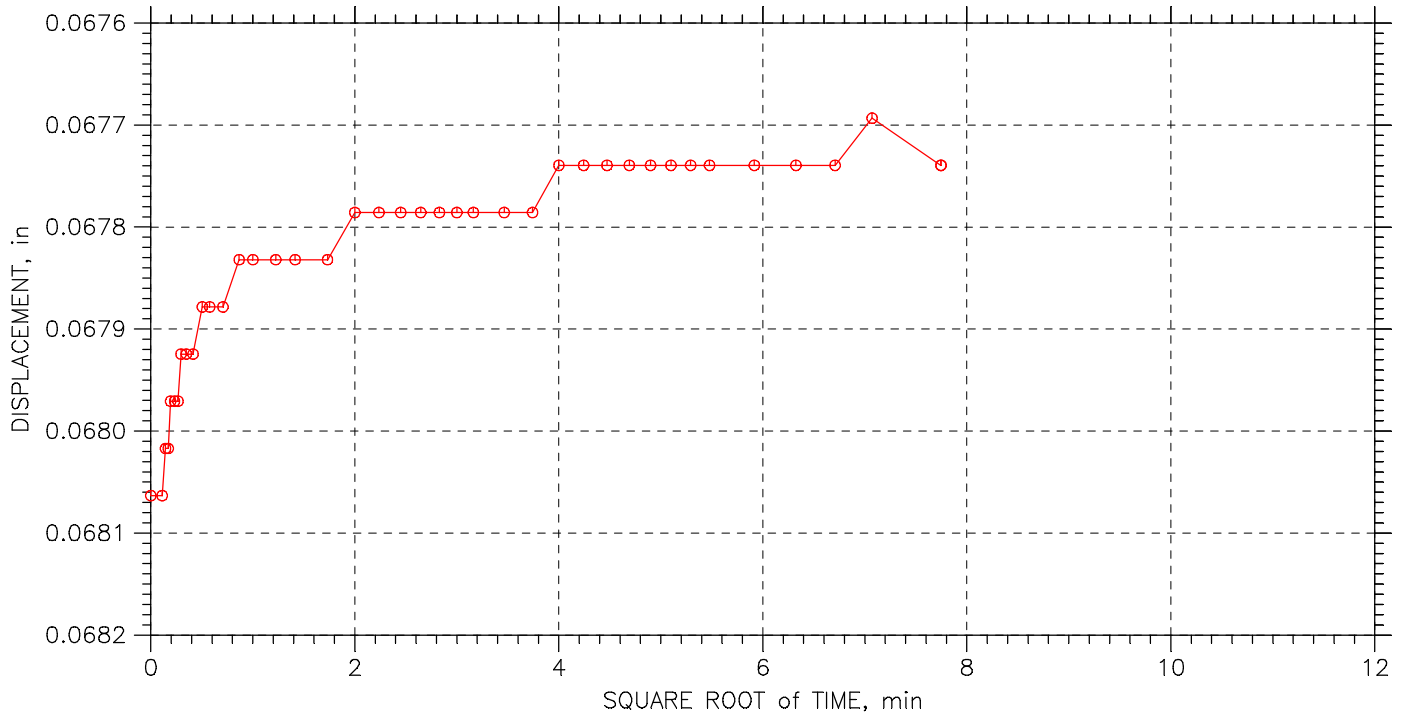
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 23 of 23

Stress: 0.125 tsf





Project: GeoConcepts Engineering	Location: Rt.340 over Cub Run	Project No.: 201401722
Boring No.: SL-3	Tested By: AS	Checked By:
Sample No.:	Test Date: 10.7.14	Depth: 6.0-8.0
Test No.:	Sample Type: ST	Elevation:
Description: Orange-brown silt(visual ML)		
Remarks: F&R Project # 75S0102		

F&R SINCE 1881

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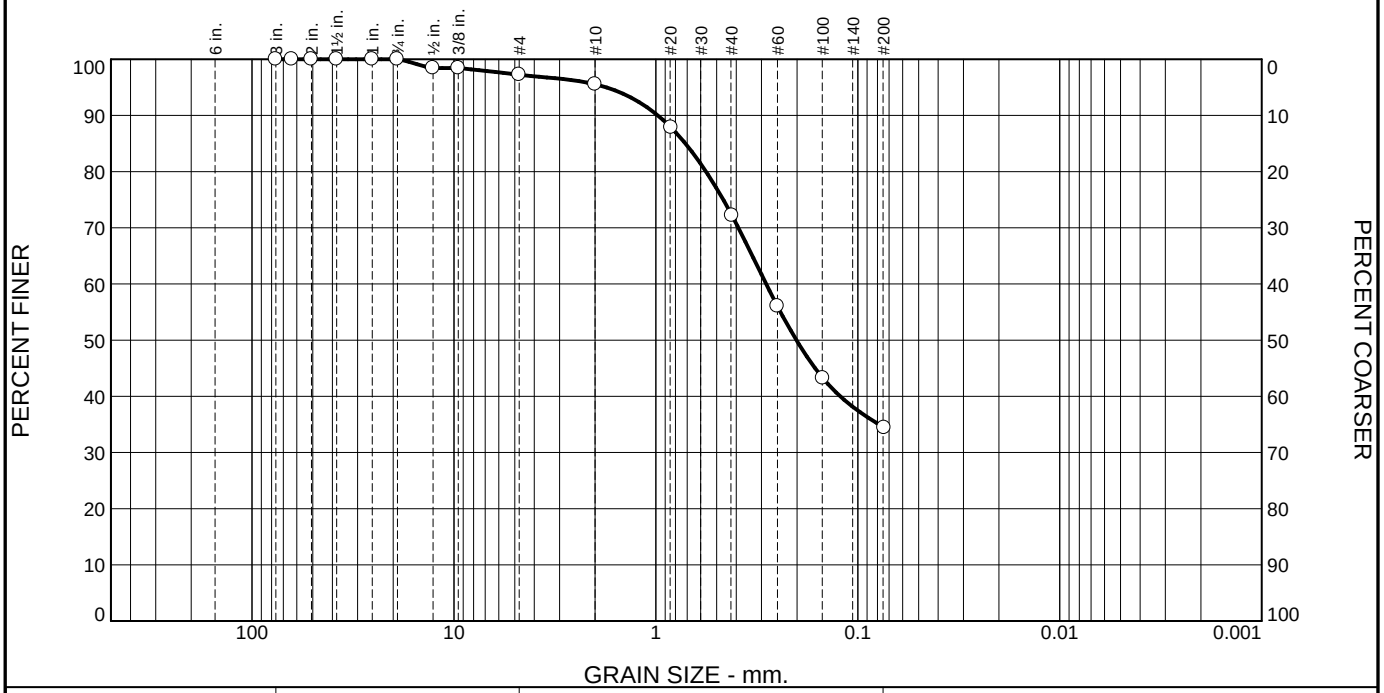
Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.8	1.7	23.0	38.0	34.5	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3	100.0		
2.5	100.0		
2	100.0		
1.5	100.0		
1	100.0		
3/4	100.0		
1/2	98.4		
3/8	98.4		
#4	97.2		
#10	95.5		
#20	87.8		
#40	72.2		
#60	56.0		
#100	43.2		
#200	34.4		

* (no specification provided)

Material Description

Tan-gray silty, clayey sand

Atterberg Limits (ASTM D 4318)

PL= 14 **LL=** 18 **PI=** 4

Classification

USCS (D 2487)= SC-SM **AASHTO (M 145)=**

Coefficients

D_{90}= 0.9786 D_{85}= 0.7144 D_{60}= 0.2844
D_{50}= 0.2014 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 9.22.14 **Date Tested:** 10.8.14

Tested By: _____

Checked By: _____

Title: _____

Sample Number: SL-1 **Depth:** 2.0-3.8 **Date Sampled:**

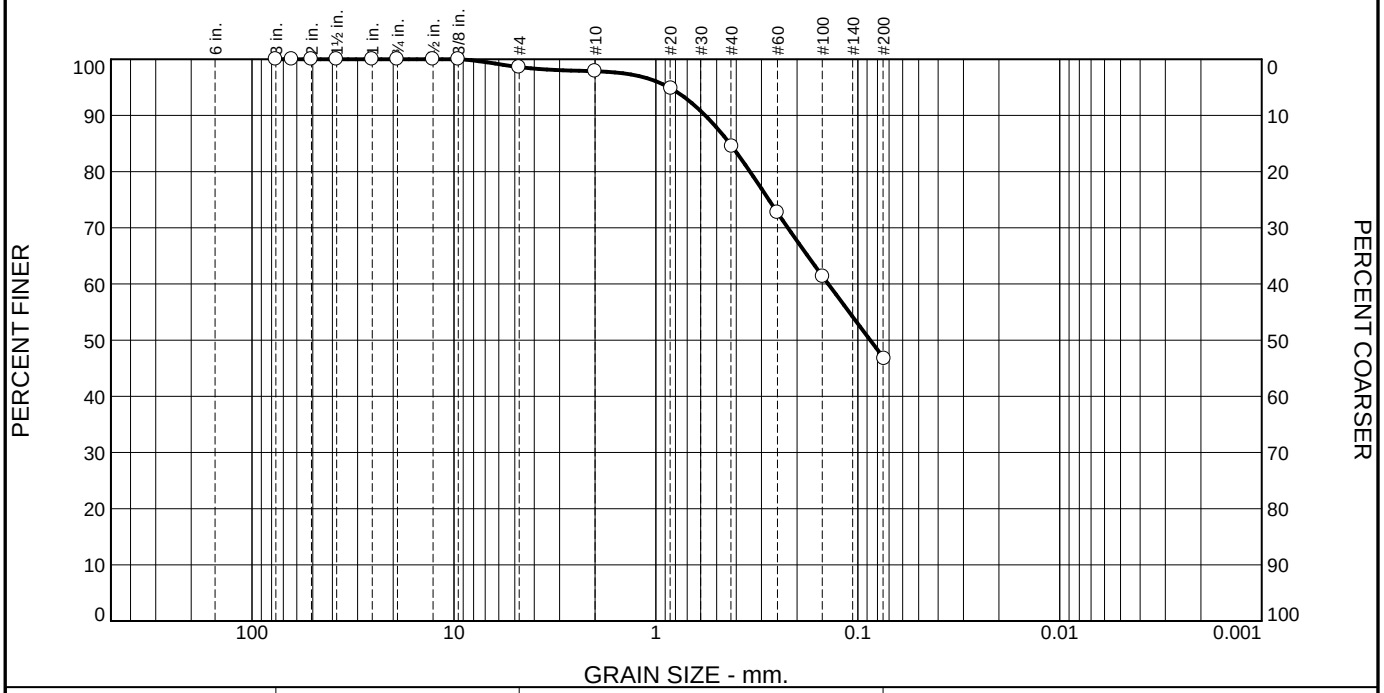
FROEHLING & ROBERTSON, INC.

Hunt Valley, Maryland

Client: GeoConcepts Engineering,Inc.
Project: Route 340 over Cub Run (13004.01)

Project No: 75S0102-201401722 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.4	0.7	13.2	37.7	47.0	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3	100.0		
2.5	100.0		
2	100.0		
1.5	100.0		
1	100.0		
3/4	100.0		
1/2	100.0		
3/8	100.0		
#4	98.6		
#10	97.9		
#20	94.8		
#40	84.5		
#60	72.7		
#100	61.3		
#200	46.7		

* (no specification provided)

Material Description

Orange-brown clayey sand

Atterberg Limits (ASTM D 4318)

PL= 27 **LL=** 51 **PI=** 24

Classification

USCS (D 2487)= SC **AASHTO (M 145)=**

Coefficients

D_{90}= 0.5693 D_{85}= 0.4307 D_{60}= 0.1401
D_{50}= 0.0868 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 9.22.14 **Date Tested:** 10.6.14

Tested By: _____

Checked By: _____

Title: _____

Sample Number: SL-3 **Depth:** 6.0-8.0 **Date Sampled:**

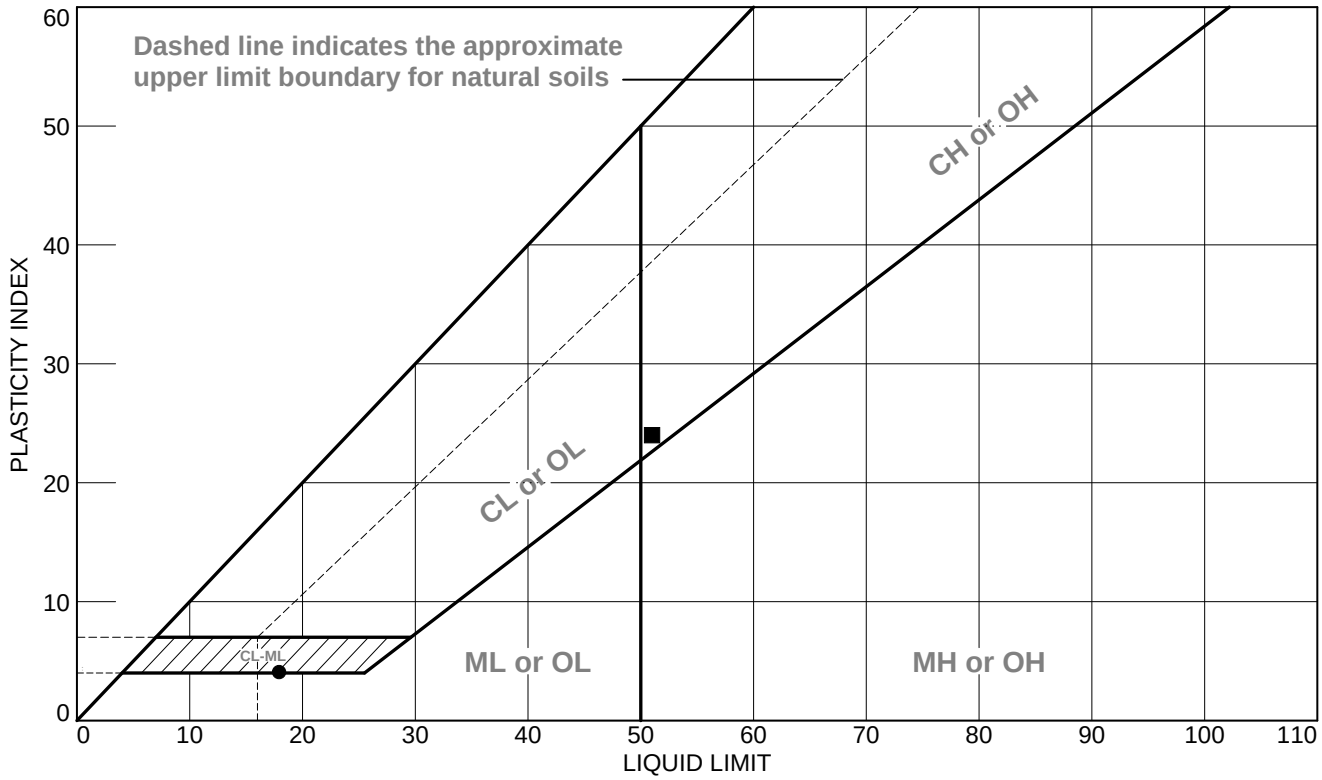
FROEHLING & ROBERTSON, INC.

Hunt Valley, Maryland

Client: GeoConcepts Engineering,Inc.
Project: Route 340 over Cub Run (13004.01)

Project No: 75S0102-201401722 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●		SL-1	2.0-3.8	25.4	14	18	4	SC-SM
■		SL-3	6.0-8.0	29.9	27	51	24	SC

FROEHLING & ROBERTSON, INC.

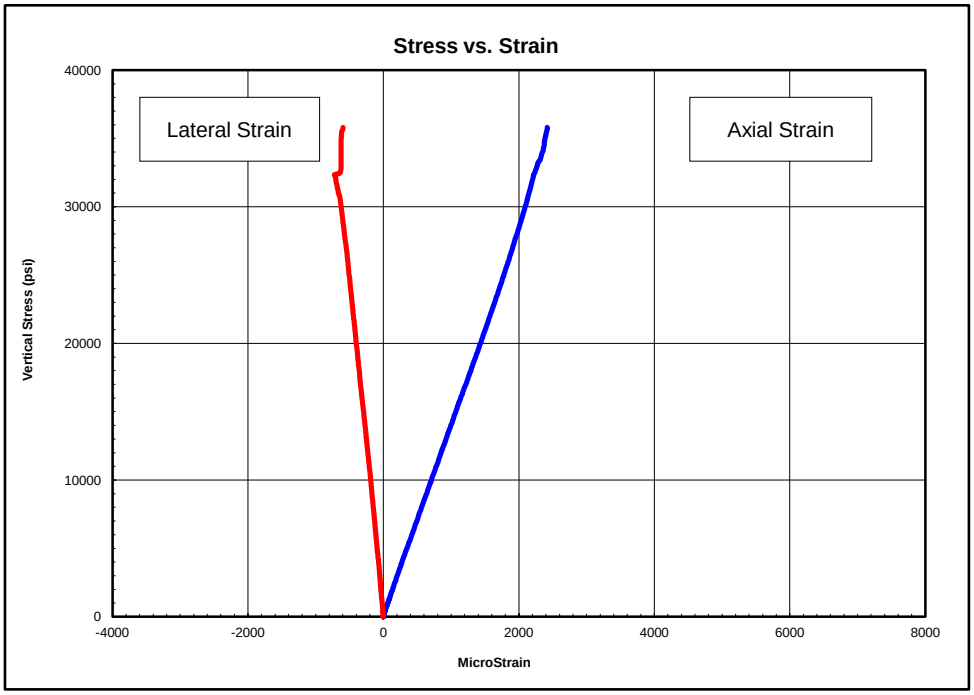
Hunt Valley, Maryland

Client: GeoConcepts Engineering,Inc.
Project: Route 340 over Cub Run (13004.01)

Project No.: 75S0102-201401722 **Figure**

Client:	GeoConcepts Engineering, Inc.
Project Name:	Route 340 Bridge over Cub Run
Project Location:	---
GTX #:	302338
Test Date:	9/29/2014
Tested By:	daa
Checked By:	mpd
Boring ID:	BR-1
Sample ID:	1
Depth, ft:	10.32-10.69
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 35,845 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
3600-13100	13,850,000	0.27
13100-22700	13,830,000	0.29
22700-32200	15,930,000	0.41

Notes: The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	GeoConcepts Engineering, Inc.	Test Date:	9/24/2014
Project Name:	Route 340 Bridge over Cub Run	Tested By:	daa
Project Location:	---	Checked By:	mpd
GTX #:	302338		
Boring ID:	BR-1		
Sample ID:	1		
Depth:	10.32-10.69 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.26	4.26	4.26
Specimen Diameter, in:	1.98	1.98	1.98
Specimen Mass, g:	608.66		
Bulk Density, lb/ft^3	176	**Minimum Diameter Tolerence Met?**	**YES**
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00030	-0.00030	-0.00020	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00020	0.00020	0.00030	0.00030	0.00030	0.00040
Diameter 2, in (rotated 90°)	-0.00050	-0.00050	-0.00050	-0.00040	-0.00030	-0.00020	-0.00010	0.00000	0.00000	0.00010	0.00020	0.00020	0.00030	0.00040	0.00050

Difference between max and min readings, in:

0° = 0.00070 90° = 0.00100

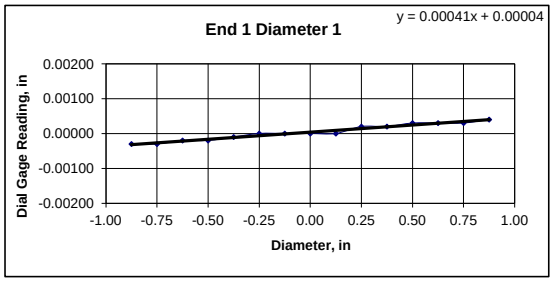
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00030	-0.00020	-0.00020	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00010	0.00010	0.00020	0.00020	0.00030	0.00040	0.00040
Diameter 2, in (rotated 90°)	-0.00050	-0.00050	-0.00050	-0.00040	-0.00030	-0.00010	-0.00010	0.00000	0.00000	0.00010	0.00020	0.00020	0.00030	0.00040	0.00040

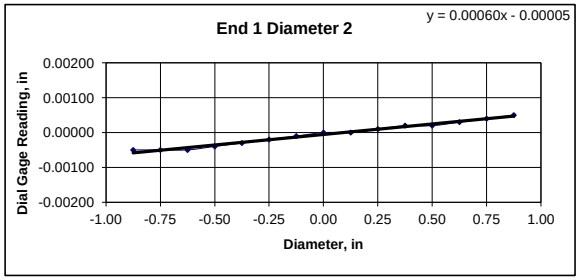
Difference between max and min readings, in:

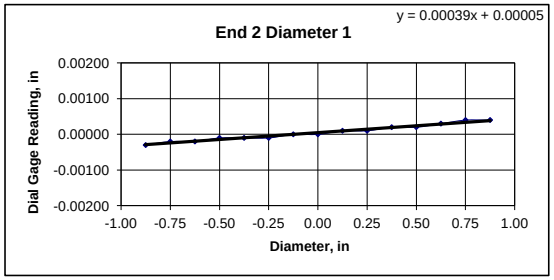
0° = 0.0007 90° = 0.0009

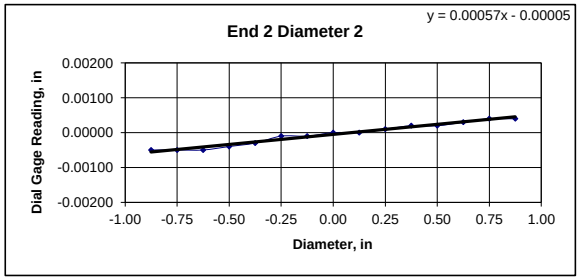
Maximum difference must be < 0.0020 in. Difference = ± 0.00050

Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:

Slope of Best Fit Line	0.00041
Angle of Best Fit Line:	0.02349

End 2:

Slope of Best Fit Line	0.00039
Angle of Best Fit Line:	0.02235

Maximum Angular Difference: 0.00115

Parallelism Tolerance Met? **YES**

Spherically Seated

DIAMETER 2

End 1:

Slope of Best Fit Line	0.00060
Angle of Best Fit Line:	0.03438

End 2:

Slope of Best Fit Line	0.00057
Angle of Best Fit Line:	0.03266

Maximum Angular Difference: 0.00172

Parallelism Tolerance Met? **YES**

Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00070	1.980	0.00035	0.020	YES
Diameter 2, in (rotated 90°)	0.00100	1.980	0.00051	0.029	YES
END 2					
Diameter 1, in	0.00070	1.980	0.00035	0.020	YES
Diameter 2, in (rotated 90°)	0.00090	1.980	0.00045	0.026	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

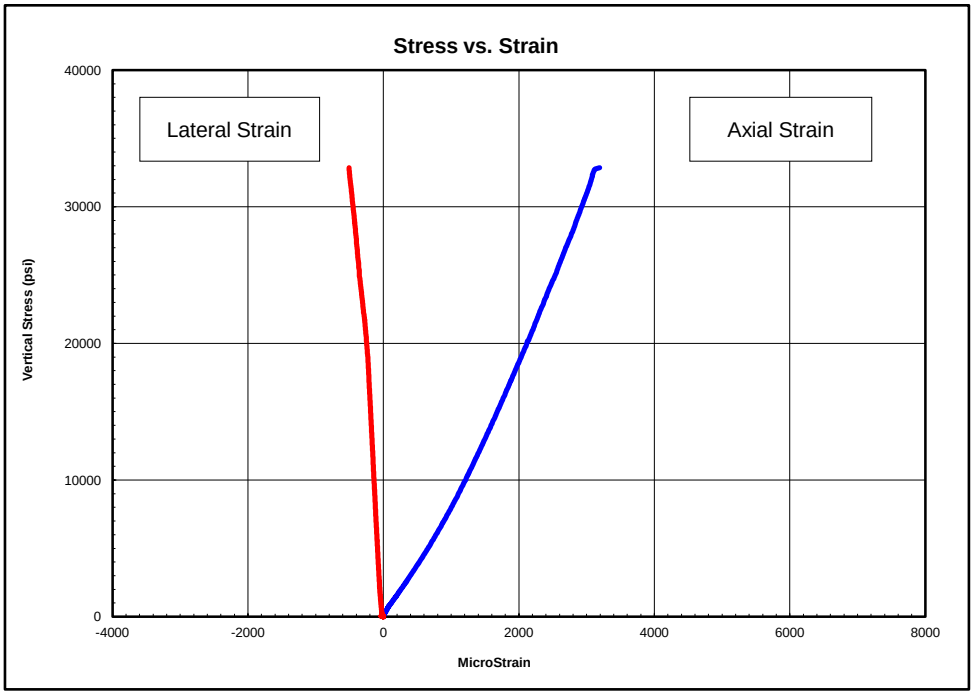
Client:	GeoConcepts Engineering, Inc.
Project Name:	Route 340 Bridge over Cub Run
Project Location:	---
GTX #:	302338
Test Date:	9/29/2014
Tested By:	daa
Checked By:	mpd
Boring ID:	BR-1
Sample ID:	1
Depth, ft:	10.32-10.69

After cutting and grinding

After break

Client:	GeoConcepts Engineering, Inc.
Project Name:	Route 340 Bridge over Cub Run
Project Location:	---
GTX #:	302338
Test Date:	9/29/2014
Tested By:	daa
Checked By:	mpd
Boring ID:	BR-3
Sample ID:	1
Depth, ft:	13.63-14.00
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 32,881 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
3300-12000	9,000,000	0.09
12000-20800	11,300,000	0.12
20800-29600	12,300,000	0.25

Notes: The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	GeoConcepts Engineering, Inc.	Test Date:	9/24/2014
Project Name:	Route 340 Bridge over Cub Run	Tested By:	daa
Project Location:	---	Checked By:	mpd
GTX #:	302338		
Boring ID:	BR-3		
Sample ID:	1		
Depth:	13.63-14.00 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.19	4.19	4.19
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	598.31		
Bulk Density, lb/ft^3	175	**Minimum Diameter Tolerence Met?**	**YES**
Length to Diameter Ratio:	2.1	**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00050	0.00050	0.00040	0.00020	0.00020	0.00010	0.00010	0.00000	0.00000	-0.00010	-0.00020	-0.00030	-0.00040	-0.00050	-0.00060
Diameter 2, in (rotated 90°)	0.00030	0.00030	0.00030	0.00020	0.00010	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00030	-0.00040	-0.00050	-0.00050

Difference between max and min readings, in:

0° = 0.00110 90° = 0.00080

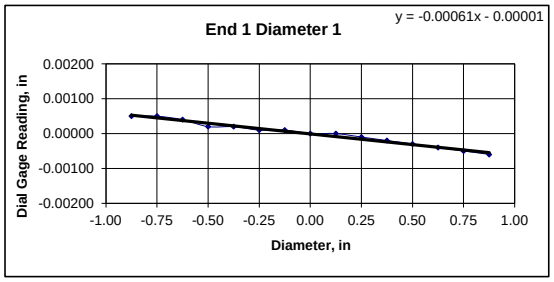
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00040	0.00040	0.00030	0.00030	0.00010	0.00010	0.00000	0.00000	-0.00010	-0.00020	-0.00030	-0.00040	-0.00050	-0.00060	-0.00070
Diameter 2, in (rotated 90°)	0.00030	0.00030	0.00030	0.00030	0.00020	0.00010	0.00000	0.00000	-0.00010	-0.00020	-0.00030	-0.00030	-0.00040	-0.00050	-0.00060

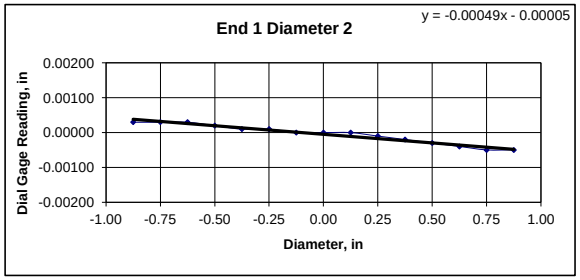
Difference between max and min readings, in:

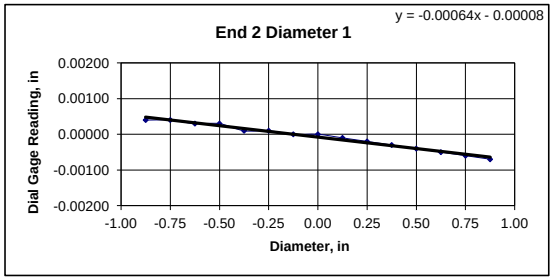
0° = 0.0011 90° = 0.0009

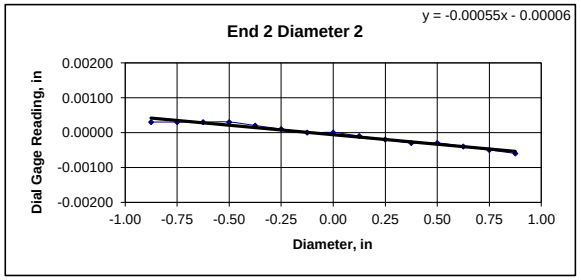
Maximum difference must be < 0.0020 in. Difference = ± 0.00055

Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:

Slope of Best Fit Line	-0.00061
Angle of Best Fit Line:	-0.03495

End 2:

Slope of Best Fit Line	-0.00064
Angle of Best Fit Line:	-0.03667

Maximum Angular Difference: 0.00172

Parallelism Tolerance Met? **YES**

Spherically Seated

DIAMETER 2

End 1:

Slope of Best Fit Line	-0.00049
Angle of Best Fit Line:	-0.02807

End 2:

Slope of Best Fit Line	-0.00055
Angle of Best Fit Line:	-0.03151

Maximum Angular Difference: 0.00344

Parallelism Tolerance Met? **YES**

Spherically Seated

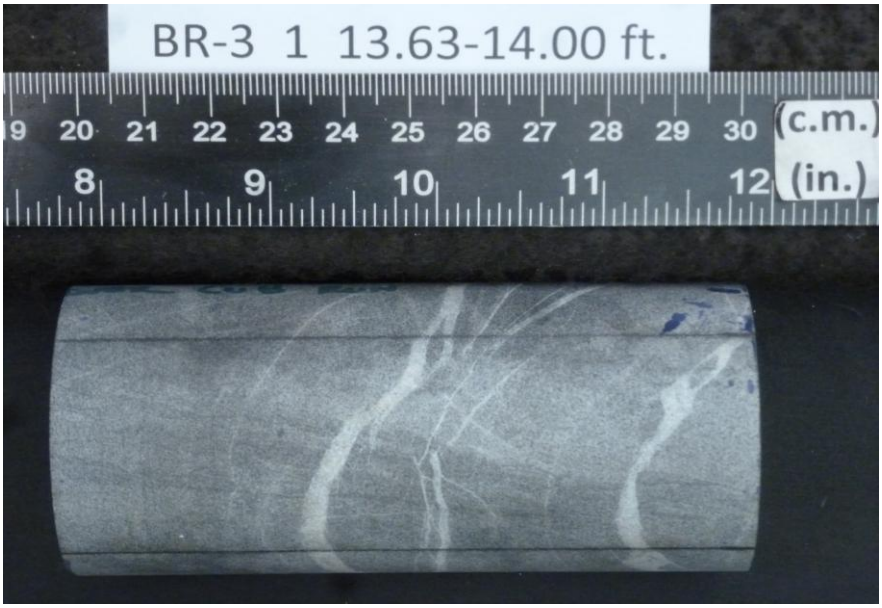
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00110	1.990	0.00055	0.032	YES
Diameter 2, in (rotated 90°)	0.00080	1.990	0.00040	0.023	YES
END 2					
Diameter 1, in	0.00110	1.990	0.00055	0.032	YES
Diameter 2, in (rotated 90°)	0.00090	1.990	0.00045	0.026	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	GeoConcepts Engineering, Inc.
Project Name:	Route 340 Bridge over Cub Run
Project Location:	---
GTX #:	302338
Test Date:	9/29/2014
Tested By:	daa
Checked By:	mpd
Boring ID:	BR-3
Sample ID:	1
Depth, ft:	13.63-14.00

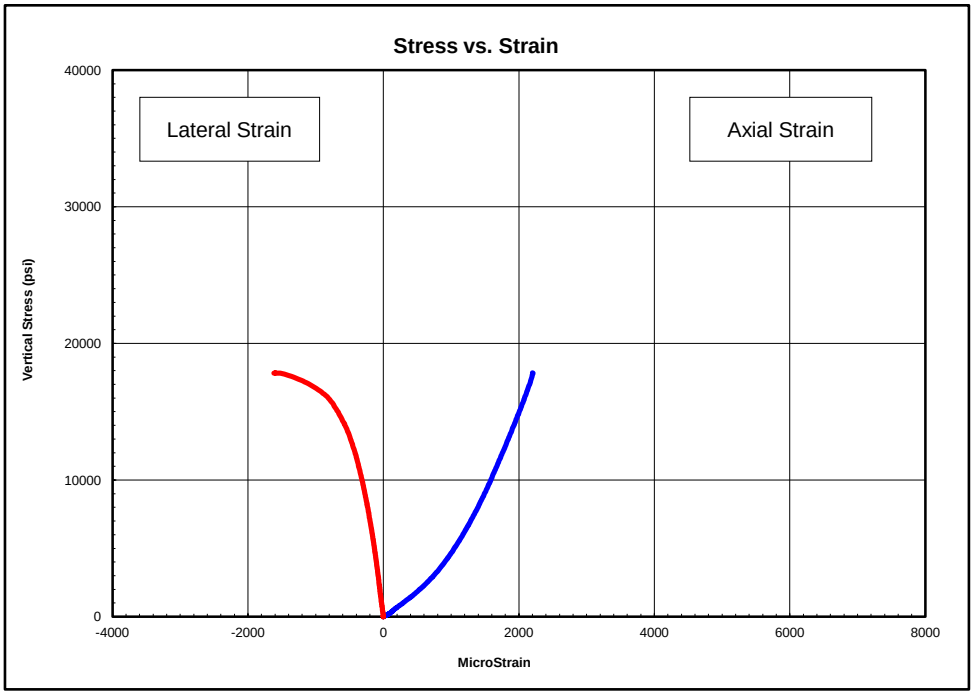


After cutting and grinding

After break

Client:	GeoConcepts Engineering, Inc.
Project Name:	Route 340 Bridge over Cub Run
Project Location:	---
GTX #:	302338
Test Date:	9/30/2014
Tested By:	daa
Checked By:	mpd
Boring ID:	BR-4
Sample ID:	1
Depth, ft:	11.33-11.70
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 17,829 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
1800-6500	6,350,000	0.18
6500-11300	10,300,000	0.43
11300-16100	12,200,000	---

Notes: The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	GeoConcepts Engineering, Inc.	Test Date:	9/24/2014
Project Name:	Route 340 Bridge over Cub Run	Tested By:	daa
Project Location:	---	Checked By:	mpd
GTX #:	302338		
Boring ID:	BR-4		
Sample ID:	1		
Depth:	11.33-11.70 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.18	4.18	4.18
Specimen Diameter, in:	1.98	1.98	1.98
Specimen Mass, g:	601.04		
Bulk Density, lb/ft^3	178	**Minimum Diameter Tolerence Met?**	**YES**
Length to Diameter Ratio:	2.1	**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00040	-0.00040	-0.00040	-0.00030	-0.00030	-0.00020	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00020	0.00020	0.00020
Diameter 2, in (rotated 90°)	-0.00050	-0.00050	-0.00050	-0.00030	-0.00030	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00010	0.00020	0.00020	0.00030

Difference between max and min readings, in:

0° = 0.00060 90° = 0.00080

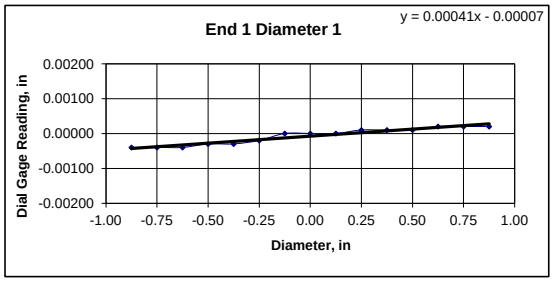
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00040	-0.00040	-0.00030	-0.00030	-0.00030	-0.00010	-0.00010	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010	0.00020	0.00020
Diameter 2, in (rotated 90°)	-0.00060	-0.00050	-0.00040	-0.00030	-0.00020	-0.00020	-0.00010	0.00000	0.00000	0.00010	0.00010	0.00010	0.00020	0.00020	0.00030

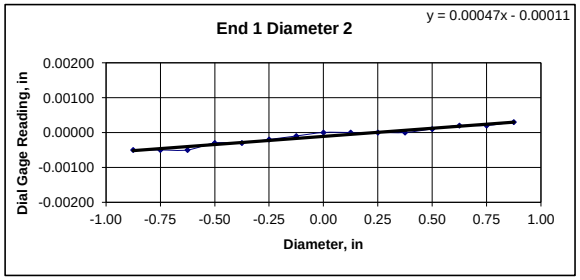
Difference between max and min readings, in:

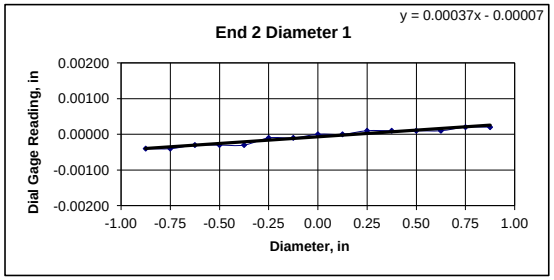
0° = 0.0006 90° = 0.0009

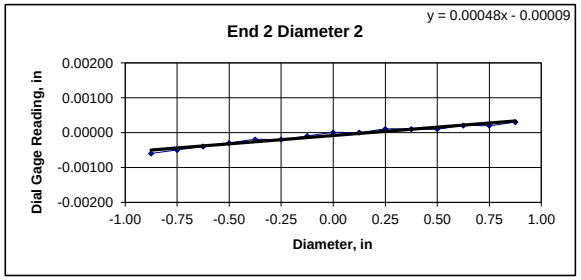
Maximum difference must be < 0.0020 in. Difference = ± 0.00045

Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:

Slope of Best Fit Line 0.00041

Angle of Best Fit Line: 0.02349

End 2:

Slope of Best Fit Line 0.00037

Angle of Best Fit Line: 0.02120

Maximum Angular Difference: 0.00229

Parallelism Tolerance Met? **YES**

Spherically Seated

DIAMETER 2

End 1:

Slope of Best Fit Line 0.00047

Angle of Best Fit Line: 0.02693

End 2:

Slope of Best Fit Line 0.00048

Angle of Best Fit Line: 0.02750

Maximum Angular Difference: 0.00057

Parallelism Tolerance Met? **YES**

Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00060	1.980	0.00030	0.017	YES
Diameter 2, in (rotated 90°)	0.00080	1.980	0.00040	0.023	YES
END 2					
Diameter 1, in	0.00060	1.980	0.00030	0.017	YES
Diameter 2, in (rotated 90°)	0.00090	1.980	0.00045	0.026	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

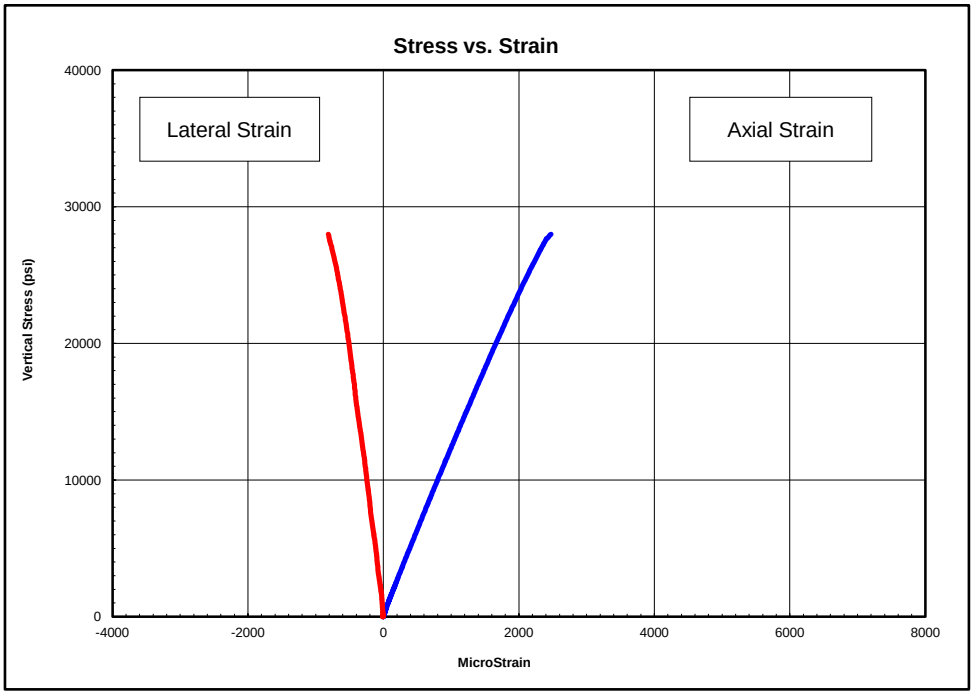
Client:	GeoConcepts Engineering, Inc.
Project Name:	Route 340 Bridge over Cub Run
Project Location:	---
GTX #:	302338
Test Date:	9/30/2014
Tested By:	daa
Checked By:	mpd
Boring ID:	BR-4
Sample ID:	1
Depth, ft:	11.33-11.70

After cutting and grinding

After break

Client:	GeoConcepts Engineering, Inc.
Project Name:	Route 340 Bridge over Cub Run
Project Location:	---
GTX #:	302338
Test Date:	9/29/2014
Tested By:	daa
Checked By:	mpd
Boring ID:	BR-7
Sample ID:	1
Depth, ft:	5.65-6.02
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 28,014 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
2800-10300	12,200,000	0.31
10300-17700	11,700,000	0.32
17700-25200	10,900,000	0.34

Notes: The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	GeoConcepts Engineering, Inc.	Test Date:	9/25/2014
Project Name:	Route 340 Bridge over Cub Run	Tested By:	daa
Project Location:	---	Checked By:	mpd
GTX #:	302338		
Boring ID:	BR-7		
Sample ID:	1		
Depth:	5.65-6.02 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.18	4.18	4.18
Specimen Diameter, in:	1.98	1.98	1.98
Specimen Mass, g:	569.52		
Bulk Density, lb/ft^3	168	**Minimum Diameter Tolerence Met?**	**YES**
Length to Diameter Ratio:	2.1	**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00030	-0.00030	-0.00030	-0.00030	-0.00020	-0.00010	-0.00010	0.00000	0.00010	0.00010	0.00010	0.00020	0.00020	0.00020	0.00030
Diameter 2, in (rotated 90°)	0.00030	0.00030	0.00030	0.00020	0.00020	0.00020	0.00000	0.00000	-0.00010	-0.00020	-0.00020	-0.00030	-0.00030	-0.00040	-0.00050

Difference between max and min readings, in:

0° = 0.00060 90° = 0.00080

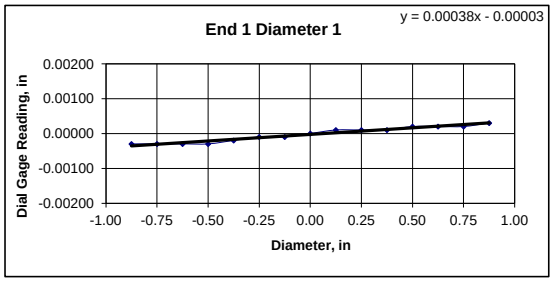
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00020	-0.00020	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00010	0.00010	0.00020	0.00020	0.00030	0.00030
Diameter 2, in (rotated 90°)	0.00040	0.00040	0.00030	0.00030	0.00030	0.00010	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00030	-0.00040	-0.00040

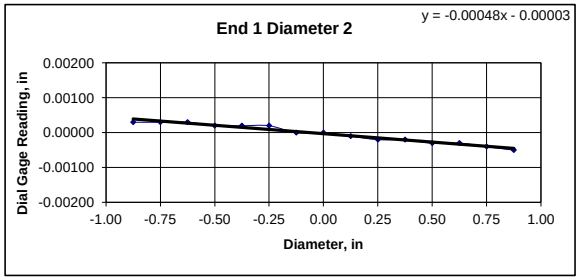
Difference between max and min readings, in:

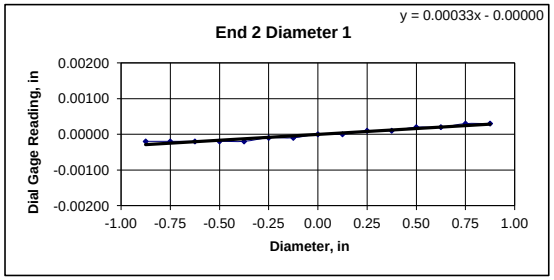
0° = 0.0005 90° = 0.0008

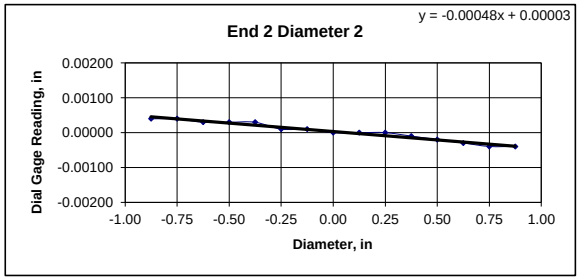
Maximum difference must be < 0.0020 in. Difference = ± 0.00040

Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:

Slope of Best Fit Line	0.00038
Angle of Best Fit Line:	0.02177

End 2:

Slope of Best Fit Line	0.00033
Angle of Best Fit Line:	0.01891

Maximum Angular Difference: 0.00286

Parallelism Tolerance Met? **YES**

Spherically Seated

DIAMETER 2

End 1:

Slope of Best Fit Line	-0.00048
Angle of Best Fit Line:	-0.02750

End 2:

Slope of Best Fit Line	-0.00048
Angle of Best Fit Line:	-0.02750

Maximum Angular Difference: 0.00000

Parallelism Tolerance Met? **YES**

Spherically Seated

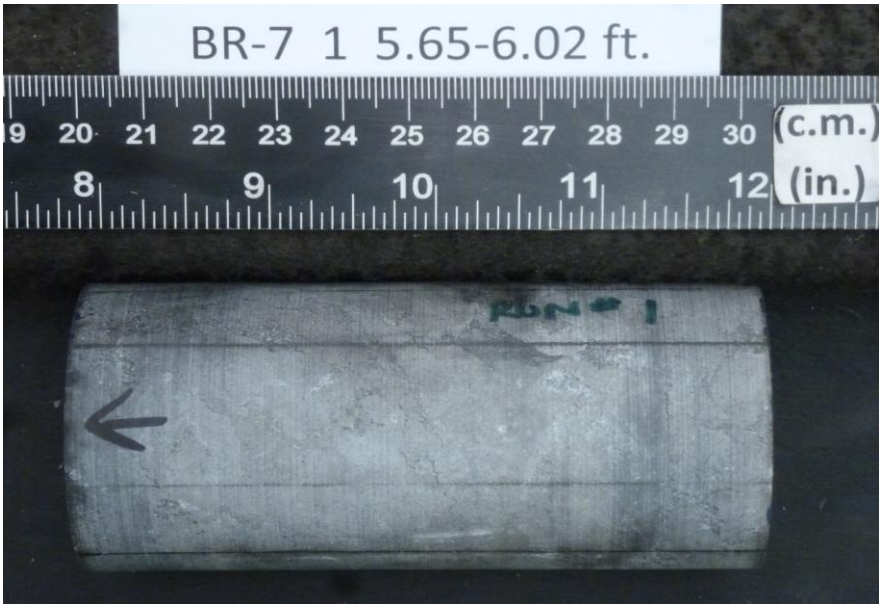
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00060	1.980	0.00030	0.017	YES
Diameter 2, in (rotated 90°)	0.00080	1.980	0.00040	0.023	YES
END 2					
Diameter 1, in	0.00050	1.980	0.00025	0.014	YES
Diameter 2, in (rotated 90°)	0.00080	1.980	0.00040	0.023	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	GeoConcepts Engineering, Inc.
Project Name:	Route 340 Bridge over Cub Run
Project Location:	---
GTX #:	302338
Test Date:	9/29/2014
Tested By:	daa
Checked By:	mpd
Boring ID:	BR-7
Sample ID:	1
Depth, ft:	5.65-6.02

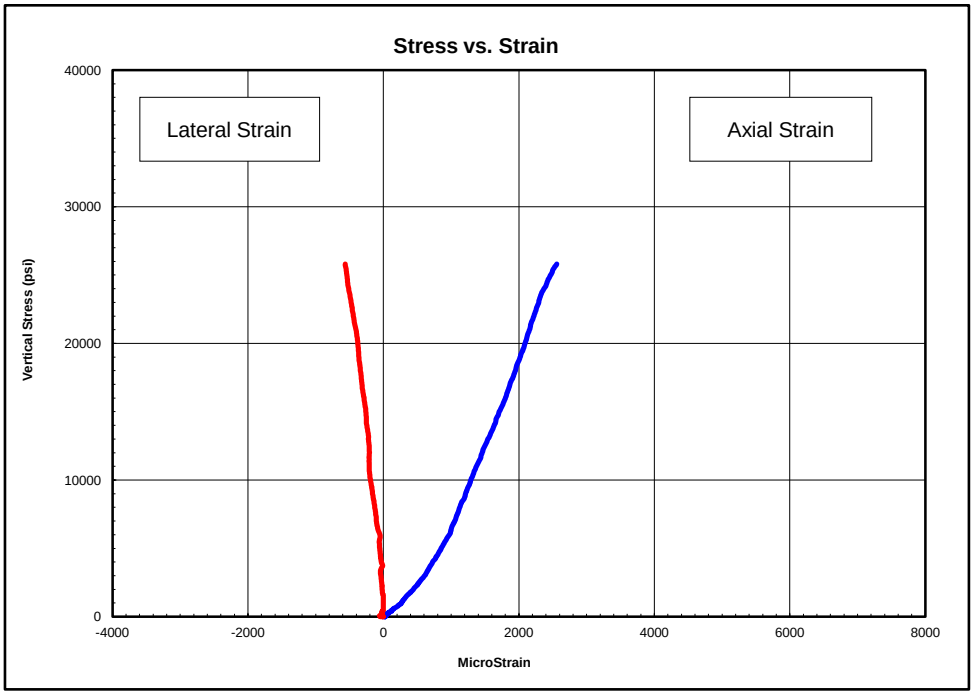


After cutting and grinding

After break

Client:	GeoConcepts Engineering, Inc.
Project Name:	Route 340 Bridge over Cub Run
Project Location:	---
GTX #:	302338
Test Date:	9/29/2014
Tested By:	daa
Checked By:	mpd
Boring ID:	BR-8
Sample ID:	1
Depth, ft:	20.75-21.12
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 25,843 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
2600-9500	9,750,000	0.23
9500-16400	11,800,000	0.19
16400-23200	14,300,000	0.37

Notes: The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	GeoConcepts Engineering, Inc.	Test Date:	9/25/2014
Project Name:	Route 340 Bridge over Cub Run	Tested By:	daa
Project Location:	---	Checked By:	mpd
GTX #:	302338		
Boring ID:	BR-8		
Sample ID:	1		
Depth:	20.75-21.12 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.17	4.17	4.17
Specimen Diameter, in:	1.98	1.98	1.98
Specimen Mass, g:	594.95		
Bulk Density, lb/ft^3	176	**Minimum Diameter Tolerence Met?**	**YES**
Length to Diameter Ratio:	2.1	**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00040	-0.00040	-0.00040	-0.00020	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00020	0.00020	0.00030
Diameter 2, in (rotated 90°)	-0.00040	-0.00040	-0.00040	-0.00030	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00020	0.00030	0.00030	0.00030	0.00040

Difference between max and min readings, in:

0° = 0.00070 90° = 0.00080

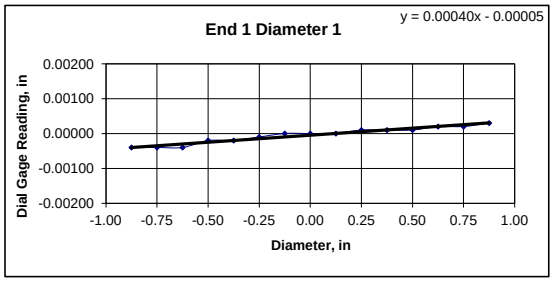
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00040	-0.00040	-0.00040	-0.00040	-0.00030	-0.00020	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00020	0.00020	0.00020
Diameter 2, in (rotated 90°)	-0.00050	-0.00050	-0.00050	-0.00040	-0.00020	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00010	0.00020	0.00020	0.00030

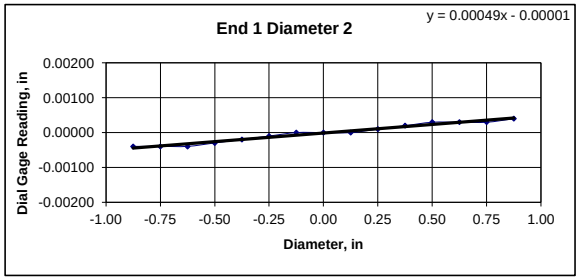
Difference between max and min readings, in:

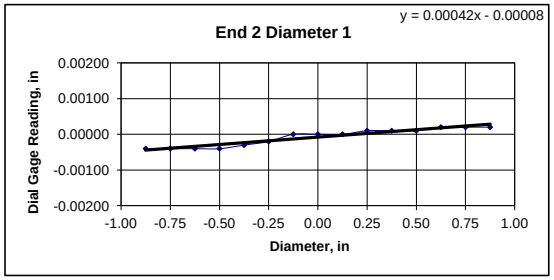
0° = 0.0006 90° = 0.0008

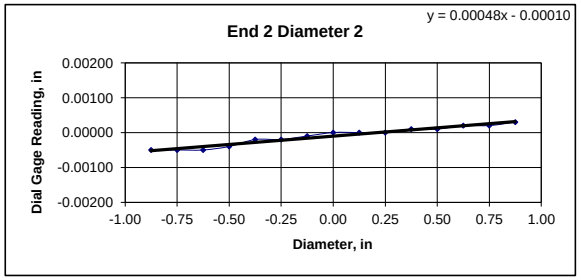
Maximum difference must be < 0.0020 in. Difference = ± 0.00040

Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:

Slope of Best Fit Line	0.00040
Angle of Best Fit Line:	0.02292

End 2:

Slope of Best Fit Line	0.00042
Angle of Best Fit Line:	0.02406

Maximum Angular Difference: 0.00115

Parallelism Tolerance Met? **YES**

Spherically Seated

DIAMETER 2

End 1:

Slope of Best Fit Line	0.00049
Angle of Best Fit Line:	0.02807

End 2:

Slope of Best Fit Line	0.00048
Angle of Best Fit Line:	0.02750

Maximum Angular Difference: 0.00057

Parallelism Tolerance Met? **YES**

Spherically Seated

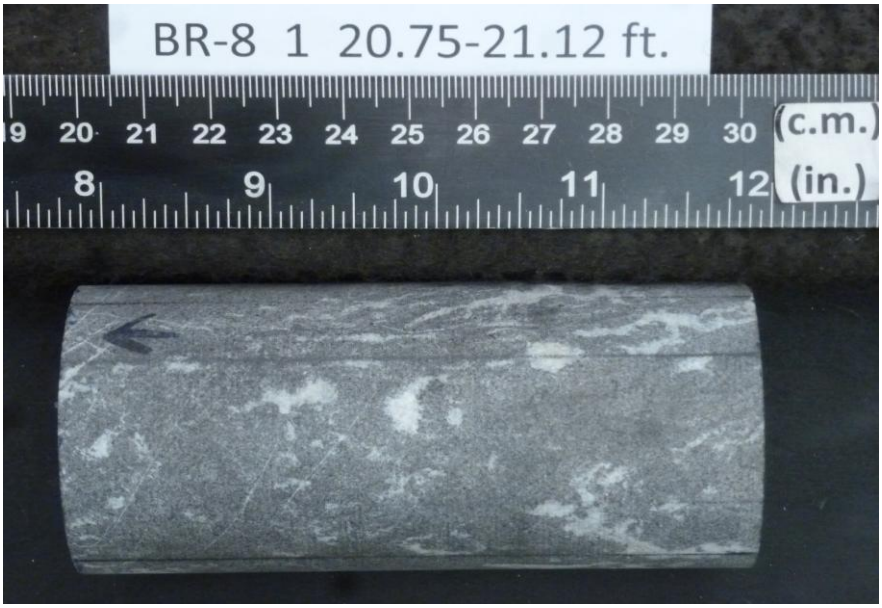
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00070	1.980	0.00035	0.020	YES
Diameter 2, in (rotated 90°)	0.00080	1.980	0.00040	0.023	YES
END 2					
Diameter 1, in	0.00060	1.980	0.00030	0.017	YES
Diameter 2, in (rotated 90°)	0.00080	1.980	0.00040	0.023	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	GeoConcepts Engineering, Inc.
Project Name:	Route 340 Bridge over Cub Run
Project Location:	---
GTX #:	302338
Test Date:	9/29/2014
Tested By:	daa
Checked By:	mpd
Boring ID:	BR-8
Sample ID:	1
Depth, ft:	20.75-21.12



After cutting and grinding

After break

GeoConcepts Engineering, Inc.

19955 Highland Vista Dr., Suite 170
Ashburn, Virginia 20147
(703) 726-8030
www.geoconcepts-eng.com

UNCONFINED ROCK COMPRESSIVE STRENGTH TEST REPORT

Project Number:	13004.01
Project:	Rt. 340 Over Cub Run
Client:	Dewberry

Sample No.	Sample Depth (feet)	Rock Type	Test Date	Length Uncapped (in.)	Diameter (in.)	Area (in^2)	Load (lbs.)	Compressive Strength (psi)	L/D	Corrected Compressive Strength (psi)
BR-1	10.8-11.5	Limestone	2/6/2015	4.09	1.98	3.08	23420	7606	2.07	7606
BR-3	14-15	Limestone	2/6/2015	4.05	1.99	3.11	24010	7720	2.04	7720
BR-3	18.3-18.7	Limestone	2/6/2015	4.15	1.98	3.08	47750	15508	2.10	15508
BR-4	9.6-10.1	Limestone	2/6/2015	4.04	1.99	3.11	27280	8771	2.03	8771
BR-7	6.5-7.6	Limestone	2/6/2015	4.02	1.98	3.08	20570	6681	2.03	6681
BR-8	18.8-19.6	Limestone	2/6/2015	3.97	1.98	3.08	38260	12426	2.01	12426

Reported by: Shawn Harris

GeoConcepts Engineering, Inc.

19955 Highland Vista Dr., Suite 170
Ashburn, Virginia 20147
(703) 726-8030
www.geoconcepts-eng.com

UNCONFINED ROCK COMPRESSIVE STRENGTH TEST REPORT

Project Number:	13004.01
Project:	Rt. 340 Over Cub Run
Client:	Dewberry

Sample No.	Sample Depth (feet)	Rock Type	Test Date	Length Uncapped (in.)	Diameter (in.)	Area (in^2)	Load (lbs.)	Compressive Strength (psi)	L/D	Corrected Compressive Strength (psi)
BR-1	10.8-11.5	Limestone	2/6/2015	4.09	1.98	3.08	23420	7606	2.07	7606
BR-3	14-15	Limestone	2/6/2015	4.05	1.99	3.11	24010	7720	2.04	7720
BR-3	18.3-18.7	Limestone	2/6/2015	4.15	1.98	3.08	47750	15508	2.10	15508
BR-4	9.6-10.1	Limestone	2/6/2015	4.04	1.99	3.11	27280	8771	2.03	8771
BR-7	6.5-7.6	Limestone	2/6/2015	4.02	1.98	3.08	20570	6681	2.03	6681
BR-8	18.8-19.6	Limestone	2/6/2015	3.97	1.98	3.08	38260	12426	2.01	12426

Reported by: Shawn Harris

HP ENVIRONMENTAL
INCORPORATED

Report Number: **144519**

Certificate of Laboratory Analysis

GeoConcepts Engineering, Inc.
Attn: Sushand Upadhyaya
19955 Highland Vista Dr.
Suite 170
Ashburn, VA 20147

Date Received: 09/17/14
Date Reported: 09/23/14
Project Location: **Rt. 340 Bridge over Cub Run**

---

1. Client Sample No: **BR-2**
Sample Matrix: Soil
Sample Location: 0.0 - 5.0 ft

HPE Sample No.: 144519-01
Date Collected: 09/17/14

Test(s) Requested: **Soil Corrosion Potential Profile**
Analysis Method(s): Various
Date Analyzed: 09/22/14

Analyte	Result	Units	Reporting Limit	Qualifier
Resistivity - ASTM G187	**10000**	ohm-cm	N/A	
Redox Potential - Electrode	+ **211**	mV	N/A	
pH - CA643	**6.2**	pH	N/A	
Chloride (Water Soluble) - CA422	**4.9**	mg/Kg	2.5	
Sulfate (Water Soluble) - CA417	< 5.0	mg/Kg	5.0	U
Sulfide (Water Soluble) EPA 376.2	< 1.2	mg/Kg	1.2	U
Moisture (Percent)	**9.2**	%	N/A	

2. Client Sample No: **BR-5**
Sample Matrix: Soil
Sample Location: 5.0 - 8.1 ft

HPE Sample No.: 144519-01
Date Collected: 09/17/14

Test(s) Requested: **Soil Corrosion Potential Profile**
Analysis Method(s): Various
Date Analyzed: 09/22/14

Analyte	Result	Units	Reporting Limit	Qualifier
Resistivity - ASTM G187	**5300**	ohm-cm	N/A	
Redox Potential - Electrode	+ **227**	mV	N/A	
pH - CA643	**6.4**	pH	N/A	
Chloride (Water Soluble) - CA422	**10**	mg/Kg	2.5	
Sulfate (Water Soluble) - CA417	**21**	mg/Kg	5.0	
Sulfide (Water Soluble) EPA 376.2	< 1.2	mg/Kg	1.2	U
Moisture (Percent)	**27**	%	N/A	

Analyte Qualifier Codes

U = Analyte was not detected
J = Analyte detected below reporting limit (estimated value)
D = Analyte reported from a sample dilution

Report Number: **144519**

HP ENVIRONMENTAL
INCORPORATED

Certificate of Laboratory Analysis

GeoConcepts Engineering, Inc.
Attn: Sushand Upadhyaya
19955 Highland Vista Dr.
Suite 170
Ashburn, VA 20147

Date Received: 09/17/14
Date Reported: 09/23/14
Project Location: **Rt. 340 Bridge over Cub Run**

3. Client Sample No: **BR-8**
Sample Matrix: Soil
Sample Location: 0.0 - 5.0 ft

HPE Sample No.: 144519-03
Date Collected: 09/17/14

Test(s) Requested: **Soil Corrosion Potential Profile**
Analysis Method(s): Various
Date Analyzed: 09/22/14

Analyte	Result	Units	Reporting Limit	Qualifier
Resistivity - ASTM G187	**13000**	ohm-cm	N/A	
Redox Potential - Electrode	+ **238**	mV	N/A	
pH - CA643	**6.5**	pH	N/A	
Chloride (Water Soluble) - CA422	**4.9**	mg/Kg	2.5	
Sulfate (Water Soluble) - CA417	**12**	mg/Kg	5.0	
Sulfide (Water Soluble) EPA 376.2	< 1.2	mg/Kg	1.2	U
Moisture (Percent)	**12**	%	N/A	

JP 09/23/14
Approved by Date

Analyte Qualifier Codes
U = Analyte was not detected
J = Analyte detected below reporting limit (estimated value)
D = Analyte reported from a sample dilution

Appendix C
Tables

Table C-1: Groundwater Readings (1 page)

Table C-2: Topsoil Thickness (1 Page)

Table C-3: Unsuitable Soil (1 page)

GeoConcepts Engineering, Inc.

Table C-1: Groundwater Readings

Test Boring No.	Ground Surface Elevation (ft)	Depth to Groundwater (ft)		Groundwater Elevation (ft)	
		First Encountered	After 24 or Longer Hours	First Encountered	After 24 or Longer Hours
BR-1	910.5	Dry	N/R	Dry	N/R
BR-2	902.8	Dry	4.0	Dry	898.8
BR-3	901.0	Dry	3.0	Dry	888.0
BR-4	904.7	5.0	3.0	899.7	901.7
BR-5	903.5	2.0	1.0	901.5	902.5
BR-6	904.6	5.0	1.0	899.6	903.6
BR-7	905.2	Dry	1.0	Dry	904.2
BR-8	932.0	Dry	3.8	Dry	928.2
BR-9	932.6	Dry	N/R	Dry	N/R
R-1	971.5	Dry	N/R	Dry	N/R
R-2	965.8	Dry	N/R	Dry	N/R
R-3	974.9	Dry	N/R	Dry	N/R
R-4	976.5	Dry	N/R	Dry	N/R
SL-1	941.6	Dry	N/R	Dry	N/R
SL-1A	941.6	Dry	N/R	Dry	N/R
SL-2	934.9	Dry	N/R	Dry	N/R
SL-3	973.8	Dry	N/R	Dry	N/R
SL-4	971	13.5	N/R	957.5	N/R
SL-5	979.1	Dry	N/R	Dry	N/R

N/R: NOT RECORDED

Table C-2: Topsoil Thickness

Station No.	Test Boring No.	Ground Surface Elevation (ft)	Thickness of Topsoil (ft)
18+50	BR-1	910.5	0.25
19+25	BR-2	902.8	0.25
19+25	BR-3	901.0	0.25
19+75	BR-4	904.7	0.25
19+75	BR-5	903.5	0.25
20+00	BR-6	904.6	0.50
20+00	BR-7	905.2	0.50
21+00	BR-8	932.0	0.50
21+00	BR-9	932.6	0.25
13+50	R-1	971.5	--
23+00	R-2	965.8	0.20
25+00	R-3	974.9	0.20
27+00	R-4	976.5	--
17+75	SL-1	941.6	0.25
17+75	SL-1A	941.6	--
21+25	SL-2	934.9	--
15+50	SL-3	973.8	0.25
23+00	SL-4	971	0.25
24+00	SL-5	979.1	0.25

GeoConcepts Engineering, Inc.

Table C-3: Unsuitable Soil

Station From	Station To	Representative Boring(s)	Depth Range of Unsuitable Soil (ft)					Range of Cut and Fill (feet)	Recommended Treatment Below Subgrade
			Excessively Wet Soil	LL>45 & PI>25 CH,MH,OL, OH	Soft or Very Loose Soil	CBR <4%	Swell >5%		
13+00	15+00	R-1	1.3-7.3, 9.3-11.3	-	-	-	-	Fill: 2.0 Cut: 11.5	A, B
15+00	16+50	B-1	-	-	-	-	-	Fill: 5.5 Cut: 12.0	No Treatment Required
16+50	18+00	B-2	-	-	-	-	-	Fill: 24.0 Cut: 9.5	No Treatment Required
18+00	19+00	B-3	6.5-8.5 13.5-40.0	-	6.5-8.5	-	-	Fill: 42.5 Cut: none	No Treatment Required
19+00	21+00	Bridge							
21+00	22+50	BR-8	0.5-8.0	-	-	-	-	Fill: 19.0 Cut: 12.5	A, B
22+50	24+00	R-2	0.0-0.9	-	-	-	-	Fill: none Cut: 18.0	A, B
24+00	26+00	R-3	2.0-8.0	1.0-8.0	-	-	-	Fill: 1.5 Cut: 17.5	C
26+00	29+50	R-4	3.5-9.5	3.5-9.5	-	-	-	Fill: 1.5 Cut: 8.5	C

Notes:
(1) Excessively soft or loose soil is defined as N ≤ 4;
(2) Cut/fill depths are estimated based on the proposed roadway cross-section and existing elevations at the test boring locations.
(3) Low CBR value is defined as CBR Value<4.

RECOMMENDED TREATMENT METHODS FOR WET SOILS:

A. Excavate unsuitable material to a minimum depth of 3 feet below subgrade and allow to dry, prior to use as embankment foundation.
B. Dry to a minimum depth of 3 feet below subgrade using pelletized quicklime, 4% by weight.

RECOMMENDED TREATMENT METHOD FOR UNSUITABLE SOILS:

C. Undercut unsuitable materials (CBR<4, CH/MH/OH/OL, Swell>5%, soft or very loose soils) to a depth of at least 3 feet below subgrade or until unsuitable soil is no longer present, whichever is less, and backfill with suitable compacted fill material with a minimum CBR value of 4.

Appendix D
Engineering Calculations

Spread Footing Bearing Resistance on Rock (1 page)

Geotechnical Factored Resistance of H-Pile Supported in Rock (1 Page)

Settlement of H-Pile Bearing on Stiffer Stratum or Rock (1 Page)

Bearing Resistance of Soil - RW-3 Retaining Wall (1 page)

Elastic Settlement at Service Limit - RW-3 Retaining Wall (1 page)

Bearing Resistance of Soil - MSE Retaining Wall (1 page)

Elastic Settlement at Service Limit - MSE Retaining Wall (1 page)

Pavement Design Calculations

Mainline and Shoulder (1 page)

Temporary Pavement Section (1 page)

Pavement Design Calculations

Lpile Analysis (10 pages)

GeoConcepts Engineering, Inc.

SPREAD FOOTING BEARING RESISTANCE ON ROCK

Route 340 Bridge Replacement and Approaches over Cub Run

Sample No.	Depth (ft)	Rock Type	Compressive Strength (psi)
BR-1	10.32-10.69	Dolostone	35,845
BR-3	13.63-14.0		32,881
BR-4	11.33-11.70		17,829
BR-7	5.65-6.02		28,014
BR-8	20.75-21.12		25,843

After neglecting the highest and the lowest values, the average of the remaining cores

$q_{u,\ avg.}$ (psi)	**28912.7**

Overall Average	
$q_{u,\ avg.}$ (psi)	**28082.4**

Use a factor of safety 10 to determine $q_{u,design}$

$q_{u,design}$ (psi)	**2808**

$q_{u,\ design}$ (psi)	**2808**
Resistance factor (φ_b)	**0.45**
Factored Resistance (q_{all}) (psf)	**181974**
Factored Resistance (tsf)	**91**

Table 10.5.5.2.2-1 - AASHTO LRFD 2012

Borings	RQD (%)					
	Run-1	Run-2	Run-3	Run-4	Run-5	Average
BR-1	78	96				87
BR-2	0	94	92			62
BR-3	0	98	100			66
BR-4	84	88				86
BR-5	92	100				96
BR-6	46	44	60			50
BR-7	66	100				83
BR-8	100	100				
BR-9	95	62				79
			Total Average			76

Reduced factored resistance based on RQD	
Factored Resistance (q'_{all}) (psf)	**105281**
Factored Resistance (q'_{all}) (tsf)	**53.0**

$q'_{all} = q_{allI}\,(RQD)^2$

GeoConcepts Engineering, Inc.

GEOTECHNCIAL FACTORED RESISTANCE OF H-PILE SUPPORTED ON ROCK

Project Number: 13004.01	**Project Engineer: JA**
Project Name: Route 340 Bridge Replacement and Approaches over Cub Run	**Principal Engineer: SU**
Project Location:Page County	**Date: 05-15-2015**

Sample No.	Depth (ft)	Rock Type	Compressive Strength (psi)
B-1	6.50-6.83	Limestone	4591
B-3	42.2-42.33	Limestone	3466
B-3	46.0-46.33	Limestone	4257
BR-1	10.32-10.69	Limestone	35845
BR-1	10.80-11.50	Limestone	7606
BR-3	13.63-14.0	Limestone	32881
BR-3	14.0-15.0	Limestone	7720
BR-4	9.60-10.10	Limestone	15508
BR-4	11.33-11.70	Limestone	17829
BR-7	5.65-6.02	Limestone	28014
BR-7	6.50-7.60	Limestone	6681
BR-8	18.80-19.60	Limestone	12426
BR-8	20.75-21.12	Limestone	25843

After neglecting the highest and the lowest values, the average of the remaining cores

$q_{u,\ avg.}$ (psi)	14850.5

Overall Average	
$q_{u,\ avg.}$ (psi)	15589.8

Use a factor of safety 5 to determine qu,design	
$q_{u,\ design.}$ (psi)	2970.1

Resistance factor (φ_b)	0.45

Assumed Angle of Friction for Rock (degrees)	40
$45+\phi/2$	65
$N\phi$	4.60
qp (psi)	16629.37

(Equation 9-56 Braja M. Das; Foundation Engineering; 4th Ed)

H-Pile Section	HP 10X42	HP 12X53	HP 12X74
Area (sq. inch)	12.4	15.5	21.8
Nominal Pile Capacity (tons)	103	129	181
Factored resistance (tons)	46	58	82
with Steel Plate at the Base			
Area of Base (sq. inch)	144		
Nominal Pile Capacity (tons)	1197.3		
Factored resistance (tons)	538.8		

GeoConcepts Engineering, Inc.

Settlement of H-Pile Bearing on Stiffer Stratum or Rock

Project No.	**13004.01**	**Project Engineer: J.A.**
Project Name:	**Route 340 Bridge Replacement and Approaches over Cub Run**	**Principal Engineer: P.E.B.**
Project Location:	**Page County, VA**	**Date: 05-15-2015**

Section	**Steel H-Pile**	**10X42**	**12X53**	**12X74**
d	pile diameter (inch)	12.4	15.5	21.8
d_b	base diameter (inch)	12.4	15.5	21.8
d/d_b	---	1	1	1
L	length of pile (inch)	504	504	504
L/d	---	41	33	23
I_o	settlement influence factor	0.05	0.055	0.075
Es	elastic modulus of bearing stratum (psi)	1635000	1635000	1635000
E_b	modulus of elasticity (psi)	2.90E+07	2.90E+07	2.90E+07
E_b/E_s	---	18	18	18
k	stiffness factor	5000	5000	5000
R_k	correction factor for pile compressibility	1.1	1.1	1.1
R_b	correction factor for stiffness of bearing stratum	0.6	0.6	0.3
R_v	correction for soil poisson's ratio	0.87	0.87	0.87
ν	poisson's ratio (LRFD Table C10.4.6.5.2)	0.23	0.23	0.23
I	influence factor	0.03	0.03	0.02
P	applied axial load (lb) - based on structural capacity	310000	388000	545000
ρ	settlement (inch)	**0.0004**	**0.0005**	**0.0003**

$$Equation\ 5.34 \qquad \rho = \frac{PI}{E_s d}$$

Pile Foundation Analysis and Design, H.G.Poulos and E.H.davis

GeoConcepts Engineering, Inc.

19955 Highland Vista Dr., Suite 170
Ashburn, Virginia 20147
(703) 726-8030
www.geoconcepts-eng.com

AASHTO LRFD Bridge Specifications 2012

Bearing Resistance of Soil - RW-3 Retaining Wall

Project Number: 13004.01	**Project Engineer: JA**
Project Name: Route 340 Bridge Over Cub Run	**Principal Engineer: PEB**
Project Location: Page County	**Date: 11-01-2014**
Test Boring No.: B-3	**Temporary Support RW-3**

Based on Bearing Capacity Equation 10.6.3.1.3-1 of AASHTO LRFD Bridge Design Specifications

γ (pcf), total or moist	120
Df (ft)	2
Dw, Depth of groundwater (feet)	25
φ_b	0.5

B (ft)	2.0	3.0	4.0	5.0	6.0	7.0	8.0
L (ft)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
$N1_{60}$	10.00						
Cwq	1.00	1.00	1.00	1.00	1.00	1.00	1.00
$Cw\gamma$	1.00	1.00	1.00	1.00	1.00	1.00	1.00
qn (ksf), nominal bearing resistance	8.0	10.0	12.0	14.0	16.0	18.0	20.0
q_R (ksf), factored resistance	4.0	5.0	6.0	7.0	8.0	9.0	10.0

q_R (ksf), extreme event limit	8.0	10.0	12.0	14.0	16.0	18.0	20.0

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AASHTO LRFD Bridge Specifications 2012

Elastic Settlement at Service Limit - RW-3 Retaining Wall

Project Number: 13004.01	**Project Engineer: JA**
Project Name: Route 340 Bridge Over Cub Run	**Principal Engineer: PEB**
Project Location: Page County	**Date: 11-01-2014**
Test Boring No.: B-3	

Elastic Half Space Method; Equation 10.6.2.4.2-1								
q0	Applied vertical stress (ksf)	1.0	2.0	3.0	3.0	3.0	3.0	3.0
B	Footing width (ft)	2	3	4	5	6	7	8
Length	Footing length (ft)	100	100	100	100	100	100	100
Es	Young's modulus of soil (ksi)	5	5	5	5	5	5	5
βz	Shape factor (from Table 10.6.2.4.2-1AASHTO LRFD 2007 manual)	1.41	1.41	1.41	1.41	1.41	1.41	1.41
ν	Poisson's Ratio	0.25	0.25	0.25	0.25	0.25	0.25	0.25
L/B	L/B	50.00	33.33	25.00	20.00	16.67	14.29	12.50
A'	Effective area of footing (sq. ft)	200	300	400	500	600	700	800
Se	Elastic settlement (ft)	0.013	0.032	0.055	0.062	0.068	0.073	0.078
Se	Elastic settlement (inch)	0.16	0.38	0.66	0.74	0.81	0.88	0.94

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AASHTO LRFD Bridge Specifications 2012

Bearing Resistance of Soil - MSE Retaining Wall

Project Number: 13004.01	**Project Engineer: JA**
Project Name: Route 340 Bridge Over Cub Run	**Principal Engineer: PEB**
Project Location: Page County	**Date: 11-01-201**
Test Boring No.: B-3	

Based on Bearing Capacity Equation 10.6.3.1.3-1 of AASHTO LRFD Bridge Design Specifications 2012

γ (pcf), total or moist	120
Df (ft)	2.5
Dw, Depth of groundwater (feet)	25
φ_b	0.65

B (ft)	5.0	6.0	7.0	8.0	9.0	10.0	11.0
L (ft)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
$N1_{60}$	10.00						
Cwq	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Cwγ	1.00	1.00	1.00	1.00	1.00	1.00	1.00
qn (ksf), nominal bearing resistance	15.0	17.0	19.0	21.0	23.0	25.0	27.0
q_R (ksf), factored resistance	9.8	11.1	12.4	13.7	15.0	16.3	17.6

q_R (ksf), extreme event limit	15.0	17.0	19.0	21.0	23.0	25.0	27.0

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AASHTO LRFD Bridge Specifications 2012

Elascitc Settlement at Service Limit - MSE Retaining Wall

Project Number: 13004.01	**Project Engineer: JA**
Project Name: Route 340 Bridge Over Cub Run	**Principal Engineer: PEB**
Project Location: Page County	**Date: 11-01-201**
Test Boring No.: B-3	

Elastic Half Space Method; Equation 10.6.2.4.2-1								
q0	Applied vertical stress (ksf)	3.0	3.0	3.0	3.0	3.0	3.0	3.0
B	Footing width (ft)	5	6	7	8	9	10	11
Length	Footing length (ft)	100	100	100	100	100	100	100
Es	Young's modulus of soil (ksi)	5	5	5	5	5	5	5
βz	Shape factor (from Table 10.6.2.4.2-1AASHTO LRFD 2007 manual)	1.41	1.41	1.41	1.41	1.41	1.41	1.41
ν	Poisson's Ratio	0.25	0.25	0.25	0.25	0.25	0.25	0.25
L/B	L/B	20.00	16.67	14.29	12.50	11.11	10.00	9.09
A'	Effective area of footing (sq. ft)	500	600	700	800	900	1000	1100
Se	Elastic settlement (ft)	0.062	0.068	0.073	0.078	0.083	0.088	0.092
Se	Elastic settlement (inch)	0.74	0.81	0.88	0.94	1.00	1.05	1.10

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product
Microsoft

Flexible Structural Design Module

Mainline and Shoulder - Route 340 Bridge Replacement and Approaches over Cub Run

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,218,368
Initial Serviceability	4.2
Terminal Serviceability	2.8
Reliability Level	85 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	4,100 psi
Stage Construction	1
Calculated Design Structural Number	4.61 in

Simple ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	5,838
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	4.8 %
Average Initial Truck Factor (ESALs/truck)	1.05
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	1.3 %
Growth	Compound
Total Calculated Cumulative ESALs	1,218,368

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	SM-9.5A	0.44	1	1.5	-	0.66
2	BM-25.0A	0.44	1	5	-	2.20
3	VDOT No.21-B	0.12	1	8	-	0.96
4	Select Material	0.1	1	10	-	1.00
Total	-	-	-	24.50	-	4.82

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product
Microsoft

Flexible Structural Design Module

Temporary Pavement Section - Route 340 Bridge Replacement and Approaches over Cub Run

Flexible Structural Design

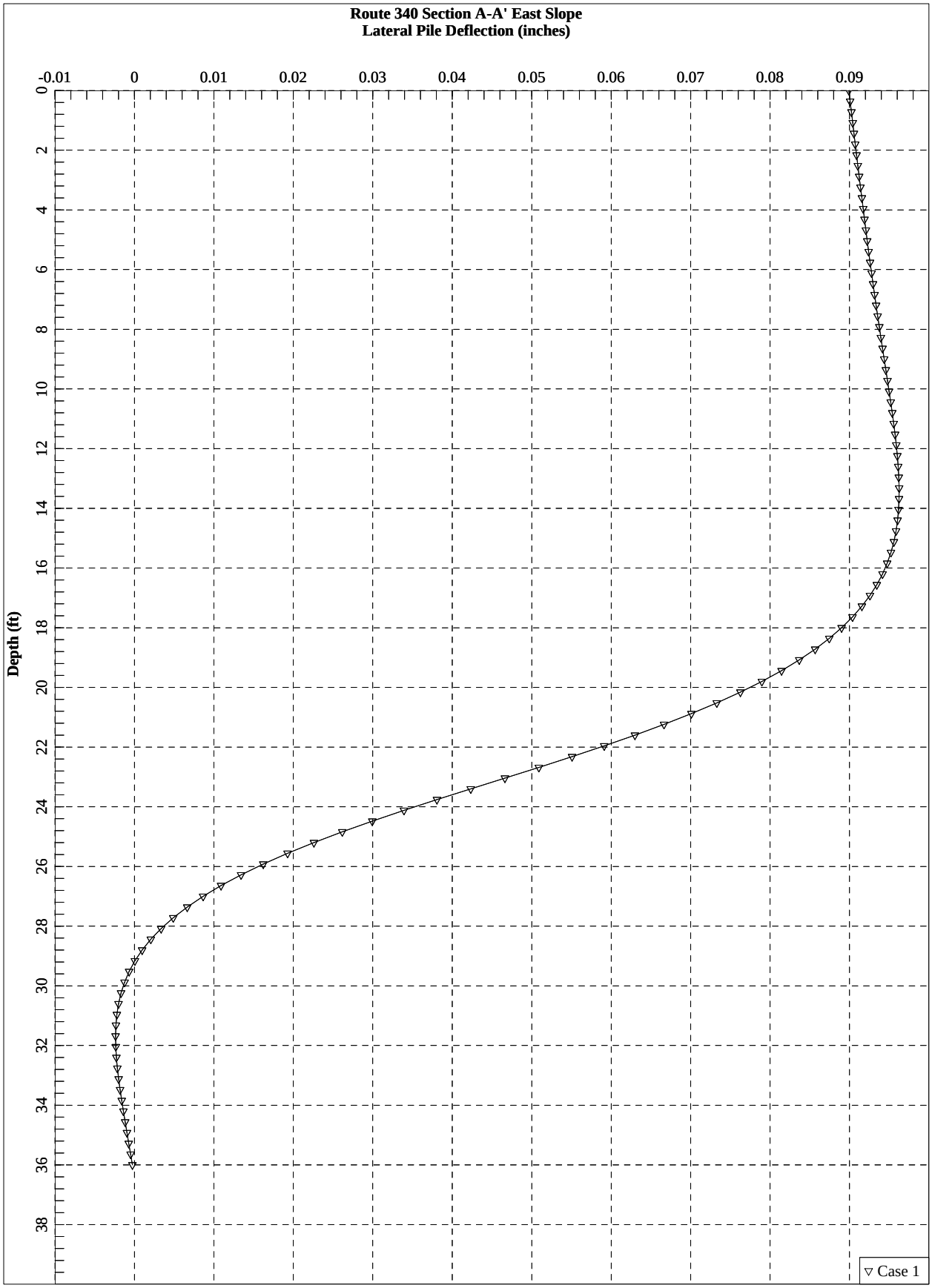
18-kip ESALs Over Initial Performance Period	108,168
Initial Serviceability	4.2
Terminal Serviceability	2.8
Reliability Level	85 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	4,100 psi
Stage Construction	1
Calculated Design Structural Number	3.04 in

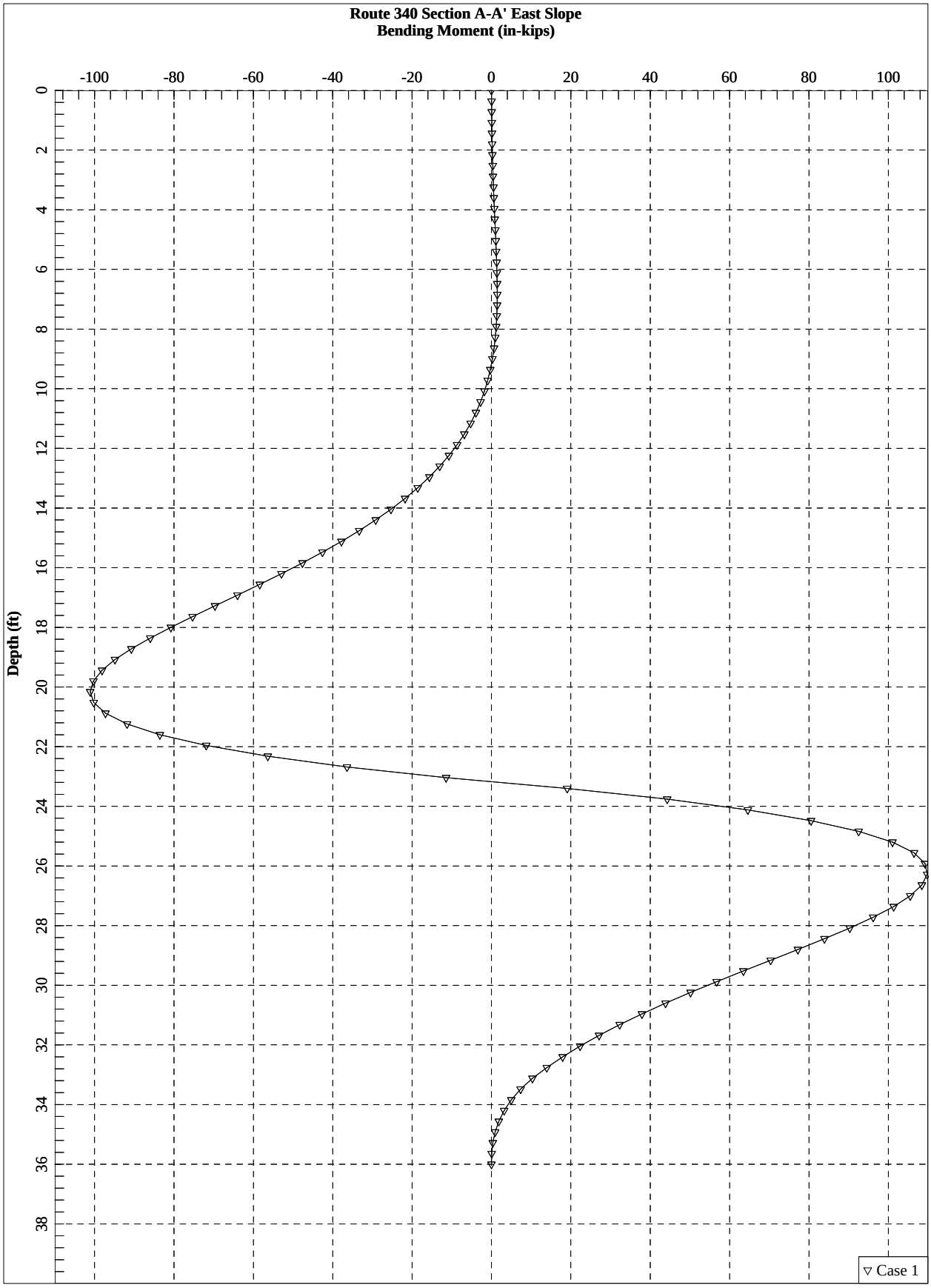
Simple ESAL Calculation

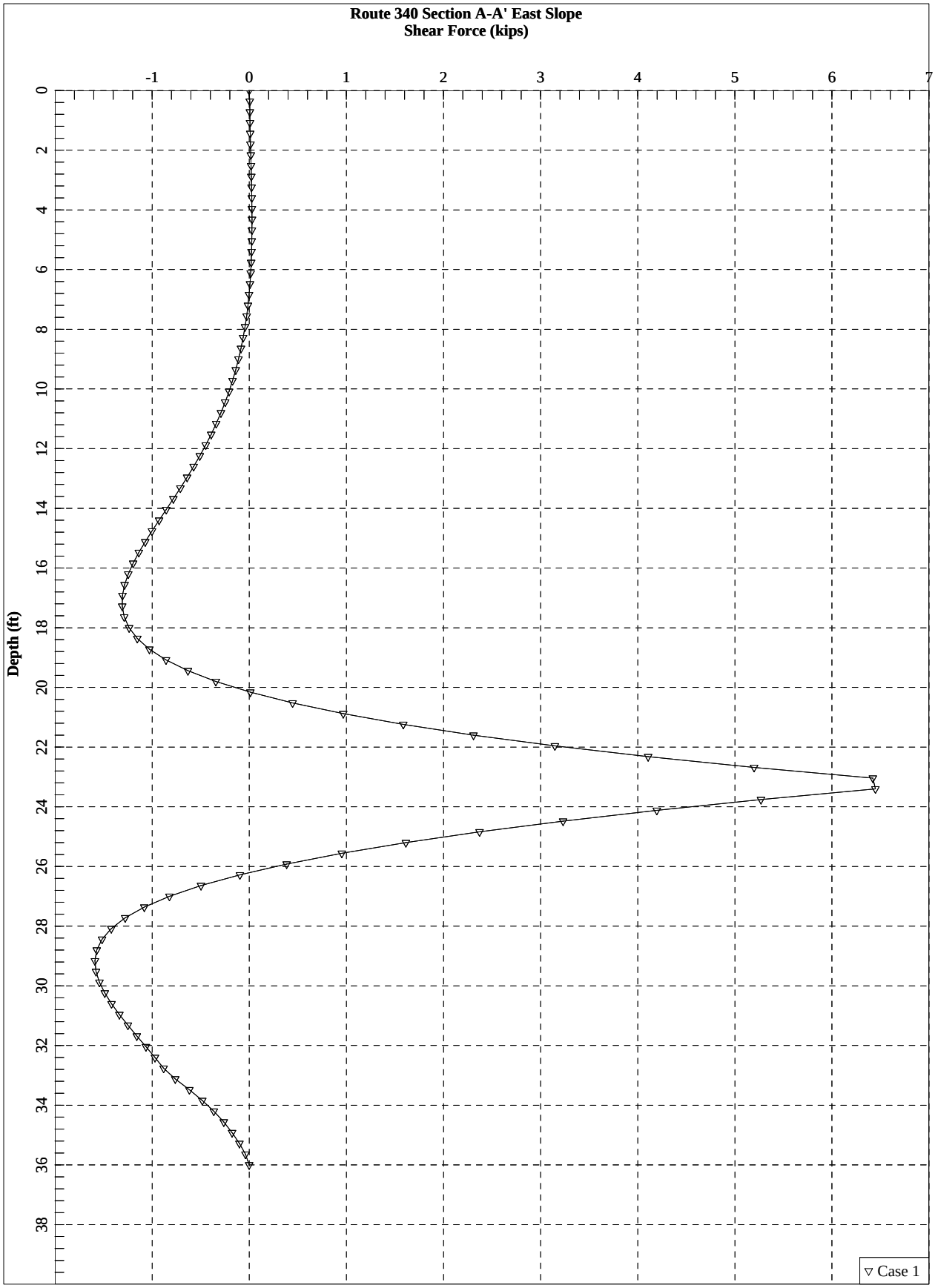
Performance Period (years)	2
Two-Way Traffic (ADT)	5,838
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	4.8 %
Average Initial Truck Factor (ESALs/truck)	1.05
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	1.3 %
Growth	Compound
Total Calculated Cumulative ESALs	108,168

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	SM-9.5A	0.44	1	1.5	-	0.66
2	BM-25.0A	0.44	1	2.5	-	1.10
3	VDOT No.21-B	0.12	1	6	-	0.72
4	Select Backfill	0.1	1	6	-	0.60
Total	-	-	-	16.00	-	3.08


Route 340 Section A-A' East Slope
Lateral Pile Deflection (inches)
-0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
Case 1


Route 340 Section A-A' East Slope
Bending Moment (in-kips)
-100
-80
-60
-40
-20
0
20
40
60
80
100
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
Case 1


Route 340 Section A-A' East Slope
Shear Force (kips)
-1
0
1
2
3
4
5
6
7
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
Case 1

```
==============================================================================

                   LPile Plus for Windows, Version 2013-07.004

                Analysis of Individual Piles and Drilled Shafts
               Subjected to Lateral Loading Using the p-y Method

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==============================================================================

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------------------------------------------------------------------------------
                            Files Used for Analysis
------------------------------------------------------------------------------

Path to file locations:        N:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Excel\LPILE\
Name of input data file:       Section A-A'.lp7d
Name of output report file:    Section A-A'.lp7o
Name of plot output file:      Section A-A'.lp7p
Name of runtime messeage file: Section A-A'.lp7r


------------------------------------------------------------------------------
                           Date and Time of Analysis
------------------------------------------------------------------------------

               Date:  November 18, 2014     Time:  14:11:56


------------------------------------------------------------------------------
                                Problem Title
------------------------------------------------------------------------------

Project Name: Route 340

Section A-A' East Slope









------------------------------------------------------------------------------
                           Program Options and Settings
------------------------------------------------------------------------------

Engineering Units of Input Data and Computations:
 - Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed                =          500
- Deflection tolerance for convergence                =   1.0000E-05 in
- Maximum allowable deflection                        =     100.0000 in
```

```
- Number of pile increments                          =          100

Loading Type and Number of Cycles of Loading:
 - Static loading specified

Computational Options:
 - Use unfactored loads in computations (conventional analysis)
 - Compute pile response under loading and nonlinear bending properties of pile
   (only if nonlinear pile properties are input)
 - Analysis uses p-y modification factors for p-y curves
 - Loading by lateral soil movements acting on pile not selected
 - Input of shear resistance at the pile tip not selected
 - Computation of pile-head foundation stiffness matrix not selected
 - Push-over analysis of pile not selected
 - Buckling analysis of pile not selected

Output Options:
 - No p-y curves to be computed and reported for user-specified depths
 - Values of pile-head deflection, bending moment, shear force, and
   soil reaction are printed for full length of pile.
 - Printing Increment (nodal spacing of output points) = 1


--------------------------------------------------------------------------------
                     Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Total number of pile sections                        =          1

Total length of pile                                 =      36.00 ft

Depth of ground surface below top of pile            =       0.00 ft

Pile diameter values used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile.

Point         Depth              Pile
                X              Diameter
                ft               in
-----       ---------        -----------
  1           0.00000         11.7950000
  2         36.000000         11.7950000


Input Structural Properties:
----------------------------

Pile Section No. 1:

   Section Type                                      =    Elastic Pile
   Cross-sectional Shape                             =   Strong H-Pile
   Section Length                                    =     36.00000 ft
   Flange Width                                      =     11.79500 in
   Section Depth                                     =     11.53000 in
   Flange Thickness                                  =      0.31000 in
   Web Thickness                                     =      0.31000 in
   Section Area                                      =     10.69500 Sq. in
   Moment of Inertia                                 =    263.75796 in^4
   Elastic Modulus                                   =    29000000. lbs/in^2


--------------------------------------------------------------------------------
                       Ground Slope and Pile Batter Angles
--------------------------------------------------------------------------------

Ground Slope Angle                                   =        0.000 degrees
                                                     =        0.000 radians
```

```
Pile Batter Angle                                    =        0.000 degrees
                                                     =        0.000 radians


--------------------------------------------------------------------------------
                       Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =       0.0000 ft
   Distance from top of pile to bottom of layer       =     33.00000 ft
   Effective unit weight at top of layer              =    120.00000 pcf
   Effective unit weight at bottom of layer           =    120.00000 pcf
   Friction angle at top of layer                     =     30.00000 deg.
   Friction angle at bottom of layer                  =     30.00000 deg.
   Subgrade k at top of layer                         =     30.00000 pci
   Subgrade k at bottom of layer                      =     30.00000 pci


Layer 2 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     33.00000 ft
   Distance from top of pile to bottom of layer       =     38.00000 ft
   Effective unit weight at top of layer              =    120.00000 pcf
   Effective unit weight at bottom of layer           =    120.00000 pcf
   Friction angle at top of layer                     =     32.00000 deg.
   Friction angle at bottom of layer                  =     32.00000 deg.
   Subgrade k at top of layer                         =     75.00000 pci
   Subgrade k at bottom of layer                      =     75.00000 pci


Layer 3 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     38.00000 ft
   Distance from top of pile to bottom of layer       =     40.00000 ft
   Effective unit weight at top of layer              =    130.00000 pcf
   Effective unit weight at bottom of layer           =    130.00000 pcf
   Friction angle at top of layer                     =     36.00000 deg.
   Friction angle at bottom of layer                  =     36.00000 deg.
   Subgrade k at top of layer                         =    150.00000 pci
   Subgrade k at bottom of layer                      =    150.00000 pci


Layer 4 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     40.00000 ft
   Distance from top of pile to bottom of layer       =     80.00000 ft
   Effective unit weight at top of layer              =    140.00000 pcf
   Effective unit weight at bottom of layer           =    140.00000 pcf
   Friction angle at top of layer                     =     40.00000 deg.
   Friction angle at bottom of layer                  =     40.00000 deg.
   Subgrade k at top of layer                         =      124000. pci
   Subgrade k at bottom of layer                      =      124000. pci


   (Depth of lowest soil layer extends   44.00 ft below pile tip)


**** Warning - Possible Input Data Error ****

Values entered for effective unit weights of soil were outside
the limits of 0.011574 pci (20 pcf) or 0.0810019 pci (140 pcf)
This data may be erroneous.  Please check your data.
```

Summary of Soil Properties

Layer Num.	Layer Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	kpy pci
1	Sand (Reese, et al.)	0.00	120.000	30.000	30.000
		33.000	120.000	30.000	30.000
2	Sand (Reese, et al.)	33.000	120.000	32.000	75.000
		38.000	120.000	32.000	75.000
3	Sand (Reese, et al.)	38.000	130.000	36.000	150.000
		40.000	130.000	36.000	150.000
4	Sand (Reese, et al.)	40.000	140.000	40.000	124000.
		80.000	140.000	40.000	124000.

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.8000	1.0000
2	35.000	0.8000	1.0000

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Distributed Lateral Loading

Distributed lateral load intensity defined using 2 points

Point No.	Depth X in	Dist. Load lbs/in
1	0.000	0.000
2	276.000	609.000

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	1	V = 0.0000 lbs	M = 0.0000 in-lbs	0.0000000	No

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head

y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

---

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs
Applied moment at pile head = 0.0 in-lbs
Axial thrust load on pile head = 0.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.0899	-1.081E-07	0.000	3.755E-05	2.416E-09	7.649E+09	0.000	0.000	2.3830
0.360	0.0901	22.2367	5.5660	3.755E-05	0.4972	7.649E+09	-9.3384	447.8976	9.5322
0.720	0.0902	48.0904	6.7493	3.757E-05	1.0753	7.649E+09	-18.7104	895.7952	19.0643
1.080	0.0904	80.5503	8.5517	3.761E-05	1.8011	7.649E+09	-28.1160	1343.6928	28.5965
1.440	0.0906	121.9771	10.8277	3.767E-05	2.7273	7.649E+09	-37.5555	1791.5904	38.1287
1.800	0.0907	174.1014	13.4311	3.775E-05	3.8928	7.649E+09	-47.0288	2239.4880	47.6609
2.160	0.0909	238.0218	16.2153	3.787E-05	5.3221	7.649E+09	-56.5361	2687.3856	57.1930
2.520	0.0910	314.2019	19.0328	3.802E-05	7.0254	7.649E+09	-66.0777	3135.2832	66.7252
2.880	0.0912	402.4654	21.7347	3.822E-05	8.9989	7.649E+09	-75.6540	3583.1808	76.2574
3.240	0.0914	501.9900	24.1706	3.848E-05	11.2243	7.649E+09	-85.2653	4031.0784	85.7896
3.600	0.0915	611.2990	26.1877	3.879E-05	13.6683	7.649E+09	-94.9122	4478.9760	95.3217
3.960	0.0917	728.2514	27.6307	3.917E-05	16.2833	7.649E+09	-104.5954	4926.8736	104.8539
4.320	0.0919	850.0285	28.3412	3.962E-05	19.0062	7.649E+09	-114.3157	5374.7712	114.3861
4.680	0.0921	973.1190	28.1565	4.013E-05	21.7585	7.649E+09	-124.0741	5822.6688	123.9183
5.040	0.0922	1093.3010	26.9101	4.072E-05	24.4457	7.649E+09	-133.8716	6270.5664	133.4504
5.400	0.0924	1205.6223	24.4301	4.137E-05	26.9571	7.649E+09	-143.7095	6718.4640	142.9826
5.760	0.0926	1304.3773	20.5395	4.207E-05	29.1652	7.649E+09	-153.5891	7166.3616	152.5148
6.120	0.0928	1383.0838	15.0556	4.283E-05	30.9251	7.649E+09	-163.5115	7614.2592	162.0470
6.480	0.0930	1434.4575	7.7897	4.363E-05	32.0738	7.649E+09	-173.4784	8062.1568	171.5791
6.840	0.0931	1450.3871	-1.4523	4.444E-05	32.4300	7.649E+09	-183.4908	8510.0544	181.1113
7.200	0.0933	1421.9099	-12.8700	4.526E-05	31.7932	7.649E+09	-193.5500	8957.9520	190.6435
7.560	0.0935	1339.1903	-26.6676	4.604E-05	29.9436	7.649E+09	-203.6569	9405.8496	200.1757
7.920	0.0937	1191.5017	-43.0527	4.675E-05	26.6414	7.649E+09	-213.8122	9853.7472	209.7078
8.280	0.0939	967.2152	-62.2344	4.736E-05	21.6265	7.649E+09	-224.0160	10302.	219.2400
8.640	0.0941	653.7967	-84.4213	4.782E-05	14.6186	7.649E+09	-234.2679	10750.	228.7722
9.000	0.0944	237.8152	-109.8183	4.807E-05	5.3174	7.649E+09	-244.5665	11197.	238.3043
9.360	0.0946	-295.0337	-138.6228	4.805E-05	6.5968	7.649E+09	-254.9098	11645.	247.8365
9.720	0.0948	-959.8861	-171.0198	4.770E-05	21.4626	7.649E+09	-265.2941	12093.	257.3687
10.080	0.0950	-1772.6452	-207.1763	4.693E-05	39.6355	7.649E+09	-275.7146	12541.	266.9009
10.440	0.0952	-2749.8892	-247.2340	4.565E-05	61.4862	7.649E+09	-286.1646	12989.	276.4330
10.800	0.0954	-3908.7466	-291.3013	4.377E-05	87.3977	7.649E+09	-296.6353	13437.	285.9652
11.160	0.0956	-5266.7324	-339.4437	4.118E-05	117.7616	7.649E+09	-307.1155	13885.	295.4974
11.520	0.0957	-6841.5400	-391.6722	3.776E-05	152.9735	7.649E+09	-317.5913	14333.	305.0296

11.880	0.0959	-8650.7801	-447.9307	3.338E-05	193.4272	7.649E+09	-328.0456	14781.	314.5617
12.240	0.0960	-10712.	-508.0813	2.792E-05	239.5075	7.649E+09	-338.4576	15229.	324.0939
12.600	0.0961	-13041.	-571.8876	2.121E-05	291.5815	7.649E+09	-348.8024	15676.	333.6261
12.960	0.0962	-15653.	-638.9963	1.311E-05	349.9884	7.649E+09	-359.0508	16124.	343.1583
13.320	0.0962	-18562.	-708.9165	3.444E-06	415.0268	7.649E+09	-369.1684	16572.	352.6904
13.680	0.0962	-21778.	-780.9970	-7.947E-06	486.9412	7.649E+09	-379.1153	17020.	362.2226
14.040	0.0962	-25309.	-854.4016	-2.124E-05	565.9047	7.649E+09	-388.8458	17468.	371.7548
14.400	0.0960	-29160.	-928.0825	-3.663E-05	651.9998	7.649E+09	-398.3075	17916.	381.2870
14.760	0.0958	-33328.	-1000.7510	-5.427E-05	745.1974	7.649E+09	-407.4414	18364.	390.8191
15.120	0.0956	-37806.	-1070.8472	-7.436E-05	845.3311	7.649E+09	-416.1810	18812.	400.3513
15.480	0.0952	-42580.	-1136.5080	-9.706E-05	952.0703	7.649E+09	-424.4523	19260.	409.8835
15.840	0.0947	-47626.	-1195.5337	-0.000123	1064.8888	7.649E+09	-432.1735	19707.	419.4157
16.200	0.0941	-52910.	-1245.3539	-0.000151	1183.0309	7.649E+09	-439.2549	20155.	428.9478
16.560	0.0934	-58386.	-1282.9937	-0.000182	1305.4740	7.649E+09	-445.5987	20603.	438.4800
16.920	0.0926	-63995.	-1305.0396	-0.000217	1430.8876	7.649E+09	-451.0999	21051.	448.0122
17.280	0.0916	-69661.	-1307.6082	-0.000255	1557.5897	7.649E+09	-455.6458	21499.	457.5443
17.640	0.0904	-75292.	-1286.3166	-0.000296	1683.4995	7.649E+09	-459.1178	21947.	467.0765
18.000	0.0890	-80775.	-1236.2573	-0.000340	1806.0883	7.649E+09	-461.3918	22395.	476.6087
18.360	0.0874	-85974.	-1151.9784	-0.000387	1922.3273	7.649E+09	-462.3398	22843.	486.1409
18.720	0.0857	-90728.	-1027.4719	-0.000437	2028.6346	7.649E+09	-461.8322	23291.	495.6730
19.080	0.0837	-94851.	-856.1710	-0.000489	2120.8207	7.649E+09	-459.7400	23739.	505.2052
19.440	0.0814	-98125.	-630.9597	-0.000544	2194.0350	7.649E+09	-455.9381	24186.	514.7374
19.800	0.0790	-100302.	-344.1981	-0.000600	2242.7135	7.649E+09	-450.3088	24634.	524.2696
20.160	0.0763	-101099.	12.2353	-0.000656	2260.5294	7.649E+09	-442.7470	25082.	533.8017
20.520	0.0733	-100197.	446.8786	-0.000713	2240.3498	7.649E+09	-433.1649	25530.	543.3339
20.880	0.0701	-97238.	968.5963	-0.000769	2174.1986	7.649E+09	-421.4991	25978.	552.8661
21.240	0.0667	-91828.	1586.4588	-0.000822	2053.2303	7.649E+09	-407.7178	26426.	562.3983
21.600	0.0630	-83531.	2309.5875	-0.000872	1867.7166	7.649E+09	-391.8291	26874.	571.9304
21.960	0.0591	-71873.	3146.9598	-0.000916	1607.0499	7.649E+09	-373.8916	27322.	581.4626
22.320	0.0551	-56341.	4107.1689	-0.000952	1259.7674	7.649E+09	-354.0245	27770.	590.9948
22.680	0.0509	-36387.	5198.1334	-0.000978	813.6015	7.649E+09	-332.4210	28218.	600.5270
23.040	0.0466	-11430.	6420.4583	-0.000992	255.5597	7.649E+09	-309.3613	28665.	607.1465
23.400	0.0423	19085.	6447.5815	-0.000990	426.7425	7.649E+09	-285.2282	29113.	0.000
23.760	0.0381	44278.	5268.7604	-0.000972	990.0241	7.649E+09	-260.5224	29561.	0.000
24.120	0.0339	64608.	4196.9518	-0.000941	1444.5943	7.649E+09	-235.6854	30009.	0.000
24.480	0.0299	80539.	3231.8944	-0.000900	1800.8173	7.649E+09	-211.1005	30457.	0.000
24.840	0.0262	92531.	2371.7925	-0.000851	2068.9517	7.649E+09	-187.0948	30905.	0.000
25.200	0.0226	101031.	1613.5532	-0.000796	2259.0149	7.649E+09	-163.9419	31353.	0.000
25.560	0.0193	106472.	953.0114	-0.000738	2380.6680	7.649E+09	-141.8645	31801.	0.000
25.920	0.0162	109265.	385.1410	-0.000677	2443.1235	7.649E+09	-121.0385	32249.	0.000
26.280	0.0134	109800.	-95.7500	-0.000615	2455.0719	7.649E+09	-101.5962	32697.	0.000
26.640	0.0109	108438.	-495.8399	-0.000553	2424.6260	7.649E+09	-83.6306	33144.	0.000
27.000	0.008642	105516.	-821.6321	-0.000493	2359.2825	7.649E+09	-67.1991	33592.	0.000
27.360	0.006641	101339.	-1079.8104	-0.000435	2265.8980	7.649E+09	-52.3279	34040.	0.000
27.720	0.004887	96186.	-1277.1126	-0.000379	2150.6780	7.649E+09	-39.0157	34488.	0.000
28.080	0.003368	90305.	-1420.2199	-0.000326	2019.1774	7.649E+09	-27.2377	34936.	0.000
28.440	0.002069	83916.	-1515.6639	-0.000277	1876.3111	7.649E+09	-16.9493	35384.	0.000
28.800	0.000975	77210.	-1569.7487	-0.000231	1726.3721	7.649E+09	-8.0899	35832.	0.000
29.160	6.974E-05	70353.	-1588.4880	-0.000190	1573.0573	7.649E+09	-0.5857	36280.	0.000
29.520	-0.000664	63485.	-1577.5556	-0.000152	1419.4981	7.649E+09	5.6470	36728.	0.000
29.880	-0.001243	56723.	-1542.2483	-0.000118	1268.2953	7.649E+09	10.6990	37176.	0.000
30.240	-0.001684	50160.	-1487.4607	-8.784E-05	1121.5570	7.649E+09	14.6657	37623.	0.000
30.600	-0.002002	43871.	-1417.6691	-6.129E-05	980.9384	7.649E+09	17.6452	38071.	0.000
30.960	-0.002213	37912.	-1336.9249	-3.819E-05	847.6829	7.649E+09	19.7364	38519.	0.000
31.320	-0.002332	32320.	-1248.8545	-1.836E-05	722.6630	7.649E+09	21.0370	38967.	0.000
31.680	-0.002372	27121.	-1156.6664	-1.575E-06	606.4214	7.649E+09	21.6427	39415.	0.000
32.040	-0.002346	22327.	-1063.1625	1.239E-05	499.2110	7.649E+09	21.6461	39863.	0.000
32.400	-0.002265	17936.	-970.7537	2.376E-05	401.0331	7.649E+09	21.1358	40311.	0.000
32.760	-0.002141	13939.	-881.4775	3.276E-05	311.6748	7.649E+09	20.1958	40759.	0.000
33.120	-0.001982	10320.	-761.7940	3.961E-05	230.7438	7.649E+09	35.2132	76751.	0.000
33.480	-0.001798	7357.3460	-615.7159	4.460E-05	164.5067	7.649E+09	32.4156	77870.	0.000
33.840	-0.001597	4999.9293	-482.6383	4.809E-05	111.7960	7.649E+09	29.1944	78990.	0.000
34.200	-0.001383	3187.3508	-364.1904	5.040E-05	71.2676	7.649E+09	25.6426	80110.	0.000
34.560	-0.001161	1853.3239	-261.6420	5.183E-05	41.4394	7.649E+09	21.8336	81230.	0.000
34.920	-0.000935	926.7641	-175.9826	5.261E-05	20.7220	7.649E+09	17.8235	82349.	0.000
35.280	-0.000707	332.8342	-100.6219	5.297E-05	7.4420	7.649E+09	17.0657	104336.	0.000
35.640	-0.000477	57.3908	-38.5225	5.308E-05	1.2832	7.649E+09	11.6841	105736.	0.000
36.000	-0.000248	0.000	0.000	5.309E-05	0.000	7.649E+09	6.1504	53568.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =      0.0899068 inches
Computed slope at pile head      =      0.0000375 radians
Maximum bending moment           =        109800. inch-lbs
Maximum shear force              =   6447.5815201 lbs
Depth of maximum bending moment  =     26.2800000 feet below pile head
Depth of maximum shear force     =     23.4000000 feet below pile head
Number of iterations             =              6
Number of zero deflection points =              1
```

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs	Maximum Shear in Pile lbs	Pile-head Rotation radians
1	1	V = 0.000	M = 0.000	0.0000000	0.08990684	109800.	6447.5815	0.00003755

The analysis ended normally.

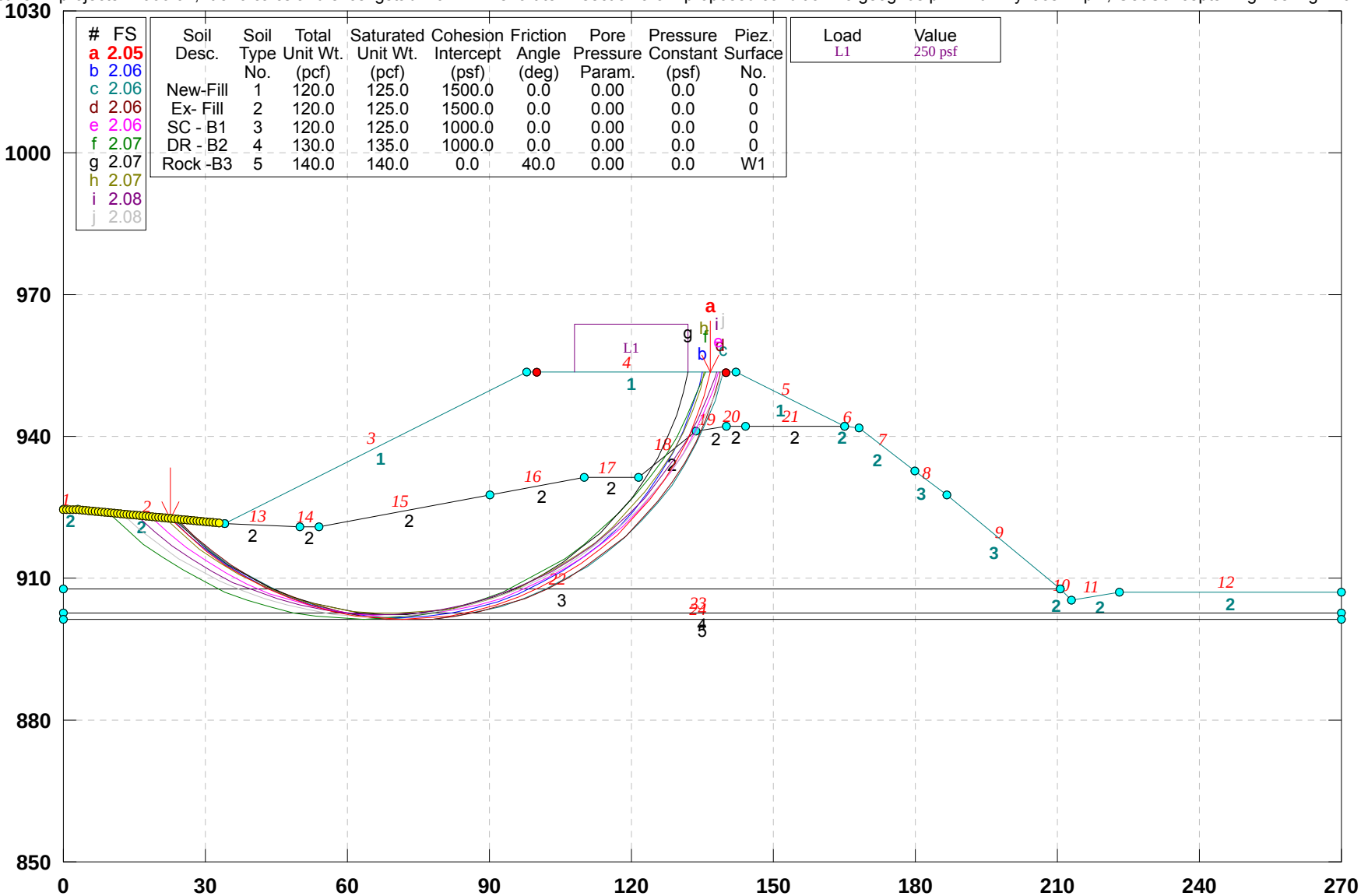
GeoConcepts Engineering, Inc.

Appendix E
Slope and Global Stability Analysis

Stability Calculations (110 pages)

Section A-A'- West Slope Proposed 2H:1V- Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - proposed condition no geogrids.pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 12:5



GSTABL7 v.2 FSmin=2.05

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
          ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                SLOPE STABILITY ANALYSIS SYSTEM
       Modified Bishop, Simplified Janbu, or GLE Method of Slices.
       (Includes Spencer & Morgenstern-Price Type Analysis)
       Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
       Nonlinear Undrained Shear Strength, Curved Phi Envelope,
       Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
       Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/23/2014
Time of Run:              12:50PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed condition no geogrids.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed condition no geogrids.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed condition no geogrids.PLT
PROBLEM DESCRIPTION:  Section  A-A'- West Slope Proposed 2H:1V
                       - Short Term
BOUNDARY COORDINATES
   12 Top   Boundaries
   24 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1         0.00     924.50       3.00     924.50        2
    2         3.00     924.50      34.00     921.58        2
    3        34.00     921.58      98.00     953.58        1
    4        98.00     953.58     142.00     953.47        1
    5       142.00     953.47     165.00     941.97        1
    6       165.00     941.97     168.00     941.96        2
    7       168.00     941.96     180.00     932.76        2
    8       180.00     932.76     186.50     927.76        3
    9       186.50     927.76     210.50     907.60        3
   10       210.50     907.60     213.00     905.50        2
   11       213.00     905.50     223.00     907.00        2
   12       223.00     907.00     270.00     907.00        2
   13        34.00     921.58      50.00     921.00        2
   14        50.00     921.00      54.00     921.00        2
   15        54.00     921.00      90.00     927.76        2
   16        90.00     927.76     110.00     931.50        2
   17       110.00     931.50     121.50     931.50        2
   18       121.50     931.50     133.50     941.00        2
   19       133.50     941.00     140.00     942.00        2
   20       140.00     942.00     144.00     942.00        2
   21       144.00     942.00     165.00     941.97        2
   22         0.00     907.60     210.50     907.60        3
   23         0.00     902.76     270.00     902.76        4
   24         0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0    1500.0      0.0    0.00       0.0      0
  2   120.0    125.0    1500.0      0.0    0.00       0.0      0
  3   120.0    125.0    1000.0      0.0    0.00       0.0      0
  4   130.0    135.0    1000.0      0.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      1
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
```

```
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      915.26
     2        192.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1        192.00      901.83
     2        270.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         108.00       132.00       250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     3 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        34.00    921.58   2625.00     1.000
        2        69.00    921.58   2625.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        38.00    923.58   2625.00     1.000
        2        73.00    923.58   2625.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        42.00    925.58   2625.00     1.000
        2        77.00    925.58   2625.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  33.50(ft)
 Each Surface Terminates Between   X = 100.00(ft)
                               and   X = 140.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   5.987   FS Min =   2.051   FS Ave =   2.771
          Standard Deviation =    0.649   Coefficient of Variation =   23.43 %
       Failure Surface Specified By 30 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         22.624      922.652
           2         26.164      919.120
           3         29.958      915.863
           4         33.984      912.899
           5         38.222      910.245
           6         42.646      907.915
           7         47.231      905.922
```

8	51.954	904.279
9	56.785	902.993
10	61.700	902.072
11	66.669	901.521
12	71.666	901.344
13	76.662	901.541
14	81.630	902.111
15	86.541	903.051
16	91.367	904.356
17	96.083	906.019
18	100.661	908.029
19	105.075	910.377
20	109.302	913.048
21	113.317	916.028
22	117.098	919.299
23	120.624	922.845
24	123.874	926.644
25	126.831	930.676
26	129.479	934.918
27	131.801	939.346
28	133.786	943.935
29	135.422	948.660
30	136.697	953.483

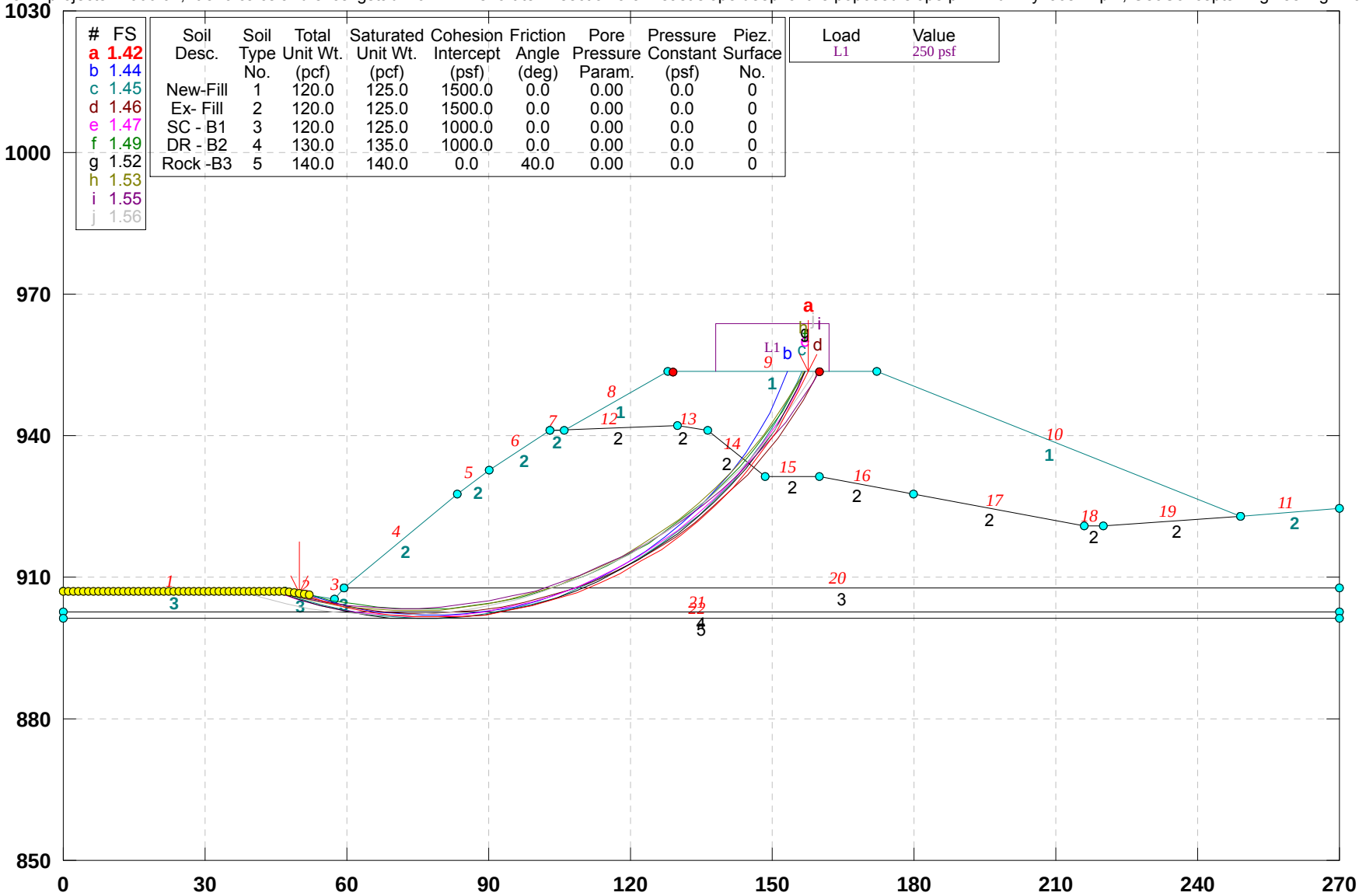
Circle Center At X = 71.534 ; Y = 968.132 ; and Radius = 66.788

Factor of Safety

*** 2.051 ***

Section A-A'- Proposed East Slope 2H:1V - Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - east slope deep failure poposed slope.pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 01:0



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock -B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=1.42

Safety Factors Are Calculated By The Modified Bishop Method

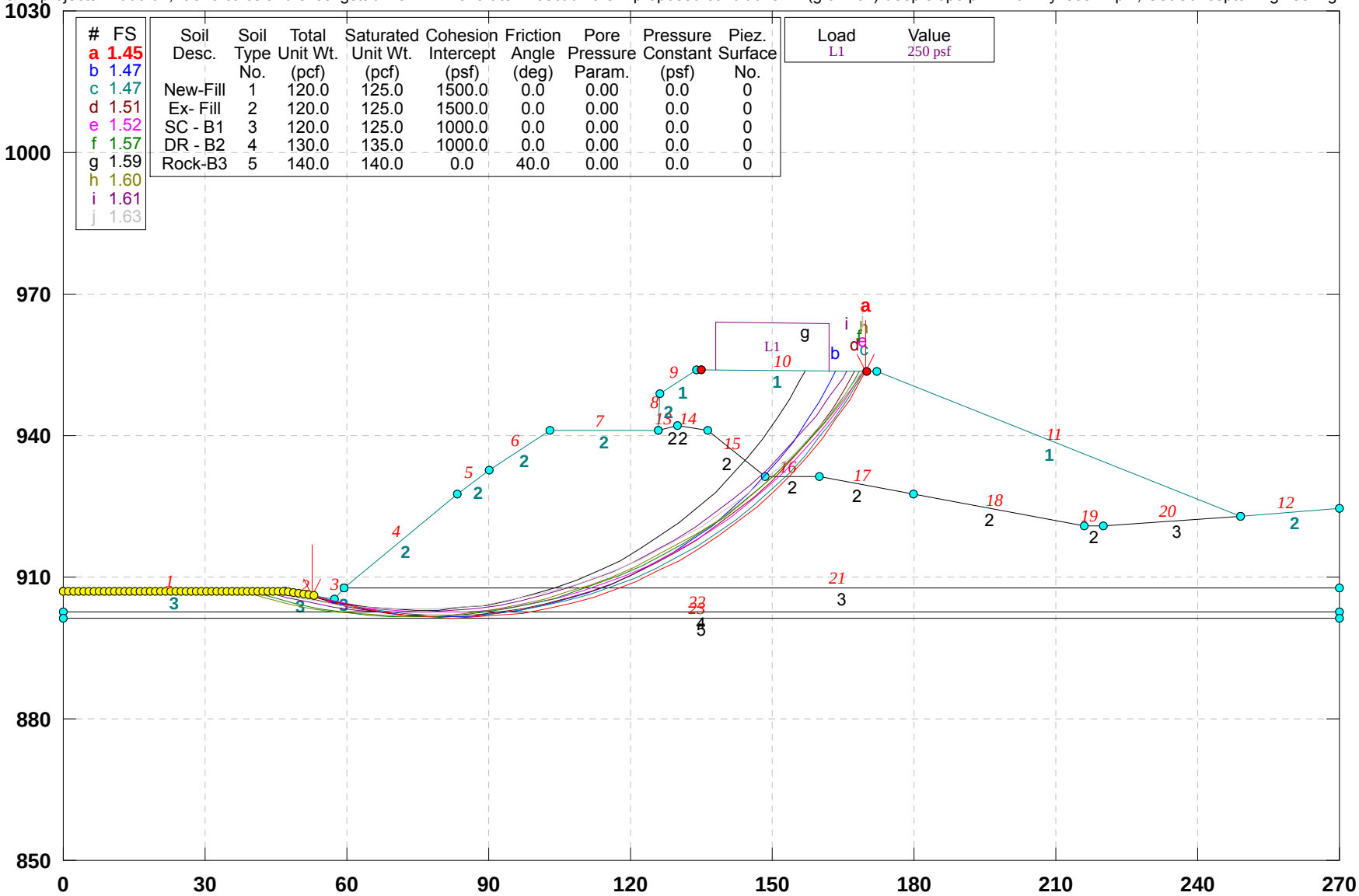
```
                    ***  GSTABL7  ***
             ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
           (All Rights Reserved-Unauthorized Use Prohibited)
*****************************************************************************
                  SLOPE STABILITY ANALYSIS SYSTEM
       Modified Bishop, Simplified Janbu, or GLE Method of Slices.
       (Includes Spencer & Morgenstern-Price Type Analysis)
       Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
       Nonlinear Undrained Shear Strength, Curved Phi Envelope,
       Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
       Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*****************************************************************************
Analysis Run Date:        10/23/2014
Time of Run:              01:08PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope.PLT
PROBLEM DESCRIPTION:  Section A-A'- Proposed East Slope 2H:1V
                      - Short Term
BOUNDARY COORDINATES
   11 Top   Boundaries
   22 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1          0.00     907.00      47.00     907.00        3
    2         47.00     907.00      57.50     905.50        3
    3         57.50     905.50      59.50     907.60        3
    4         59.50     907.60      83.50     927.76        2
    5         83.50     927.76      90.00     932.76        2
    6         90.00     932.76     103.00     941.26        2
    7        103.00     941.26     106.00     941.26        2
    8        106.00     941.26     128.00     953.47        1
    9        128.00     953.47     172.00     953.59        1
   10        172.00     953.59     249.00     923.00        1
   11        249.00     923.00     270.00     924.50        2
   12        103.00     941.26     130.00     942.00        2
   13        130.00     942.00     136.50     941.00        2
   14        136.50     941.00     148.50     931.50        2
   15        148.50     931.50     160.00     931.50        2
   16        160.00     931.50     180.00     927.76        2
   17        180.00     927.76     216.00     921.00        2
   18        216.00     921.00     220.00     921.00        2
   19        220.00     921.00     249.00     923.00        2
   20         59.50     907.60     270.00     907.60        3
   21          0.00     902.76     270.00     902.76        4
   22          0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0    1500.0      0.0    0.00       0.0      0
  2   120.0    125.0    1500.0      0.0    0.00       0.0      0
  3   120.0    125.0    1000.0      0.0    0.00       0.0      0
  4   130.0    135.0    1000.0      0.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
  Point      X-Water     Y-Water
```

```
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        105.00     941.26     105.10     906.26
 SEARCH LIMIT BOUNDARY DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  53.00(ft)
 Each Surface Terminates Between   X = 129.00(ft)
                               and   X = 160.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   3.281   FS Min =   1.419   FS Ave =   2.431
          Standard Deviation =    0.476   Coefficient of Variation =   19.58 %
       Failure Surface Specified By 27 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         49.920      906.583
           2         54.670      905.021
           3         59.503      903.740
           4         64.403      902.744
           5         69.352      902.037
           6         74.335      901.622
           7         79.334      901.499
           8         84.331      901.669
           9         89.309      902.132
          10         94.252      902.885
          11         99.142      903.927
          12        103.963      905.254
          13        108.698      906.861
          14        113.330      908.742
          15        117.844      910.892
          16        122.225      913.303
          17        126.457      915.966
          18        130.525      918.873
          19        134.416      922.013
          20        138.117      925.375
          21        141.614      928.949
          22        144.895      932.721
          23        147.950      936.680
          24        150.768      940.810
```

```
   25        153.339      945.098
   26        155.654      949.530
   27        157.463      953.550
Circle Center At X =    78.930 ; Y =   986.791 ; and Radius =    85.293
       Factor of Safety
      ***    1.419   ***
```

Section A-A' - East Slope - Temporary Shoring- Deep Failure - Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - proposed conditions - 2 (gra. wall)-deep slope.pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 02:



GSTABL7 v.2 FSmin=1.45

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
          ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
       Modified Bishop, Simplified Janbu, or GLE Method of Slices.
       (Includes Spencer & Morgenstern-Price Type Analysis)
       Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
       Nonlinear Undrained Shear Strength, Curved Phi Envelope,
       Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
       Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/23/2014
Time of Run:              02:42PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed conditions - 2 (gra. wall)-deep slope.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed conditions - 2 (gra. wall)-deep slope.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed conditions - 2 (gra. wall)-deep slope.PLT
PROBLEM DESCRIPTION:  Section A-A' - East Slope - Temporary Sh
                      oring- Deep Failure - Short Term
BOUNDARY COORDINATES
   12 Top   Boundaries
   23 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1          0.00     907.00      47.00     907.00        3
    2         47.00     907.00      57.50     905.50        3
    3         57.50     905.50      59.50     907.60        3
    4         59.50     907.60      83.50     927.76        2
    5         83.50     927.76      90.00     932.76        2
    6         90.00     932.76     103.00     941.26        2
    7        103.00     941.26     126.00     941.26        2
    8        126.00     941.26     126.10     948.96        2
    9        126.10     948.96     134.00     953.97        1
   10        134.00     953.97     172.00     953.59        1
   11        172.00     953.59     249.00     923.00        1
   12        249.00     923.00     270.00     924.50        2
   13        126.00     941.26     130.00     942.00        2
   14        130.00     942.00     136.50     941.00        2
   15        136.50     941.00     148.50     931.50        2
   16        148.50     931.50     160.00     931.50        2
   17        160.00     931.50     180.00     927.76        2
   18        180.00     927.76     216.00     921.00        2
   19        216.00     921.00     220.00     921.00        2
   20        220.00     921.00     249.00     923.00        3
   21         59.50     907.60     270.00     907.60        3
   22          0.00     902.76     270.00     902.76        4
   23          0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0    1500.0      0.0    0.00       0.0      0
  2   120.0    125.0    1500.0      0.0    0.00       0.0      0
  3   120.0    125.0    1000.0      0.0    0.00       0.0      0
  4   130.0    135.0    1000.0      0.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
```

```
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00       250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  5 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        126.00     939.26     126.10     948.96
     2        126.10     948.96     127.00     948.96
     3        127.00     948.96     129.00     939.26
     4        126.00     939.26     129.00     939.26
     5        105.00     941.26     105.10     906.26
 SEARCH LIMIT BOUNDARY DATA HAS BEEN SUPPRESSED
REINFORCING LAYER(S)
     4 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.00    941.26   1877.00     1.000
        2       136.00    941.26   1877.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.02    943.26   1877.00     1.000
        2       136.02    943.26   1877.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.05    945.26   1877.00     1.000
        2       136.05    945.26   1877.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.08    947.26   1877.00     1.000
        2       136.08    947.26   1877.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  54.00(ft)
 Each Surface Terminates Between   X = 135.00(ft)
                               and   X = 170.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
```

Total Number of Trial Surfaces Attempted = 500
Number of Trial Surfaces With Valid FS = 500
Statistical Data On All Valid FS Values:
FS Max = 3.765 FS Min = 1.452 FS Ave = 2.614
Standard Deviation = 0.539 Coefficient of Variation = 20.63 %
Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	52.810	906.170
2	57.606	904.757
3	62.467	903.589
4	67.382	902.671
5	72.338	902.003
6	77.320	901.588
7	82.318	901.428
8	87.317	901.521
9	92.305	901.869
10	97.269	902.469
11	102.195	903.322
12	107.072	904.423
13	111.887	905.772
14	116.627	907.363
15	121.280	909.194
16	125.834	911.258
17	130.277	913.552
18	134.598	916.068
19	138.785	918.801
20	142.827	921.743
21	146.715	924.887
22	150.438	928.225
23	153.986	931.748
24	157.351	935.446
25	160.523	939.311
26	163.495	943.332
27	166.258	947.499
28	168.806	951.801
29	169.758	953.612

Circle Center At X = 82.980 ; Y = 999.724 ; and Radius = 98.299
Factor of Safety
*** 1.452 ***

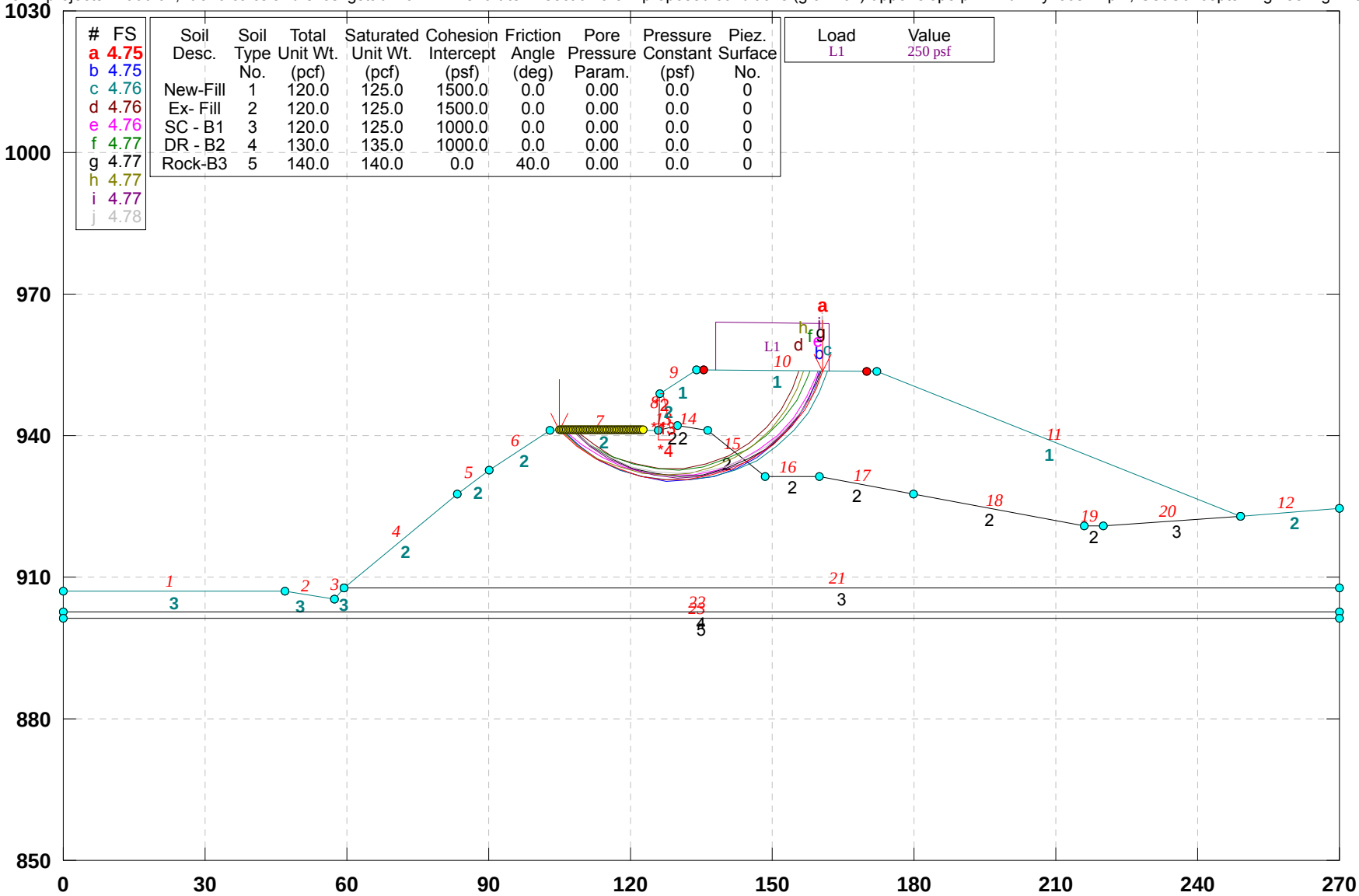
Section A-A'- East Slope - Temporary Shoring - Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - proposed conditions (gra. wall)-upper slope.pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 01:0

#	FS
a	4.75
b	4.75
c	4.76
d	4.76
e	4.76
f	4.77
g	4.77
h	4.77
i	4.77
j	4.78

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock-B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

Load	Value
L1	250 psf



GSTABL7 v.2 FSmin=4.75

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
              ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
           (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
       Modified Bishop, Simplified Janbu, or GLE Method of Slices.
       (Includes Spencer & Morgenstern-Price Type Analysis)
       Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
       Nonlinear Undrained Shear Strength, Curved Phi Envelope,
       Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
       Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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Analysis Run Date:        10/23/2014
Time of Run:              01:06PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed conditions (gra. wall)-upper slope.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed conditions (gra. wall)-upper slope.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed conditions (gra. wall)-upper slope.PLT
PROBLEM DESCRIPTION:  Section A-A'- East Slope - Temporary Sho
                      ring - Short Term
BOUNDARY COORDINATES
   12 Top   Boundaries
   23 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1          0.00     907.00      47.00     907.00        3
    2         47.00     907.00      57.50     905.50        3
    3         57.50     905.50      59.50     907.60        3
    4         59.50     907.60      83.50     927.76        2
    5         83.50     927.76      90.00     932.76        2
    6         90.00     932.76     103.00     941.26        2
    7        103.00     941.26     126.00     941.26        2
    8        126.00     941.26     126.10     948.96        2
    9        126.10     948.96     134.00     953.97        1
   10        134.00     953.97     172.00     953.59        1
   11        172.00     953.59     249.00     923.00        1
   12        249.00     923.00     270.00     924.50        2
   13        126.00     941.26     130.00     942.00        2
   14        130.00     942.00     136.50     941.00        2
   15        136.50     941.00     148.50     931.50        2
   16        148.50     931.50     160.00     931.50        2
   17        160.00     931.50     180.00     927.76        2
   18        180.00     927.76     216.00     921.00        2
   19        216.00     921.00     220.00     921.00        2
   20        220.00     921.00     249.00     923.00        3
   21         59.50     907.60     270.00     907.60        3
   22          0.00     902.76     270.00     902.76        4
   23          0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0    1500.0      0.0    0.00       0.0      0
  2   120.0    125.0    1500.0      0.0    0.00       0.0      0
  3   120.0    125.0    1000.0      0.0    0.00       0.0      0
  4   130.0    135.0    1000.0      0.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
```

```
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00       250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  4 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        126.00     939.26     126.10     948.96
     2        126.10     948.96     127.00     948.96
     3        127.00     948.96     129.00     939.26
     4        126.00     939.26     129.00     939.26
REINFORCING LAYER(S)
     4 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.00    941.26   1877.00     1.000
        2       136.00    941.26   1877.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.02    943.26   1877.00     1.000
        2       136.02    943.26   1877.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.05    945.26   1877.00     1.000
        2       136.05    945.26   1877.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.08    947.26   1877.00     1.000
        2       136.08    947.26   1877.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X = 105.00(ft)
                                and  X = 123.00(ft)
 Each Surface Terminates Between   X = 135.50(ft)
                               and   X = 170.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
```

Statistical Data On All Valid FS Values:
FS Max = 8.519 FS Min = 4.749 FS Ave = 5.629
Standard Deviation = 0.724 Coefficient of Variation = 12.86 %

Failure Surface Specified By 15 Coordinate Points

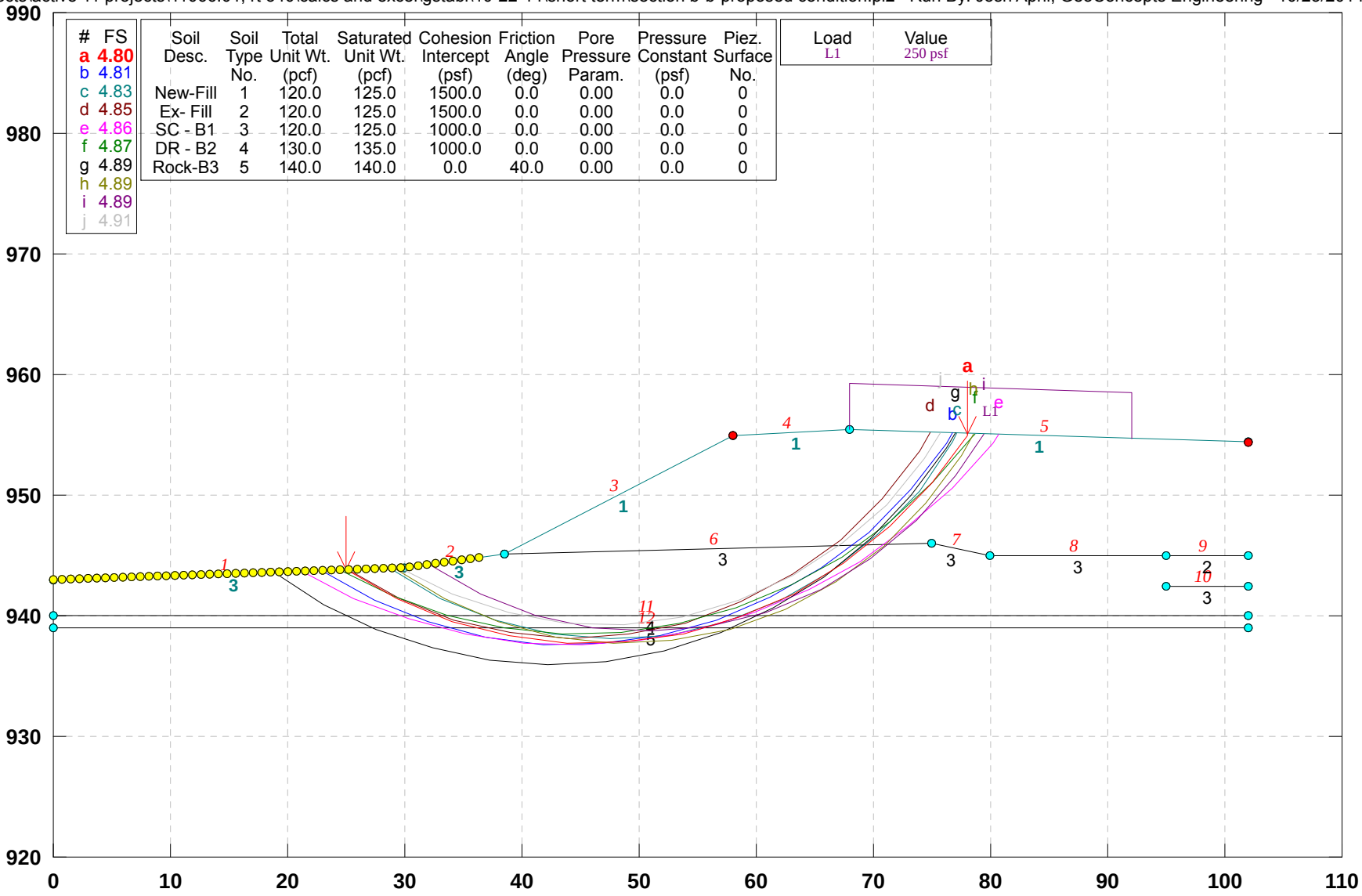
Point No.	X-Surf (ft)	Y-Surf (ft)
1	105.000	941.260
2	108.663	937.857
3	112.798	935.045
4	117.309	932.888
5	122.093	931.436
6	127.042	930.722
7	132.042	930.762
8	136.978	931.555
9	141.739	933.083
10	146.215	935.311
11	150.305	938.188
12	153.913	941.649
13	156.959	945.614
14	159.373	949.993
15	160.737	953.703

Circle Center At X = 129.280 ; Y = 963.724 ; and Radius = 33.077

Factor of Safety
*** 4.749 ***

Section B-B' Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section b-b-proposed condition.pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 12:53PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock-B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=4.80

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
       ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
                   (All Rights Reserved-Unauthorized Use Prohibited)
    ******************************************************************************
                        SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    ******************************************************************************
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    Time of Run:              12:53PM
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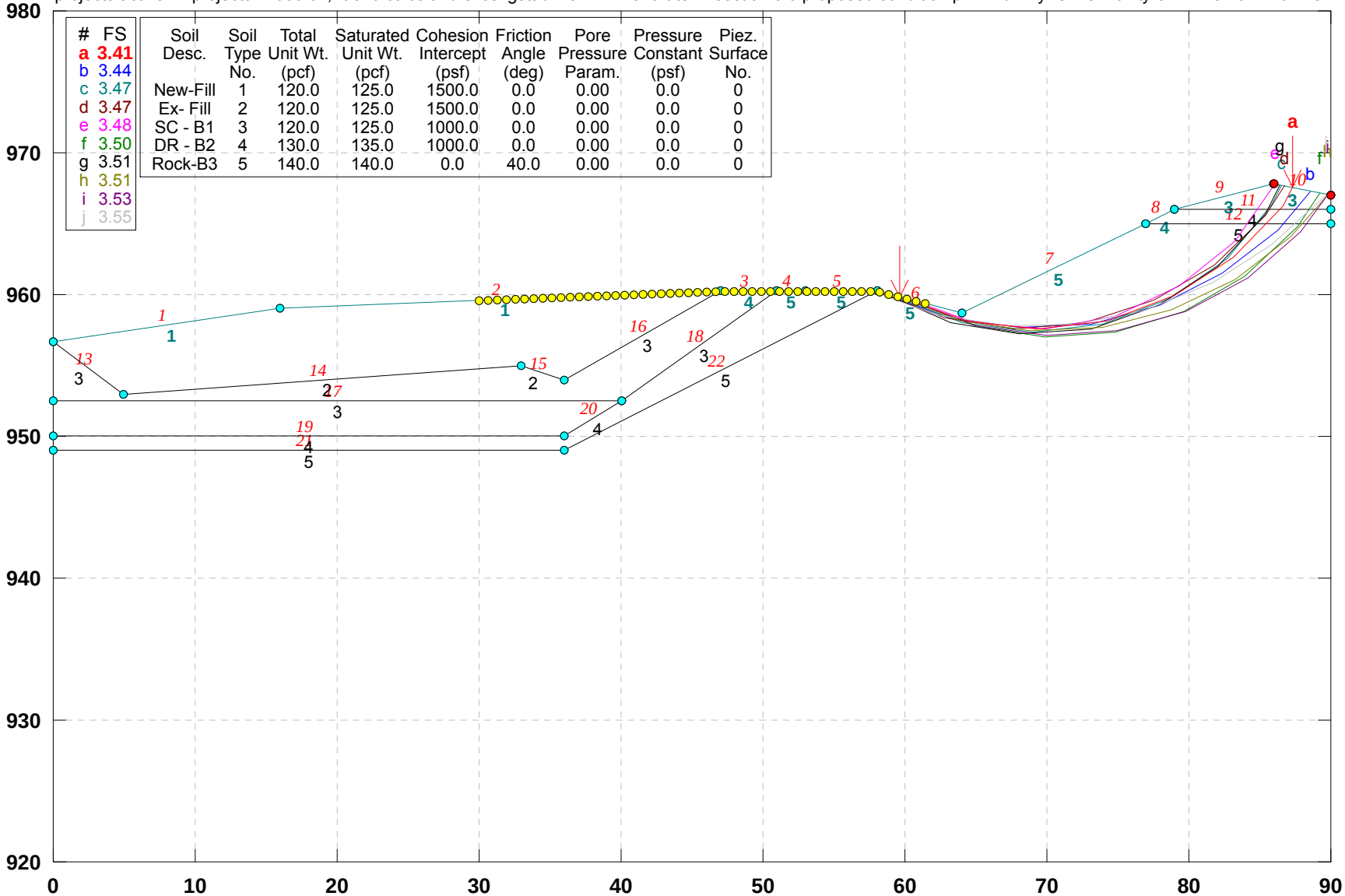
cel\GStabl\10-22-14\Short Term\section b-b-proposed condition.in
    Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section b-b-proposed condition.OUT
    Unit System:              English
    Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section b-b-proposed condition.PLT
    PROBLEM DESCRIPTION:  Section B-B' Short Term
    BOUNDARY COORDINATES
        5 Top   Boundaries
       12 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00     943.00      30.00     944.00        3
        2         30.00     944.00      38.50     945.12        3
        3         38.50     945.12      58.00     954.95        1
        4         58.00     954.95      68.00     955.42        1
        5         68.00     955.42     102.00     954.37        1
        6         38.50     945.12      75.00     946.00        3
        7         75.00     946.00      80.00     945.00        3
        8         80.00     945.00      95.00     945.00        3
        9         95.00     945.00     102.00     945.00        2
       10         95.00     942.50     102.00     942.50        3
       11          0.00     940.00     102.00     940.00        4
       12          0.00     939.00     102.00     939.00        5
    User Specified Y-Origin =       920.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0    1500.0      0.0    0.00       0.0      0
      2   120.0    125.0    1500.0      0.0    0.00       0.0      0
      3   120.0    125.0    1000.0      0.0    0.00       0.0      0
      4   130.0    135.0    1000.0      0.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1         78.00      915.26
        2        270.00      915.26
    Piezometric Surface No.  2 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1          0.00      901.83
        2         78.00      901.83
    WATER SURFACE DATA HAS BEEN SUPPRESSED
   BOUNDARY LOAD(S)
```

```
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1          68.00        92.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     4 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.00    941.26   1877.00     1.000
        2       136.00    941.26   1877.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.02    943.26   1877.00     1.000
        2       136.02    943.26   1877.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.05    945.26   1877.00     1.000
        2       136.05    945.26   1877.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.08    947.26   1877.00     1.000
        2       136.08    947.26   1877.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                 and  X =  37.00(ft)
 Each Surface Terminates Between   X =  58.00(ft)
                                 and   X = 102.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =  28.446   FS Min =   4.803   FS Ave =   7.170
          Standard Deviation =    2.583   Coefficient of Variation =   36.02 %
       Failure Surface Specified By 14 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         24.988      943.833
           2         29.356      941.400
           3         34.003      939.554
           4         38.850      938.326
           5         43.815      937.736
           6         48.814      937.795
           7         53.764      938.502
           8         58.581      939.844
           9         63.183      941.799
          10         67.492      944.334
          11         71.437      947.406
          12         74.951      950.964
          13         77.973      954.947
          14         78.066      955.109
```

```
Circle Center At X =    45.858 ; Y =   976.154 ; and Radius =    38.474
       Factor of Safety
      ***    4.803   ***
```

Section C - C', Proposed West Slope - Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section c-c-proposed condition.pl2 Run By: Chris McIntyre 11/18/2014 01:48PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock-B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=3.41

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
       ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
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    ******************************************************************************
                       SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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    Time of Run:              01:48PM
    Run By:                   Chris McIntyre
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    Unit System:              English
    Plotted Output Filename:  N:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section c-c-proposed condition.PLT
    PROBLEM DESCRIPTION:  Section C - C', Proposed West Slope - Sh
                          ort Term
    BOUNDARY COORDINATES
       10 Top   Boundaries
       22 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1         0.00     956.63      16.00     959.03        1
        2        16.00     959.03      47.00     960.22        1
        3        47.00     960.22      51.00     960.22        4
        4        51.00     960.22      53.00     960.22        5
        5        53.00     960.22      58.00     960.22        5
        6        58.00     960.22      64.00     958.72        5
        7        64.00     958.72      77.00     965.00        5
        8        77.00     965.00      79.00     966.00        4
        9        79.00     966.00      86.00     967.82        3
       10        86.00     967.82      90.00     967.00        3
       11        79.00     966.00      90.00     966.00        4
       12        77.00     965.00      90.00     965.00        5
       13         0.00     956.63       5.00     953.00        3
       14         5.00     953.00      33.00     955.00        2
       15        33.00     955.00      36.00     954.00        2
       16        36.00     954.00      47.00     960.22        3
       17         0.00     952.50      40.00     952.50        3
       18        40.00     952.50      51.00     960.22        3
       19         0.00     950.00      36.00     950.00        4
       20        36.00     950.00      40.00     952.50        4
       21         0.00     949.00      36.00     949.00        5
       22        36.00     949.00      58.00     960.22        5
    User Specified Y-Origin =       920.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0    1500.0      0.0    0.00       0.0      0
      2   120.0    125.0    1500.0      0.0    0.00       0.0      0
      3   120.0    125.0    1000.0      0.0    0.00       0.0      0
      4   130.0    135.0    1000.0      0.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
```

```
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         68.00        92.00        250.0           0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED
REINFORCING LAYER(S)
     4 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.00    941.26   1877.00     1.000
        2       136.00    941.26   1877.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.02    943.26   1877.00     1.000
        2       136.02    943.26   1877.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.05    945.26   1877.00     1.000
        2       136.05    945.26   1877.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.08    947.26   1877.00     1.000
        2       136.08    947.26   1877.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =  30.00(ft)
                              and  X =  62.00(ft)
 Each Surface Terminates Between   X =  86.00(ft)
                             and   X =  90.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =  16.250   FS Min =   3.407   FS Ave =   6.711
          Standard Deviation =    2.423   Coefficient of Variation =   36.11 %
       Failure Surface Specified By  8 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         59.628      959.813
           2         64.337      958.133
```

3	69.306	957.578
4	74.270	958.177
5	78.964	959.898
6	83.139	962.650
7	86.571	966.286
8	87.305	967.552

Circle Center At X = 69.184 ; Y = 978.998 ; and Radius = 21.433

Factor of Safety

*** 3.407 ***

Individual data on the 13 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.4	142.8	0.0	0.0	0.	0.	0.0	0.0	0.0
2	0.3	28.7	0.0	0.0	0.	0.	0.0	0.0	0.0
3	5.0	1549.5	0.0	0.0	0.	0.	0.0	0.0	0.0
4	5.0	3200.0	0.0	0.0	0.	0.	0.0	0.0	0.0
5	2.7	2164.4	0.0	0.0	0.	0.	0.0	0.0	0.0
6	2.0	1627.4	0.0	0.0	0.	0.	0.0	0.0	0.0
7	0.0	30.0	0.0	0.0	0.	0.	0.0	0.0	0.0
8	4.1	2957.2	0.0	0.0	0.	0.	0.0	0.0	0.0
9	2.2	1016.3	0.0	0.0	0.	0.	0.0	0.0	0.0
10	0.6	189.1	0.0	0.0	0.	0.	0.0	0.0	0.0
11	0.3	70.8	0.0	0.0	0.	0.	0.0	0.0	0.0
12	0.3	51.5	0.0	0.0	0.	0.	0.0	0.0	0.0
13	0.7	62.4	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	58.473	960.102
2	63.166	958.377
3	68.112	957.643
4	73.104	957.930
5	77.933	959.226
6	82.397	961.477
7	86.311	964.589
8	88.562	967.295

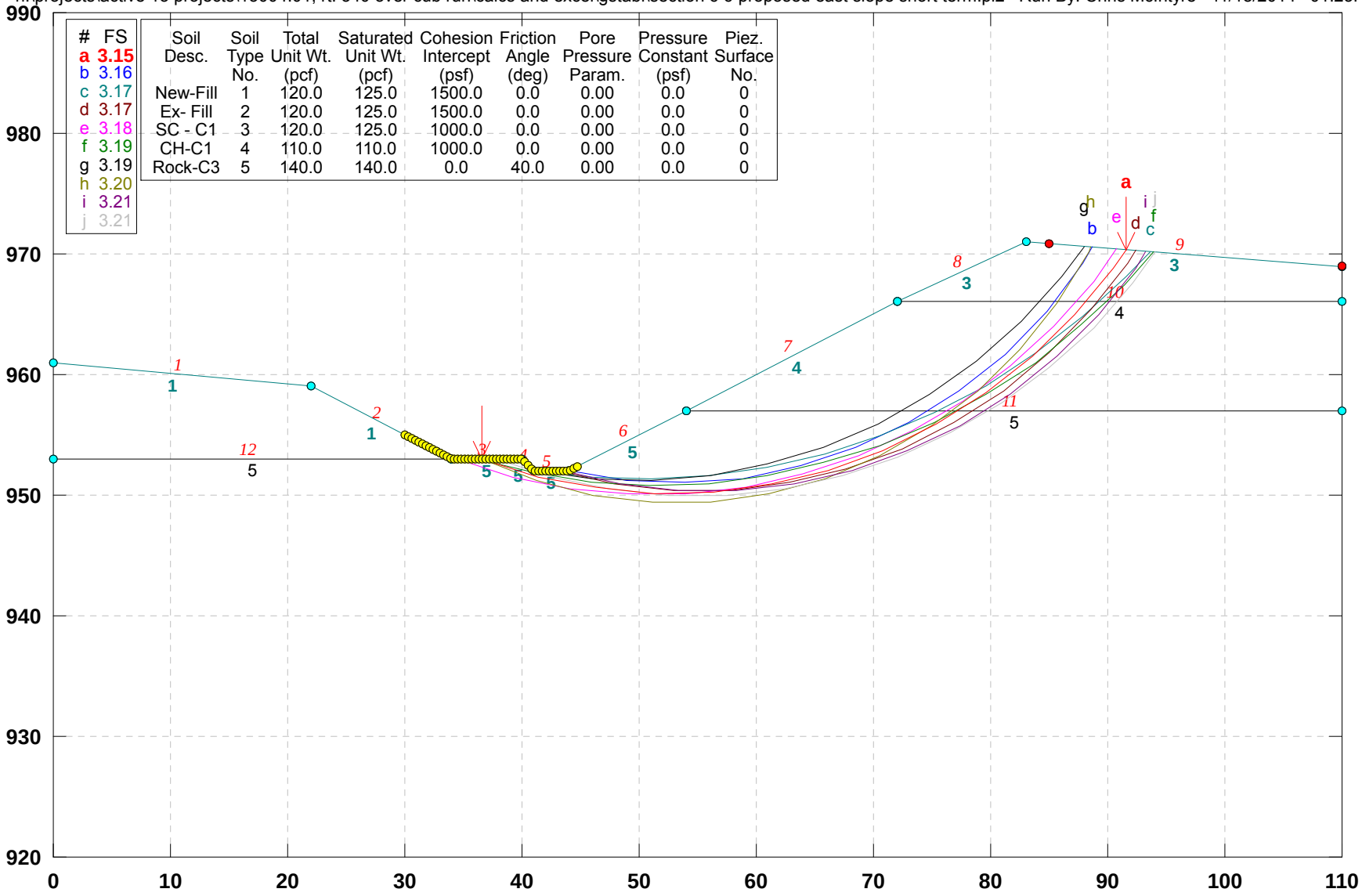
Circle Center At X = 69.179 ; Y = 981.849 ; and Radius = 24.239

Factor of Safety

*** 3.440 ***

Section C - C', Proposed East Slope - Short Term

n:\projects\active 13 projects\13004.01, rt. 340 over cub run\calcs and excel\gstabl\section c-c-proposed east slope short term.pl2 Run By: Chris McIntyre 11/18/2014 01:23PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - C1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
CH-C1	4	110.0	110.0	1000.0	0.0	0.00	0.0	0
Rock-C3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=3.15

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
       ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
                  (All Rights Reserved-Unauthorized Use Prohibited)
    ******************************************************************************
                        SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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    Analysis Run Date:        11/18/2014
    Time of Run:              01:23PM
    Run By:                   Chris McIntyre
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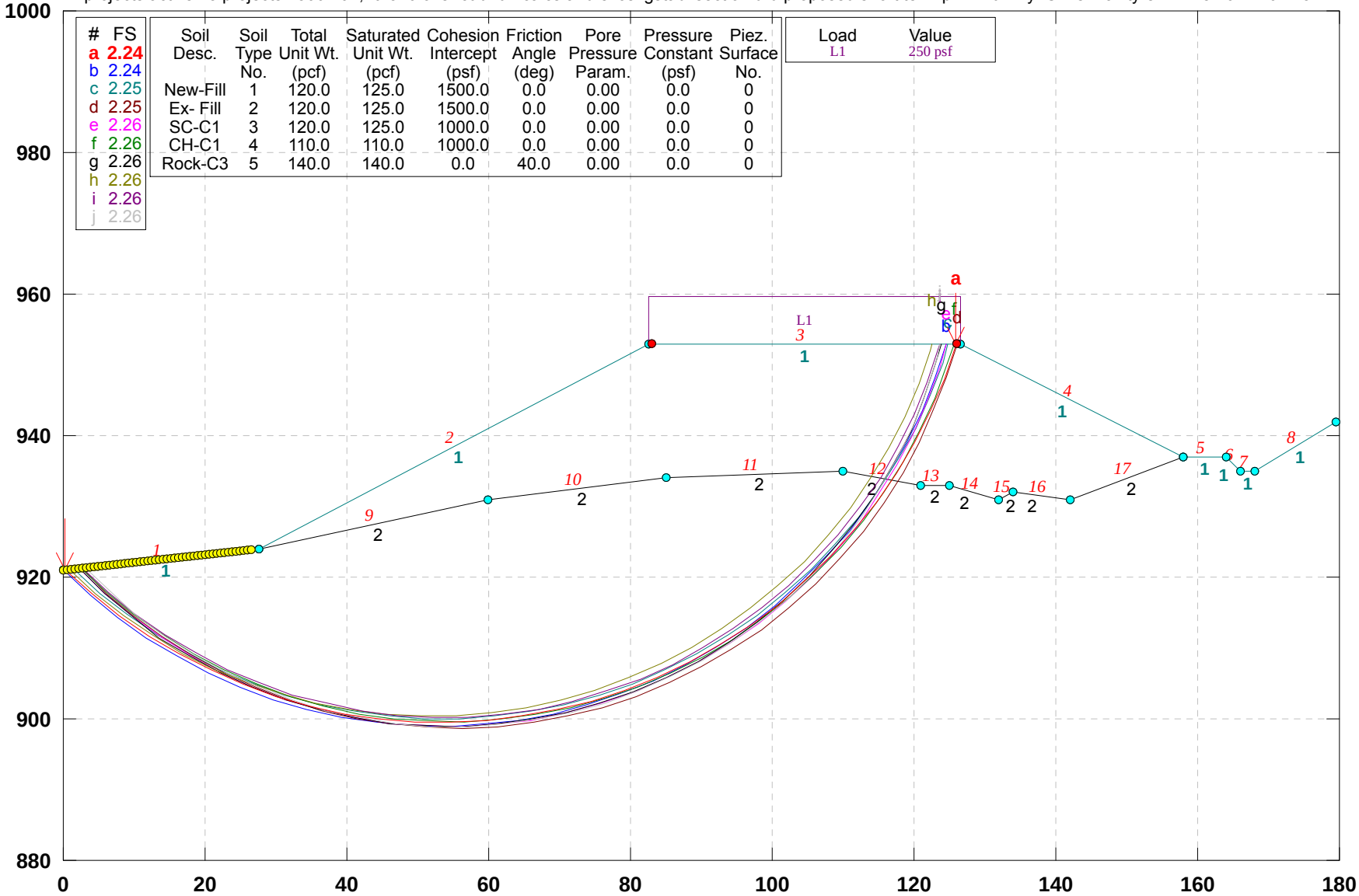
n\Calcs and Excel\GSTABL\section c-c-proposed east slope short term.in
    Output Filename:          N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section c-c-proposed east slope short term.OUT
    Unit System:              English
    Plotted Output Filename:  N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section c-c-proposed east slope short term.PLT
    PROBLEM DESCRIPTION:  Section C - C', Proposed East Slope - Sh
                          ort Term
    BOUNDARY COORDINATES
        9 Top   Boundaries
       12 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00     961.00      22.00     959.00        1
        2         22.00     959.00      34.00     953.00        1
        3         34.00     953.00      40.00     953.00        5
        4         40.00     953.00      41.00     952.00        5
        5         41.00     952.00      44.00     952.00        5
        6         44.00     952.00      54.00     957.00        5
        7         54.00     957.00      72.00     966.00        4
        8         72.00     966.00      83.00     971.00        3
        9         83.00     971.00     110.00     969.00        3
       10         72.00     966.00     110.00     966.00        4
       11         54.00     957.00     110.00     957.00        5
       12          0.00     953.00      34.00     953.00        5
    User Specified Y-Origin =       920.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0    1500.0      0.0    0.00       0.0      0
      2   120.0    125.0    1500.0      0.0    0.00       0.0      0
      3   120.0    125.0    1000.0      0.0    0.00       0.0      0
      4   110.0    110.0    1000.0      0.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1         78.00      915.26
        2        270.00      915.26
    Piezometric Surface No.  2 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1          0.00      901.83
        2         78.00      901.83
    WATER SURFACE DATA HAS BEEN SUPPRESSED
```

```
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1          68.00        92.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED
REINFORCING LAYER(S)
     4 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.00    941.26   1877.00     1.000
        2       136.00    941.26   1877.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.02    943.26   1877.00     1.000
        2       136.02    943.26   1877.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.05    945.26   1877.00     1.000
        2       136.05    945.26   1877.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.08    947.26   1877.00     1.000
        2       136.08    947.26   1877.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =  30.00(ft)
                              and  X =  45.00(ft)
 Each Surface Terminates Between   X =  85.00(ft)
                             and   X = 110.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =  12.678   FS Min =   3.153   FS Ave =   4.616
          Standard Deviation =    0.836   Coefficient of Variation =   18.11 %
       Failure Surface Specified By 14 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         36.643      953.000
           2         41.426      951.543
           3         46.336      950.599
           4         51.319      950.178
           5         56.318      950.285
           6         61.277      950.919
           7         66.142      952.072
           8         70.859      953.732
           9         75.374      955.880
          10         79.637      958.493
          11         83.601      961.540
          12         87.221      964.989
```

```
   13         90.458      968.800
   14         91.527      970.368
Circle Center At X =    52.802 ; Y =   997.339 ; and Radius =    47.192
       Factor of Safety
      ***    3.153   ***
```

Section D - D', Proposed Conditions - Short Term

n:\projects\active 13 projects\13004.01, rt. 340 over cub run\calcs and excel\gstabl\section d-d proposed short term.pl2 Run By: Chris McIntyre 11/18/2014 01:25PM



GSTABL7 v.2 FSmin=2.24

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
      ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
                  (All Rights Reserved-Unauthorized Use Prohibited)
    ******************************************************************************
                        SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    ******************************************************************************
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    Time of Run:              01:25PM
    Run By:                   Chris McIntyre
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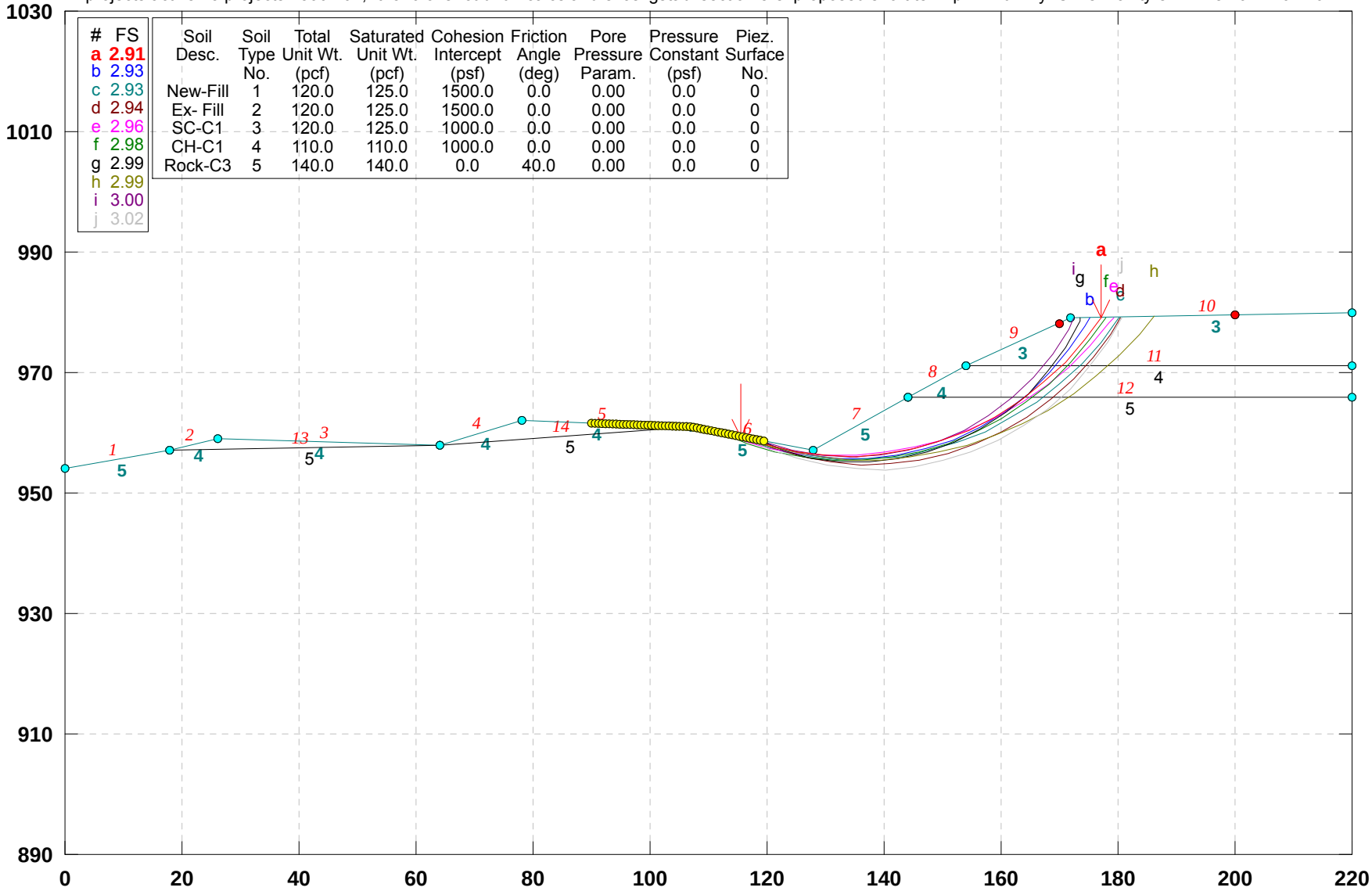
n\Calcs and Excel\GSTABL\section d-d proposed short term.in
    Output Filename:          N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section d-d proposed short term.OUT
    Unit System:              English
    Plotted Output Filename:  N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section d-d proposed short term.PLT
    PROBLEM DESCRIPTION:  Section D - D', Proposed Conditions - Sh
                          ort Term
    BOUNDARY COORDINATES
        8 Top   Boundaries
       17 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1         0.00     921.00      27.50     924.00        1
        2        27.50     924.00      82.50     953.00        1
        3        82.50     953.00     126.50     953.00        1
        4       126.50     953.00     158.00     937.00        1
        5       158.00     937.00     164.00     937.00        1
        6       164.00     937.00     166.00     935.00        1
        7       166.00     935.00     168.00     935.00        1
        8       168.00     935.00     179.50     942.00        1
        9        27.50     924.00      60.00     931.00        2
       10        60.00     931.00      85.00     934.00        2
       11        85.00     934.00     110.00     935.00        2
       12       110.00     935.00     121.00     933.00        2
       13       121.00     933.00     125.00     933.00        2
       14       125.00     933.00     132.00     931.00        2
       15       132.00     931.00     134.00     932.00        2
       16       134.00     932.00     142.00     931.00        2
       17       142.00     931.00     158.00     937.00        2
    User Specified Y-Origin =       880.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0    1500.0      0.0    0.00       0.0      0
      2   120.0    125.0    1500.0      0.0    0.00       0.0      0
      3   120.0    125.0    1000.0      0.0    0.00       0.0      0
      4   110.0    110.0    1000.0      0.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1         78.00      915.26
        2        270.00      915.26
    Piezometric Surface No.  2 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
```

```
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1          82.50       126.50       250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     3 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        27.50    924.00   2625.00     1.000
        2        67.50    924.00   2625.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        31.29    926.00   2625.00     1.000
        2        71.29    926.00   2625.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        35.09    928.00   2625.00     1.000
        2        75.09    928.00   2625.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                 and  X =  27.00(ft)
 Each Surface Terminates Between   X =  83.00(ft)
                                 and   X = 126.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   9.667   FS Min =   2.243   FS Ave =   2.864
          Standard Deviation =    0.737   Coefficient of Variation =   25.74 %
       Failure Surface Specified By 33 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1          0.325      921.035
           2          4.019      917.666
           3          7.926      914.546
           4         12.030      911.691
           5         16.314      909.111
           6         20.757      906.819
           7         25.342      904.823
           8         30.048      903.134
           9         34.855      901.758
          10         39.742      900.701
          11         44.688      899.967
          12         49.671      899.561
          13         54.670      899.483
          14         59.664      899.733
```

```
   15         64.630      900.312
   16         69.548      901.216
   17         74.395      902.442
   18         79.152      903.984
   19         83.797      905.835
   20         88.309      907.987
   21         92.671      910.432
   22         96.862      913.158
   23        100.865      916.154
   24        104.663      919.407
   25        108.238      922.902
   26        111.575      926.625
   27        114.661      930.560
   28        117.481      934.689
   29        120.023      938.994
   30        122.277      943.457
   31        124.233      948.059
   32        125.881      952.779
   33        125.942      953.000
Circle Center At X =    53.356 ; Y =   975.461 ; and Radius =    75.989
       Factor of Safety
      ***    2.243   ***
```

Section E - E', Proposed Conditions - Short Term

n:\projects\active 13 projects\13004.01, rt. 340 over cub run\calcs and excel\gstabl\section e-e'-proposed short term.pl2 Run By: Chris McIntyre 11/18/2014 01:26PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC-C1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
CH-C1	4	110.0	110.0	1000.0	0.0	0.00	0.0	0
Rock-C3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=2.91

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
       ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
                   (All Rights Reserved-Unauthorized Use Prohibited)
    ***************************************************************************
                         SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    ***************************************************************************
    Analysis Run Date:        11/18/2014
    Time of Run:              01:26PM
    Run By:                   Chris McIntyre
    Input Data Filename:      N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section e-e'-proposed short term.in
    Output Filename:          N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section e-e'-proposed short term.OUT
    Unit System:              English
    Plotted Output Filename:  N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section e-e'-proposed short term.PLT
    PROBLEM DESCRIPTION:  Section E - E', Proposed Conditions - Sh
                          ort Term
    BOUNDARY COORDINATES
       10 Top   Boundaries
       14 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1         0.00     954.00      18.00     957.00        5
        2        18.00     957.00      26.00     959.00        4
        3        26.00     959.00      64.00     958.00        4
        4        64.00     958.00      78.00     962.00        4
        5        78.00     962.00     107.00     961.00        4
        6       107.00     961.00     128.00     957.00        5
        7       128.00     957.00     144.00     966.00        5
        8       144.00     966.00     154.00     971.00        4
        9       154.00     971.00     172.00     979.00        3
       10       172.00     979.00     220.00     980.00        3
       11       154.00     971.00     220.00     971.00        4
       12       144.00     966.00     220.00     966.00        5
       13        18.00     957.00      64.00     958.00        5
       14        64.00     958.00     107.00     961.00        5
    User Specified Y-Origin =       890.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0    1500.0      0.0    0.00       0.0      0
      2   120.0    125.0    1500.0      0.0    0.00       0.0      0
      3   120.0    125.0    1000.0      0.0    0.00       0.0      0
      4   110.0    110.0    1000.0      0.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1         78.00      915.26
        2        270.00      915.26
    Piezometric Surface No.  2 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1          0.00      901.83
```

```
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1          82.50       126.50       250.0           0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED
REINFORCING LAYER(S)
     3 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        27.50    924.00   2625.00     1.000
        2        62.50    924.00   2625.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        31.29    926.00   2625.00     1.000
        2        66.29    926.00   2625.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        35.09    928.00   2625.00     1.000
        2        70.09    928.00   2625.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =  90.00(ft)
                                and  X = 120.00(ft)
 Each Surface Terminates Between   X = 170.00(ft)
                              and   X = 200.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   6.159   FS Min =   2.909   FS Ave =   4.144
          Standard Deviation =    0.589   Coefficient of Variation =   14.22 %
       Failure Surface Specified By 15 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1        115.551      959.371
           2        120.317      957.861
           3        125.206      956.812
           4        130.173      956.235
           5        135.172      956.134
           6        140.157      956.512
           7        145.084      957.363
           8        149.907      958.681
           9        154.583      960.453
          10        159.067      962.664
          11        163.321      965.293
          12        167.304      968.316
          13        170.980      971.705
          14        174.315      975.429
          15        177.022      979.105
       Circle Center At X =   133.722 ; Y =  1008.429 ; and Radius =    52.314
```

```
 Factor of Safety
***    2.909   ***
```

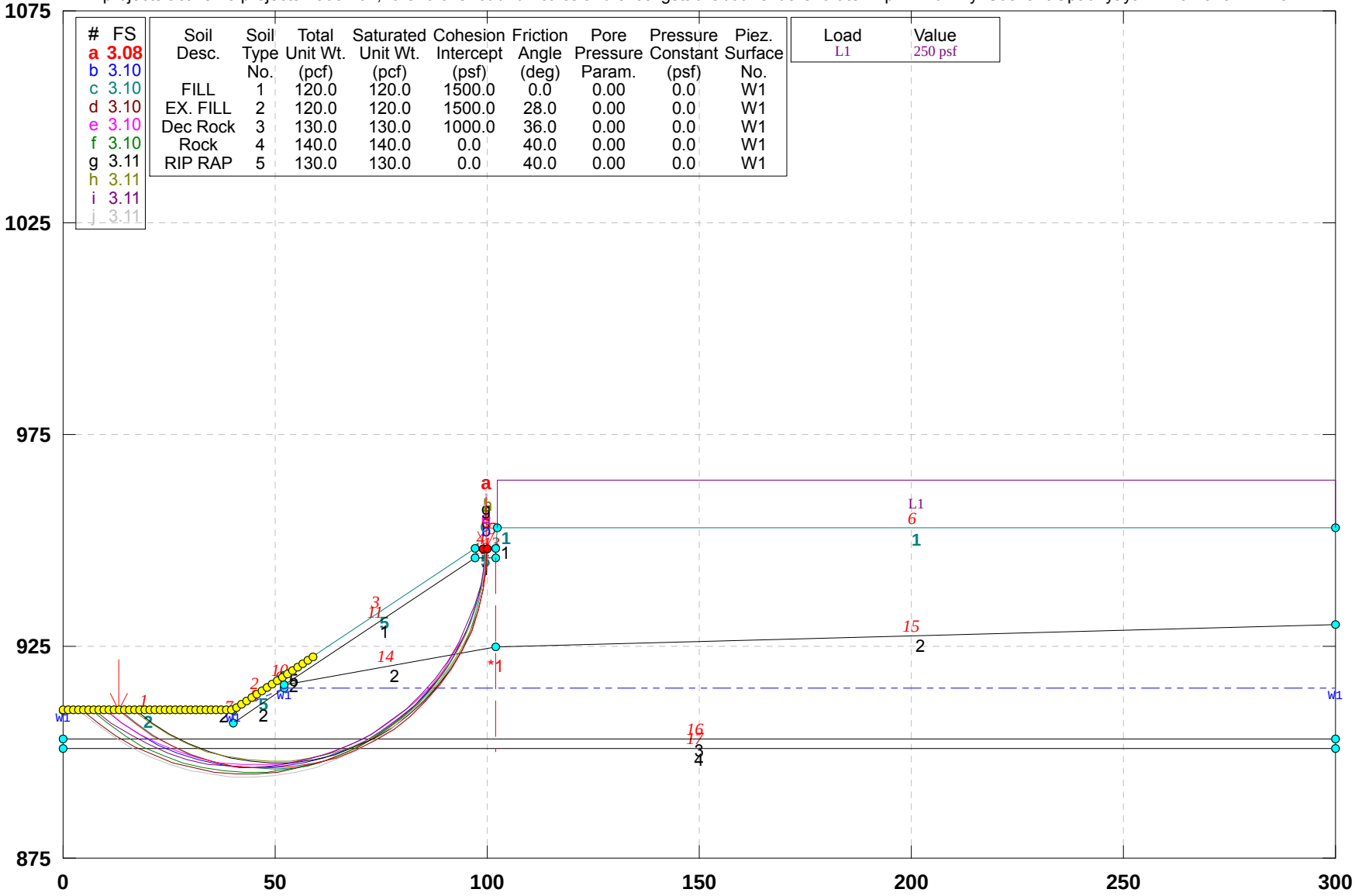
Route 340 over Cub Run Abutment A- Short Term

n:\projects\active 13 projects\13004.01, rt. 340 over cub run\calcs and excel\gstabl\abutment a-short term.pl2 Run By: Sushant Upadhyaya 4/29/2015 12:13PM

#	FS
a	3.08
b	3.10
c	3.10
d	3.10
e	3.10
f	3.10
g	3.11
h	3.11
i	3.11
j	3.11

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
FILL	1	120.0	120.0	1500.0	0.0	0.00	0.0	W1
EX. FILL	2	120.0	120.0	1500.0	28.0	0.00	0.0	W1
Dec Rock	3	130.0	130.0	1000.0	36.0	0.00	0.0	W1
Rock	4	140.0	140.0	0.0	40.0	0.00	0.0	W1
RIP RAP	5	130.0	130.0	0.0	40.0	0.00	0.0	W1

Load	Value
L1	250 psf



GSTABL7 v.2 FSmin=3.08

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
      ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
                 (All Rights Reserved-Unauthorized Use Prohibited)
    ******************************************************************************
                        SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    ******************************************************************************
    Analysis Run Date:        4/29/2015
    Time of Run:              12:13PM
    Run By:                   Sushant Upadhyaya
    Input Data Filename:      N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\abutment a-short term.in
    Output Filename:          N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\abutment a-short term.OUT
    Unit System:              English
    Plotted Output Filename:  N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\abutment a-short term.PLT
    PROBLEM DESCRIPTION:  Route 340 over Cub Run
                          Abutment A- Short Term
    BOUNDARY COORDINATES
        6 Top   Boundaries
       17 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00     910.00      40.10     910.00        2
        2         40.10     910.00      52.20     918.00        5
        3         52.20     918.00      97.00     948.00        5
        4         97.00     948.00     102.10     948.00        5
        5        102.10     948.00     102.20     953.00        1
        6        102.20     953.00     300.00     953.00        1
        7         40.10     910.00      40.20     907.00        2
        8         40.20     907.00      52.00     915.00        2
        9         52.00     915.00      52.10     916.00        2
       10         52.10     916.00      52.20     918.00        5
       11         52.10     916.00      97.00     946.00        1
       12         97.00     946.00     102.00     946.00        1
       13        102.00     946.00     102.10     948.00        1
       14         52.10     916.00     102.00     925.00        2
       15        102.00     925.00     300.00     930.00        2
       16          0.00     903.00     300.00     903.00        3
       17          0.00     901.00     300.00     901.00        4
    User Specified Y-Origin =       875.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    120.0    1500.0      0.0    0.00       0.0      1
      2   120.0    120.0    1500.0     28.0    0.00       0.0      1
      3   130.0    130.0    1000.0     36.0    0.00       0.0      1
      4   140.0    140.0       0.0     40.0    0.00       0.0      1
      5   130.0    130.0       0.0     40.0    0.00       0.0      1
    1 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  4 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1          0.00      910.00
        2         40.10      910.00
        3         52.00      915.00
        4        300.00      915.00
```

```
   BOUNDARY LOAD(S)
        1 Load(s) Specified
    Load        X-Left      X-Right     Intensity     Deflection
     No.         (ft)         (ft)        (psf)          (deg)
      1         102.20       300.00       250.0           0.0
    NOTE - Intensity Is Specified As A Uniformly Distributed
           Force Acting On A Horizontally Projected Surface.
   Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
    Of Which The First  0 Boundaries Will Deflect Surfaces Upward
    Boundary     X-Left     Y-Left    X-Right    Y-Right
       No.        (ft)       (ft)       (ft)       (ft)
        1        102.00     946.00     102.00     900.00
   REINFORCING LAYER(S)
        4 REINFORCING LAYER(S) SPECIFIED
    REINFORCING LAYER NO.   1
      2 POINTS DEFINE THIS LAYER
         POINT     X-COORD   Y-COORD   FORCE   INCLINATION
          NO.                                   FACTOR
           1        63.00    922.00   4000.00     1.000
           2        93.00    922.00   4000.00     1.000
    REINFORCING LAYER NO.   2
      2 POINTS DEFINE THIS LAYER
         POINT     X-COORD   Y-COORD   FORCE   INCLINATION
          NO.                                   FACTOR
           1        63.00    925.00   4000.00     1.000
           2        93.00    925.00   4000.00     1.000
    REINFORCING LAYER NO.   3
      2 POINTS DEFINE THIS LAYER
         POINT     X-COORD   Y-COORD   FORCE   INCLINATION
          NO.                                   FACTOR
           1        67.13    928.00   4000.00     1.000
           2        97.13    928.00   4000.00     1.000
    REINFORCING LAYER NO.   4
      2 POINTS DEFINE THIS LAYER
         POINT     X-COORD   Y-COORD   FORCE   INCLINATION
          NO.                                   FACTOR
           1        71.61    931.00   4000.00     1.000
           2       101.61    931.00   4000.00     1.000
    REINFORCING LAYER DATA HAS BEEN SUPPRESSED
    A Critical Failure Surface Searching Method, Using A Random
    Technique For Generating Circular Surfaces, Has Been Specified.
     500 Trial Surfaces Have Been Generated.
       1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
    Along The Ground Surface Between  X =   0.00(ft)
                                  and  X =  60.00(ft)
    Each Surface Terminates Between   X =  99.00(ft)
                                 and   X = 100.00(ft)
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =      0.00(ft)
     5.00(ft) Line Segments Define Each Trial Failure Surface.
    ****  ERROR - RC11  ****
>>200 attempts to generate failure surface have failed. Revise limitations
    Following Are Displayed The Ten Most Critical Of The Trial
          Failure Surfaces Evaluated. They Are
          Ordered - Most Critical First.
          * * Safety Factors Are Calculated By The Modified Bishop Method * *
          Total Number of Trial Surfaces Attempted =   500
          Number of Failed Attempts to Generate Trial Surface  =  184
          Number of Trial Surfaces With Valid FS =  316
          Percentage of Trial Surfaces With Non-Valid FS Solutions
          of the Total Attempted =  36.8 %
          Statistical Data On All Valid FS Values:
             FS Max =   6.753   FS Min =   3.082   FS Ave =   3.857
             Standard Deviation =    0.517   Coefficient of Variation =   13.41 %
          Failure Surface Specified By 25 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
              1         13.226      910.000
              2         17.046      906.773
              3         21.161      903.932
```

4	25.531	901.504
5	30.117	899.510
6	34.874	897.971
7	39.758	896.900
8	44.722	896.308
9	49.721	896.200
10	54.707	896.577
11	59.633	897.436
12	64.452	898.768
13	69.119	900.562
14	73.591	902.799
15	77.824	905.460
16	81.779	908.518
17	85.420	911.946
18	88.710	915.711
19	91.621	919.776
20	94.123	924.105
21	96.193	928.656
22	97.813	933.387
23	98.966	938.252
24	99.643	943.206
25	99.827	948.000

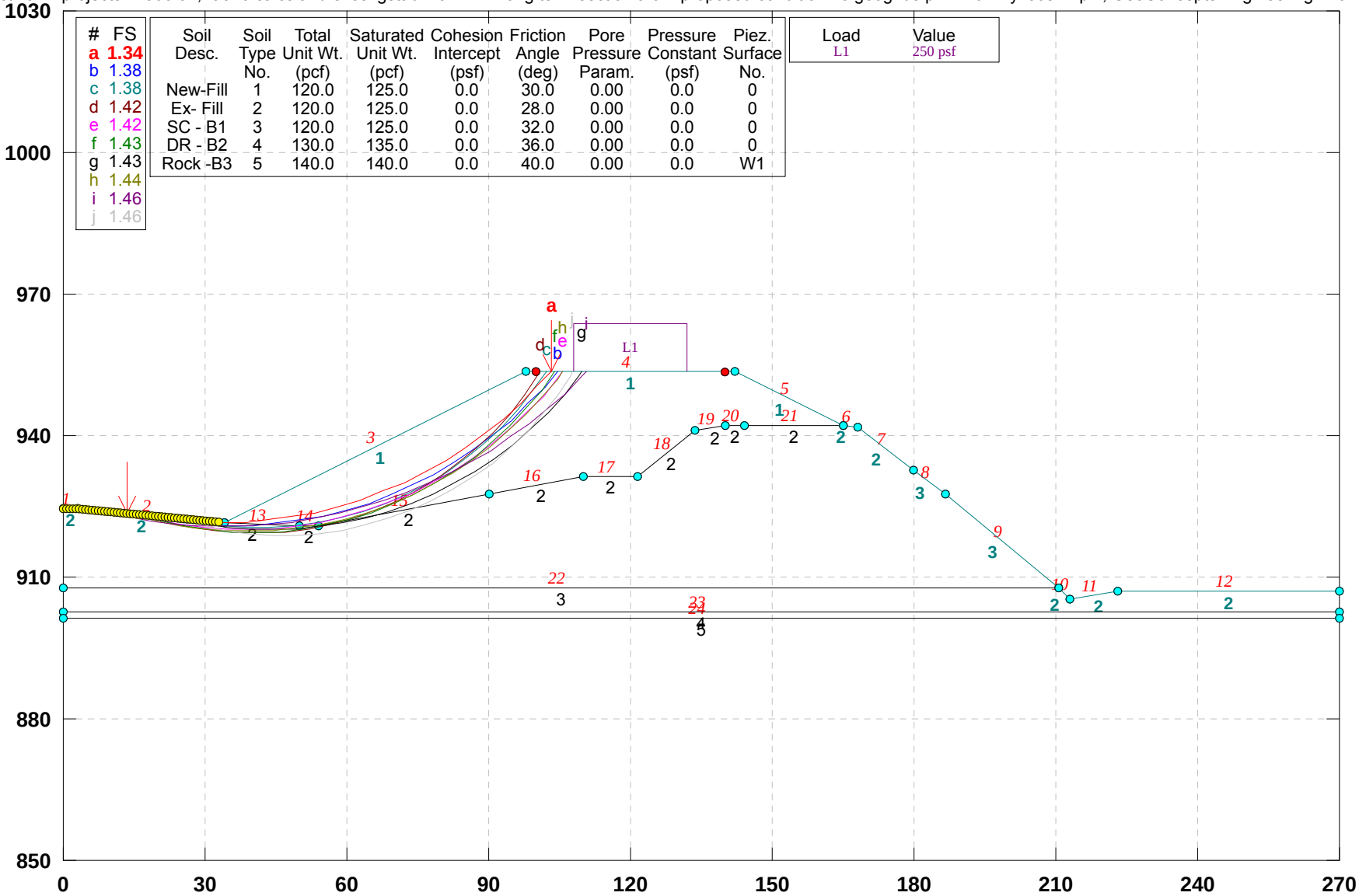
Circle Center At X = 48.333 ; Y = 947.686 ; and Radius = 51.504

Factor of Safety

*** 3.082 ***

Section A-A'- West Slope Proposed 2H:1V- Long Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section a-a' - proposed condition no geogrids.pl2 Run By: Josh April, GeoConcepts Engineering 10/22/2014 04:31



GSTABL7 v.2 FSmin=1.34

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
            ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
        Modified Bishop, Simplified Janbu, or GLE Method of Slices.
        (Includes Spencer & Morgenstern-Price Type Analysis)
        Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
        Nonlinear Undrained Shear Strength, Curved Phi Envelope,
        Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
        Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/22/2014
Time of Run:              04:31PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - proposed condition no geogrids.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - proposed condition no geogrids.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - proposed condition no geogrids.PLT
PROBLEM DESCRIPTION:  Section  A-A'- West Slope Proposed 2H:1V
                      - Long Term
BOUNDARY COORDINATES
   12 Top   Boundaries
   24 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1         0.00     924.50       3.00     924.50        2
    2         3.00     924.50      34.00     921.58        2
    3        34.00     921.58      98.00     953.58        1
    4        98.00     953.58     142.00     953.47        1
    5       142.00     953.47     165.00     941.97        1
    6       165.00     941.97     168.00     941.96        2
    7       168.00     941.96     180.00     932.76        2
    8       180.00     932.76     186.50     927.76        3
    9       186.50     927.76     210.50     907.60        3
   10       210.50     907.60     213.00     905.50        2
   11       213.00     905.50     223.00     907.00        2
   12       223.00     907.00     270.00     907.00        2
   13        34.00     921.58      50.00     921.00        2
   14        50.00     921.00      54.00     921.00        2
   15        54.00     921.00      90.00     927.76        2
   16        90.00     927.76     110.00     931.50        2
   17       110.00     931.50     121.50     931.50        2
   18       121.50     931.50     133.50     941.00        2
   19       133.50     941.00     140.00     942.00        2
   20       140.00     942.00     144.00     942.00        2
   21       144.00     942.00     165.00     941.97        2
   22         0.00     907.60     210.50     907.60        3
   23         0.00     902.76     270.00     902.76        4
   24         0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0       0.0      30.0    0.00       0.0      0
  2   120.0    125.0       0.0      28.0    0.00       0.0      0
  3   120.0    125.0       0.0      32.0    0.00       0.0      0
  4   130.0    135.0       0.0      36.0    0.00       0.0      0
  5   140.0    140.0       0.0      40.0    0.00       0.0      1
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
```

```
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      915.26
     2        192.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1        192.00      901.83
     2        270.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         108.00       132.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     3 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        34.00    921.58   2625.00     1.000
        2        69.00    921.58   2625.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        38.00    923.58   2625.00     1.000
        2        73.00    923.58   2625.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        42.00    925.58   2625.00     1.000
        2        77.00    925.58   2625.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  33.50(ft)
 Each Surface Terminates Between   X = 100.00(ft)
                               and   X = 140.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   3.375   FS Min =   1.338   FS Ave =   2.186
          Standard Deviation =    0.465   Coefficient of Variation =   21.29 %
       Failure Surface Specified By 21 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         13.494      923.512
           2         18.411      922.604
           3         23.370      921.962
           4         28.356      921.587
           5         33.354      921.480
           6         38.352      921.642
           7         43.333      922.071
```

8	48.285	922.767
9	53.192	923.727
10	58.040	924.950
11	62.815	926.431
12	67.505	928.166
13	72.094	930.150
14	76.571	932.377
15	80.921	934.841
16	85.133	937.536
17	89.195	940.452
18	93.094	943.582
19	96.819	946.917
20	100.361	950.446
21	103.172	953.567

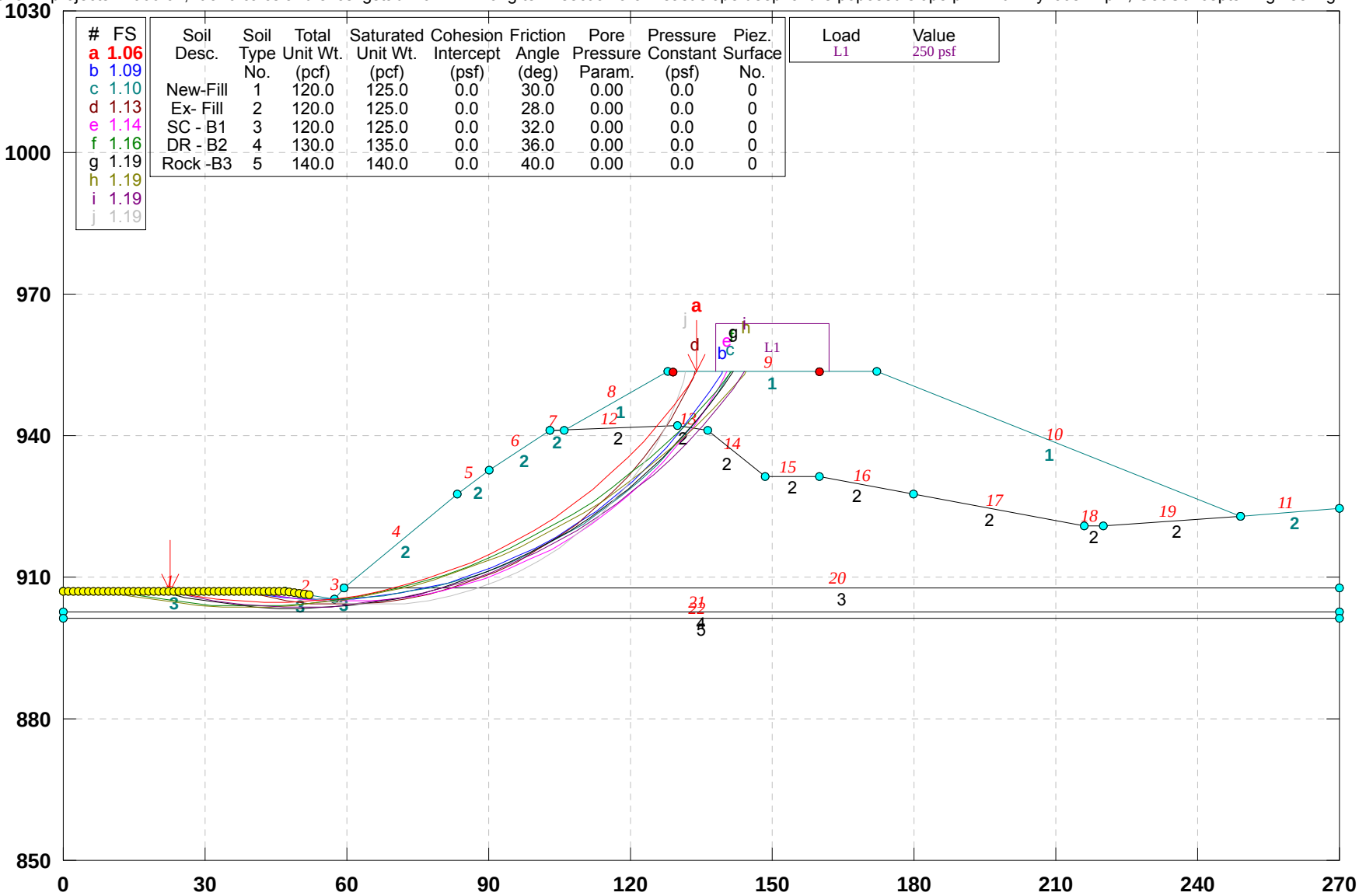
Circle Center At X = 32.848 ; Y = 1014.638 ; and Radius = 93.158

Factor of Safety

*** 1.338 ***

Section A-A'- Proposed East Slope 2H:1V

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section a-a' - east slope deep failure poposed slope.pl2 Run By: Josh April, GeoConcepts Engineering 11/4/2014 01:2



GSTABL7 v.2 FSmin=1.06

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
             ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
         Modified Bishop, Simplified Janbu, or GLE Method of Slices.
         (Includes Spencer & Morgenstern-Price Type Analysis)
         Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
         Nonlinear Undrained Shear Strength, Curved Phi Envelope,
         Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
         Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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Analysis Run Date:        11/4/2014
Time of Run:              01:22PM
Run By:                   Josh April, GeoConcepts Engineering
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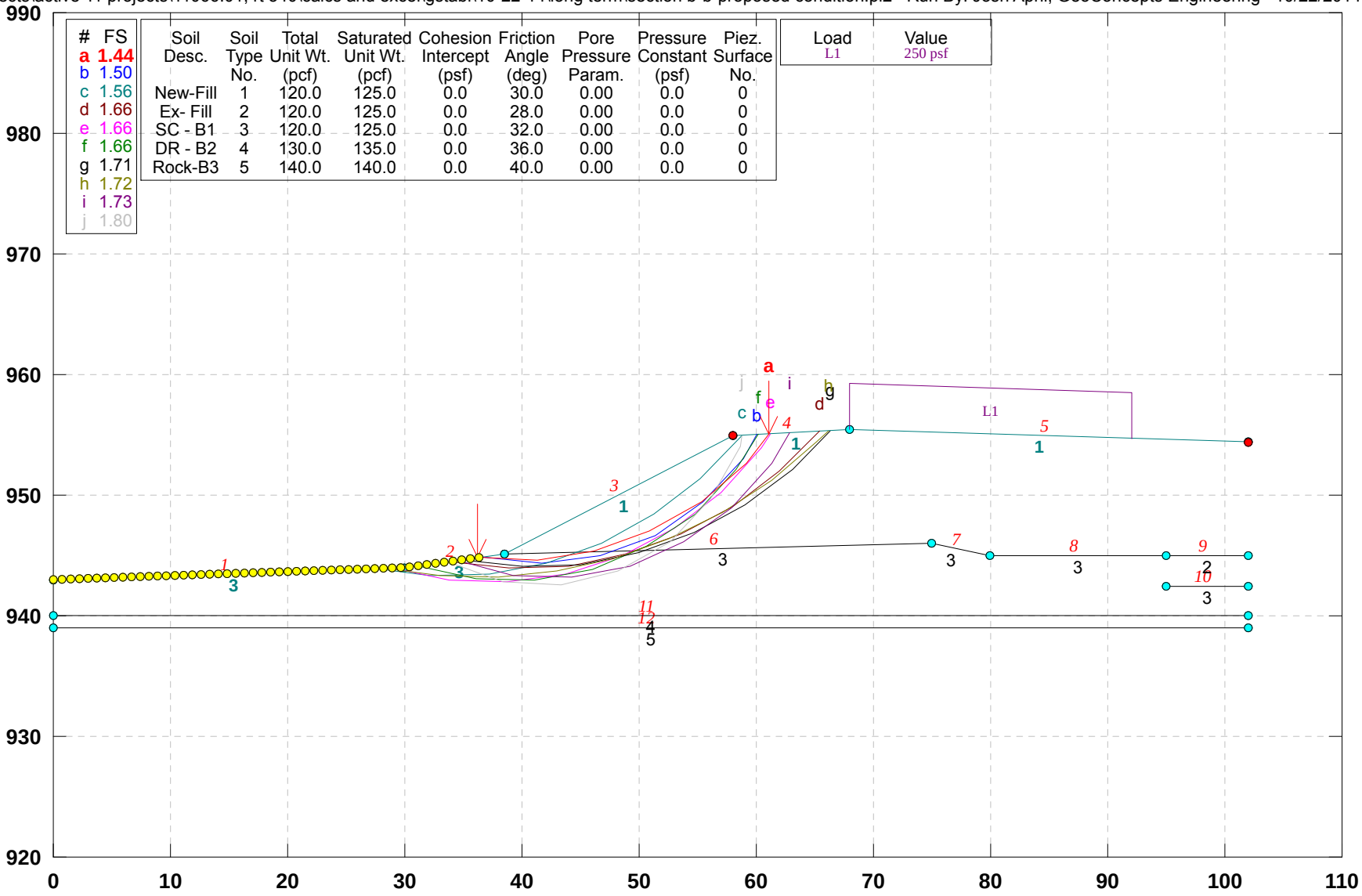
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope.in
Output Filename:          N:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope.OUT
Unit System:              English
Plotted Output Filename:  N:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope.PLT
PROBLEM DESCRIPTION:  Section A-A'- Proposed East Slope 2H:1V
BOUNDARY COORDINATES
   11 Top   Boundaries
   22 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1          0.00     907.00      47.00     907.00        3
    2         47.00     907.00      57.50     905.50        3
    3         57.50     905.50      59.50     907.60        3
    4         59.50     907.60      83.50     927.76        2
    5         83.50     927.76      90.00     932.76        2
    6         90.00     932.76     103.00     941.26        2
    7        103.00     941.26     106.00     941.26        2
    8        106.00     941.26     128.00     953.47        1
    9        128.00     953.47     172.00     953.59        1
   10        172.00     953.59     249.00     923.00        1
   11        249.00     923.00     270.00     924.50        2
   12        103.00     941.26     130.00     942.00        2
   13        130.00     942.00     136.50     941.00        2
   14        136.50     941.00     148.50     931.50        2
   15        148.50     931.50     160.00     931.50        2
   16        160.00     931.50     180.00     927.76        2
   17        180.00     927.76     216.00     921.00        2
   18        216.00     921.00     220.00     921.00        2
   19        220.00     921.00     249.00     923.00        2
   20         59.50     907.60     270.00     907.60        3
   21          0.00     902.76     270.00     902.76        4
   22          0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0       0.0     30.0    0.00       0.0      0
  2   120.0    125.0       0.0     28.0    0.00       0.0      0
  3   120.0    125.0       0.0     32.0    0.00       0.0      0
  4   130.0    135.0       0.0     36.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
  Point      X-Water     Y-Water
   No.         (ft)        (ft)
```

```
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        105.00     941.26     105.10     906.26
 SEARCH LIMIT BOUNDARY DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  53.00(ft)
 Each Surface Terminates Between   X = 129.00(ft)
                                and   X = 160.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   3.290   FS Min =   1.060   FS Ave =   2.290
          Standard Deviation =    0.614   Coefficient of Variation =   26.80 %
       Failure Surface Specified By 27 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         22.623      907.000
           2         27.536      906.070
           3         32.487      905.372
           4         37.466      904.909
           5         42.460      904.682
           6         47.460      904.690
           7         52.454      904.934
           8         57.431      905.414
           9         62.380      906.127
          10         67.290      907.074
          11         72.149      908.251
          12         76.948      909.656
          13         81.675      911.285
          14         86.320      913.136
          15         90.872      915.204
          16         95.322      917.485
          17         99.659      919.973
          18        103.874      922.662
          19        107.957      925.548
          20        111.900      928.623
          21        115.693      931.880
          22        119.328      935.313
          23        122.797      938.914
          24        126.093      942.674
          25        129.208      946.585
```

```
   26        132.134      950.640
   27        133.991      953.486
Circle Center At X =    44.786 ; Y =  1010.610 ; and Radius =   105.954
       Factor of Safety
      ***    1.060   ***
```

Section B-B' - Long Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section b-b-proposed condition.pl2 Run By: Josh April, GeoConcepts Engineering 10/22/2014 04:55PM



#	FS
a	1.44
b	1.50
c	1.56
d	1.66
e	1.66
f	1.66
g	1.71
h	1.72
i	1.73
j	1.80

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	0.0	30.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	0.0	28.0	0.00	0.0	0
SC - B1	3	120.0	125.0	0.0	32.0	0.00	0.0	0
DR - B2	4	130.0	135.0	0.0	36.0	0.00	0.0	0
Rock-B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

Load	Value
L1	250 psf

GSTABL7 v.2 FSmin=1.44

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
       ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
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    ******************************************************************************
                       SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    ******************************************************************************
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    Time of Run:              04:55PM
    Run By:                   Josh April, GeoConcepts Engineering
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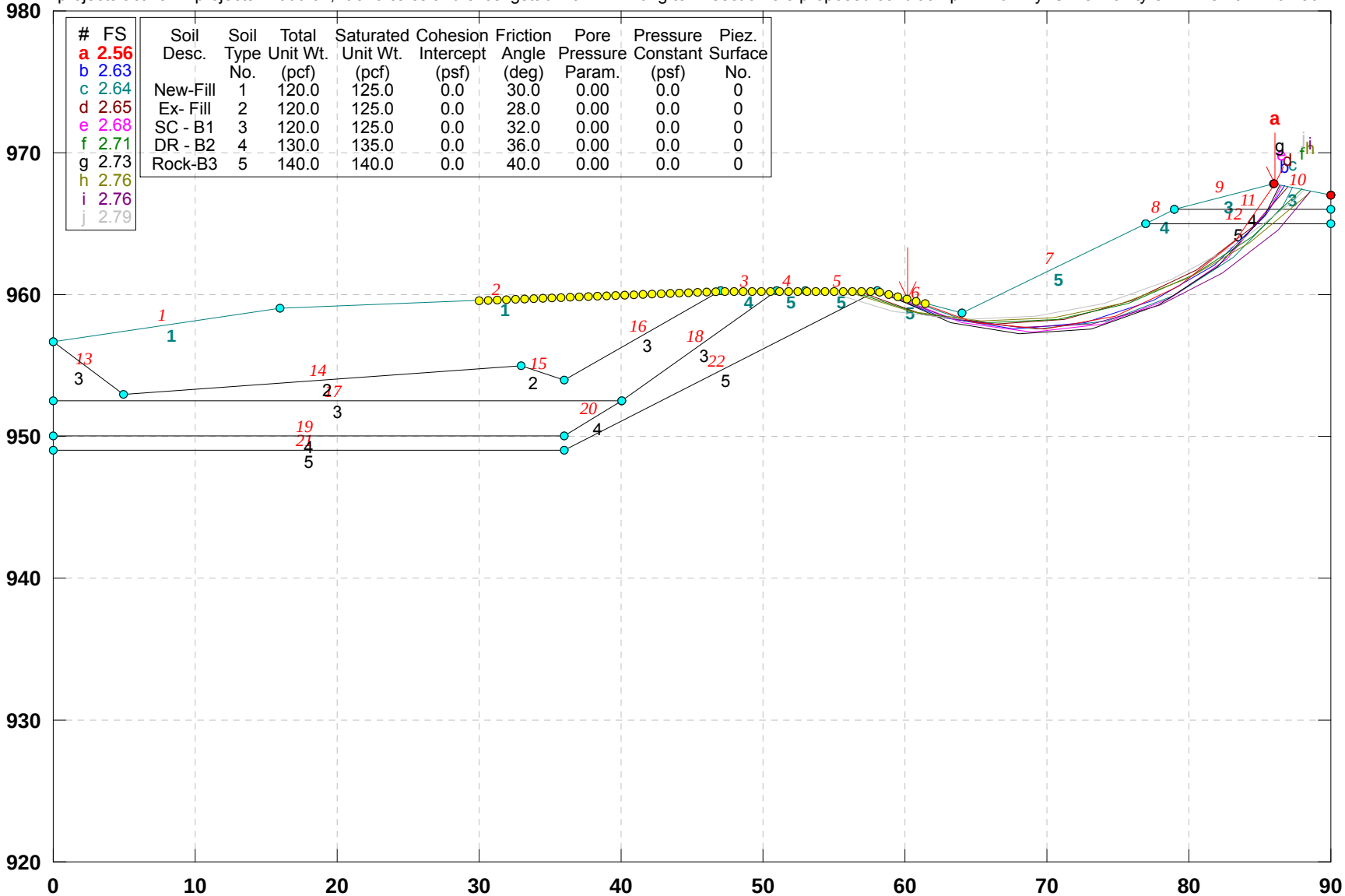
cel\GStabl\10-22-14\Long Term\section b-b-proposed condition.in
    Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section b-b-proposed condition.OUT
    Unit System:              English
    Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section b-b-proposed condition.PLT
    PROBLEM DESCRIPTION:  Section B-B' - Long Term
    BOUNDARY COORDINATES
        5 Top   Boundaries
       12 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00     943.00      30.00     944.00        3
        2         30.00     944.00      38.50     945.12        3
        3         38.50     945.12      58.00     954.95        1
        4         58.00     954.95      68.00     955.42        1
        5         68.00     955.42     102.00     954.37        1
        6         38.50     945.12      75.00     946.00        3
        7         75.00     946.00      80.00     945.00        3
        8         80.00     945.00      95.00     945.00        3
        9         95.00     945.00     102.00     945.00        2
       10         95.00     942.50     102.00     942.50        3
       11          0.00     940.00     102.00     940.00        4
       12          0.00     939.00     102.00     939.00        5
    User Specified Y-Origin =       920.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0       0.0     30.0    0.00       0.0      0
      2   120.0    125.0       0.0     28.0    0.00       0.0      0
      3   120.0    125.0       0.0     32.0    0.00       0.0      0
      4   130.0    135.0       0.0     36.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1         78.00      915.26
        2        270.00      915.26
    Piezometric Surface No.  2 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1          0.00      901.83
        2         78.00      901.83
    WATER SURFACE DATA HAS BEEN SUPPRESSED
   BOUNDARY LOAD(S)
```

```
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1          68.00        92.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     4 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.00    941.26   1877.00     1.000
        2       136.00    941.26   1877.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.02    943.26   1877.00     1.000
        2       136.02    943.26   1877.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.05    945.26   1877.00     1.000
        2       136.05    945.26   1877.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.08    947.26   1877.00     1.000
        2       136.08    947.26   1877.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                 and  X =  37.00(ft)
 Each Surface Terminates Between   X =  58.00(ft)
                                 and   X = 102.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   9.090   FS Min =   1.436   FS Ave =   4.350
          Standard Deviation =    1.494   Coefficient of Variation =   34.34 %
       Failure Surface Specified By  7 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         36.259      944.825
           2         41.255      944.631
           3         46.202      945.357
           4         50.932      946.978
           5         55.284      949.439
           6         59.110      952.658
           7         61.111      955.096
       Circle Center At X =    39.805 ; Y =   971.728 ; and Radius =    27.136
              Factor of Safety
            ***    1.436   ***
```

Section C - C', Proposed West Slope - Long Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section c-c-proposed condition.pl2 Run By: Chris McIntyre 11/18/2014 01:50PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	0.0	30.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	0.0	28.0	0.00	0.0	0
SC - B1	3	120.0	125.0	0.0	32.0	0.00	0.0	0
DR - B2	4	130.0	135.0	0.0	36.0	0.00	0.0	0
Rock-B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=2.56

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                          ** GSTABL7 by Garry H. Gregory, P.E. **
        ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
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    ******************************************************************************
                        SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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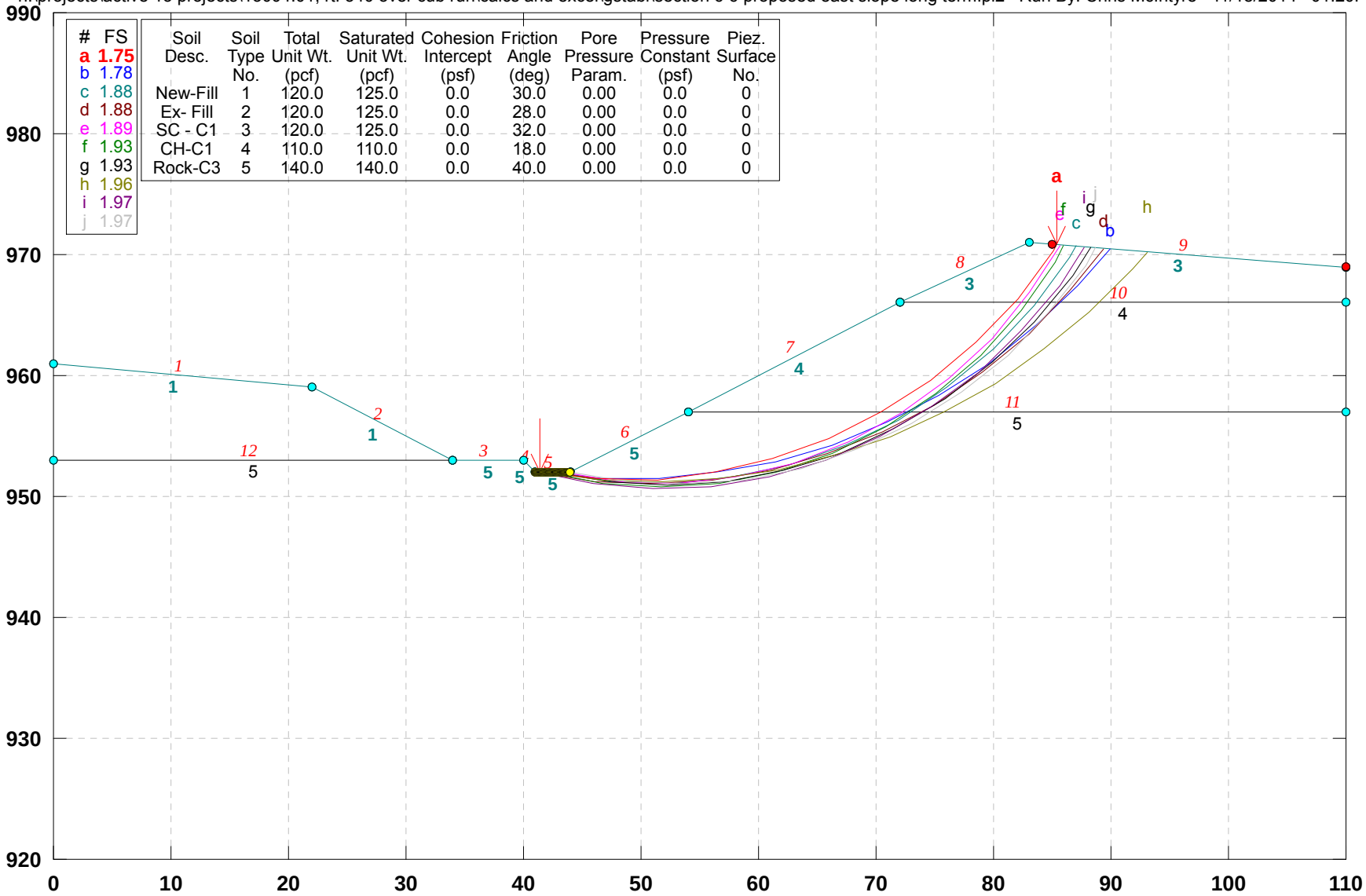
    Output Filename:          N:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section c-c-proposed condition.OUT
    Unit System:              English
    Plotted Output Filename:  N:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section c-c-proposed condition.PLT
    PROBLEM DESCRIPTION:  Section C - C', Proposed West Slope - Lo
                          ng Term
    BOUNDARY COORDINATES
       10 Top   Boundaries
       22 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00     956.63      16.00     959.03        1
        2         16.00     959.03      47.00     960.22        1
        3         47.00     960.22      51.00     960.22        4
        4         51.00     960.22      53.00     960.22        5
        5         53.00     960.22      58.00     960.22        5
        6         58.00     960.22      64.00     958.72        5
        7         64.00     958.72      77.00     965.00        5
        8         77.00     965.00      79.00     966.00        4
        9         79.00     966.00      86.00     967.82        3
       10         86.00     967.82      90.00     967.00        3
       11         79.00     966.00      90.00     966.00        4
       12         77.00     965.00      90.00     965.00        5
       13          0.00     956.63       5.00     953.00        3
       14          5.00     953.00      33.00     955.00        2
       15         33.00     955.00      36.00     954.00        2
       16         36.00     954.00      47.00     960.22        3
       17          0.00     952.50      40.00     952.50        3
       18         40.00     952.50      51.00     960.22        3
       19          0.00     950.00      36.00     950.00        4
       20         36.00     950.00      40.00     952.50        4
       21          0.00     949.00      36.00     949.00        5
       22         36.00     949.00      58.00     960.22        5
    User Specified Y-Origin =       920.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0       0.0     30.0    0.00       0.0      0
      2   120.0    125.0       0.0     28.0    0.00       0.0      0
      3   120.0    125.0       0.0     32.0    0.00       0.0      0
      4   130.0    135.0       0.0     36.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
```

```
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         68.00        92.00        250.0           0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED
REINFORCING LAYER(S)
     4 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.00    941.26   1877.00     1.000
        2       136.00    941.26   1877.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.02    943.26   1877.00     1.000
        2       136.02    943.26   1877.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.05    945.26   1877.00     1.000
        2       136.05    945.26   1877.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.08    947.26   1877.00     1.000
        2       136.08    947.26   1877.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =  30.00(ft)
                                and  X =  62.00(ft)
 Each Surface Terminates Between   X =  86.00(ft)
                               and   X =  90.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   8.056   FS Min =   2.558   FS Ave =   4.983
          Standard Deviation =    1.239   Coefficient of Variation =   24.87 %
       Failure Surface Specified By  7 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         60.205      959.669
           2         64.925      958.020
```

```
    3         69.909      957.623
    4         74.831      958.503
    5         79.368      960.604
    6         83.224      963.787
    7         86.112      967.797
Circle Center At X =    68.957 ; Y =   977.144 ; and Radius =    19.544
       Factor of Safety
      ***    2.558   ***
```

Section C - C', Proposed East Slope - Long Term

n:\projects\active 13 projects\13004.01, rt. 340 over cub run\calcs and excel\gstabl\section c-c-proposed east slope long term.pl2 Run By: Chris McIntyre 11/18/2014 01:20PM



GSTABL7 v.2 FSmin=1.75

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
       ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
                   (All Rights Reserved-Unauthorized Use Prohibited)
    ******************************************************************************
                       SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    ******************************************************************************
    Analysis Run Date:        11/18/2014
    Time of Run:              01:20PM
    Run By:                   Chris McIntyre
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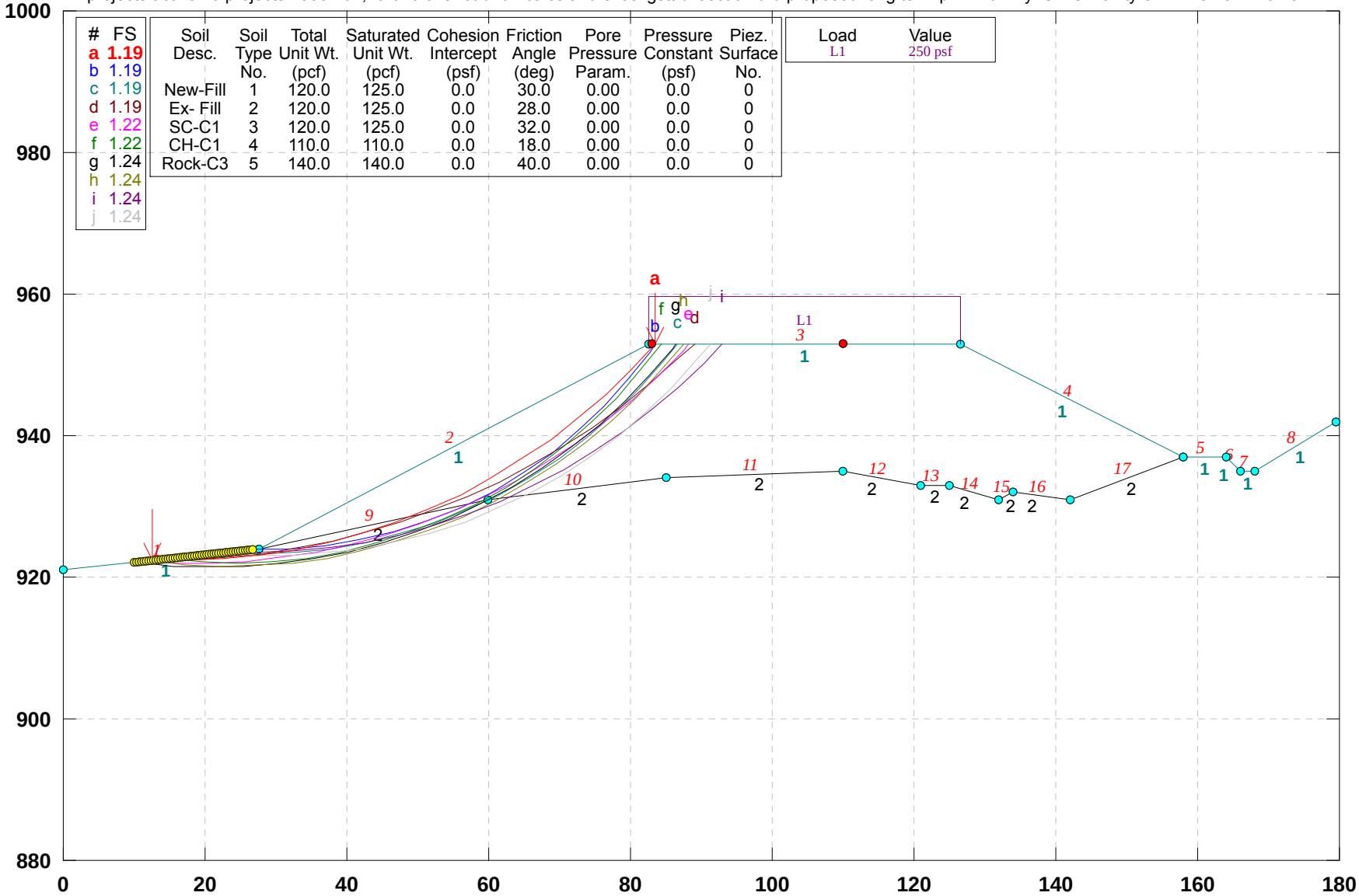
n\Calcs and Excel\GSTABL\section c-c-proposed east slope long term.in
    Output Filename:          N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section c-c-proposed east slope long term.OUT
    Unit System:              English
    Plotted Output Filename:  N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section c-c-proposed east slope long term.PLT
    PROBLEM DESCRIPTION:  Section C - C', Proposed East Slope - Lo
                          ng Term
    BOUNDARY COORDINATES
        9 Top   Boundaries
       12 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1         0.00     961.00      22.00     959.00        1
        2        22.00     959.00      34.00     953.00        1
        3        34.00     953.00      40.00     953.00        5
        4        40.00     953.00      41.00     952.00        5
        5        41.00     952.00      44.00     952.00        5
        6        44.00     952.00      54.00     957.00        5
        7        54.00     957.00      72.00     966.00        4
        8        72.00     966.00      83.00     971.00        3
        9        83.00     971.00     110.00     969.00        3
       10        72.00     966.00     110.00     966.00        4
       11        54.00     957.00     110.00     957.00        5
       12         0.00     953.00      34.00     953.00        5
    User Specified Y-Origin =       920.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0       0.0     30.0    0.00       0.0      0
      2   120.0    125.0       0.0     28.0    0.00       0.0      0
      3   120.0    125.0       0.0     32.0    0.00       0.0      0
      4   110.0    110.0       0.0     18.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1         78.00      915.26
        2        270.00      915.26
    Piezometric Surface No.  2 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1          0.00      901.83
        2         78.00      901.83
    WATER SURFACE DATA HAS BEEN SUPPRESSED
```

```
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1          68.00        92.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED
REINFORCING LAYER(S)
     4 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.00    941.26   1877.00     1.000
        2       136.00    941.26   1877.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.02    943.26   1877.00     1.000
        2       136.02    943.26   1877.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.05    945.26   1877.00     1.000
        2       136.05    945.26   1877.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.08    947.26   1877.00     1.000
        2       136.08    947.26   1877.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =  41.00(ft)
                              and  X =  44.00(ft)
 Each Surface Terminates Between   X =  85.00(ft)
                             and   X = 110.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   6.045   FS Min =   1.749   FS Ave =   4.011
          Standard Deviation =    1.076   Coefficient of Variation =   26.83 %
       Failure Surface Specified By 12 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         41.433      952.000
           2         46.399      951.421
           3         51.399      951.412
           4         56.368      951.971
           5         61.240      953.093
           6         65.954      954.762
           7         70.446      956.957
           8         74.659      959.649
           9         78.539      962.803
          10         82.034      966.379
          11         85.100      970.329
          12         85.399      970.822
```

```
Circle Center At X =    48.994 ; Y =   995.100 ; and Radius =    43.758
       Factor of Safety
      ***    1.749   ***
```

Section D - D', Proposed Conditions - Long Term

n:\projects\active 13 projects\13004.01, rt. 340 over cub run\calcs and excel\gstabl\section d-d proposed long term.pl2 Run By: Chris McIntyre 11/18/2014 01:31PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	0.0	30.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	0.0	28.0	0.00	0.0	0
SC-C1	3	120.0	125.0	0.0	32.0	0.00	0.0	0
CH-C1	4	110.0	110.0	0.0	18.0	0.00	0.0	0
Rock-C3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=1.19

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
      ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
                  (All Rights Reserved-Unauthorized Use Prohibited)
    ******************************************************************************
                        SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    ******************************************************************************
    Analysis Run Date:        11/18/2014
    Time of Run:              01:31PM
    Run By:                   Chris McIntyre
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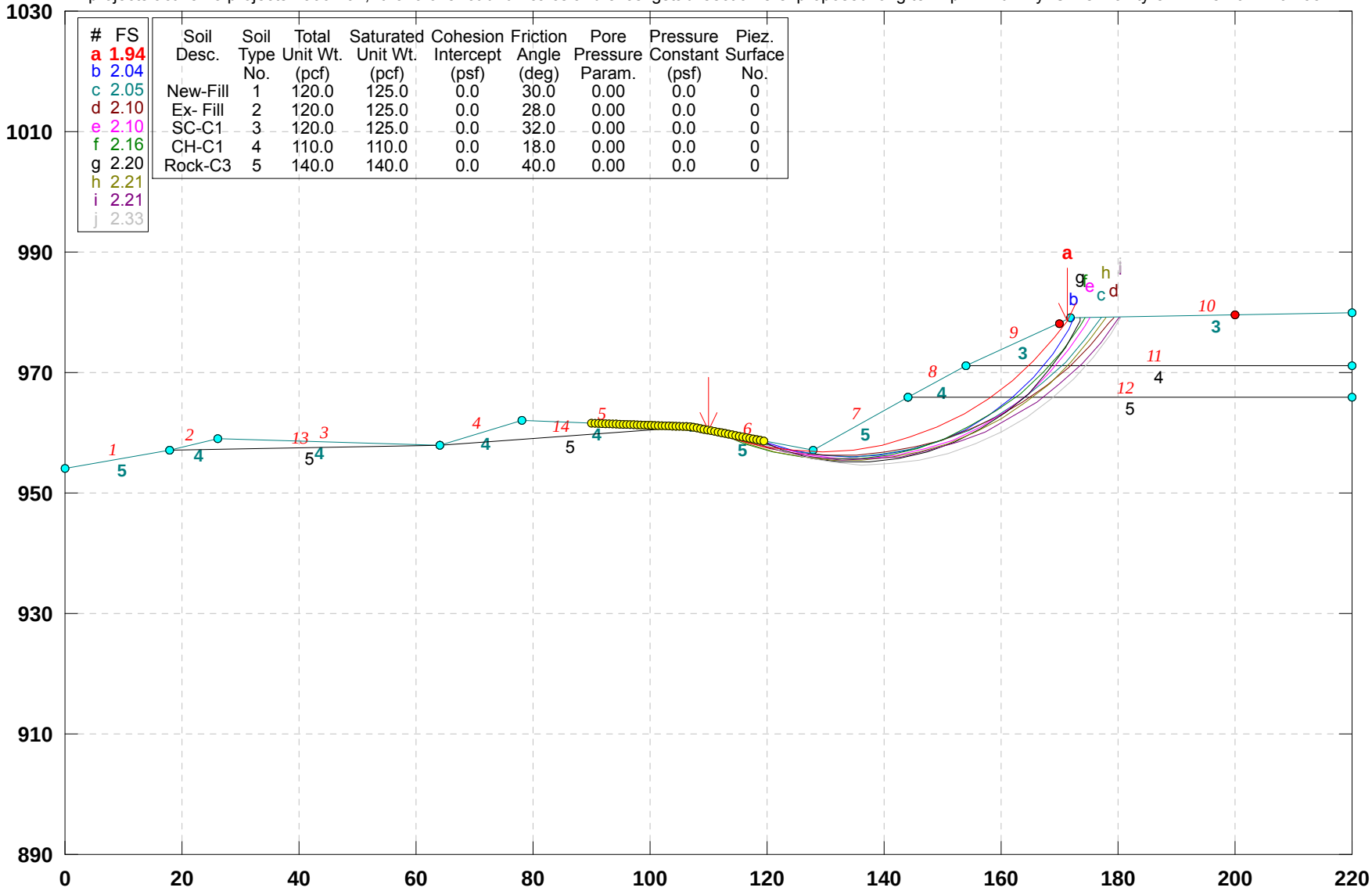
n\Calcs and Excel\GSTABL\section d-d proposed long term.in
    Output Filename:          N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section d-d proposed long term.OUT
    Unit System:              English
    Plotted Output Filename:  N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section d-d proposed long term.PLT
    PROBLEM DESCRIPTION:  Section D - D', Proposed Conditions - Lo
                          ng Term
    BOUNDARY COORDINATES
        8 Top   Boundaries
       17 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1         0.00     921.00      27.50     924.00        1
        2        27.50     924.00      82.50     953.00        1
        3        82.50     953.00     126.50     953.00        1
        4       126.50     953.00     158.00     937.00        1
        5       158.00     937.00     164.00     937.00        1
        6       164.00     937.00     166.00     935.00        1
        7       166.00     935.00     168.00     935.00        1
        8       168.00     935.00     179.50     942.00        1
        9        27.50     924.00      60.00     931.00        2
       10        60.00     931.00      85.00     934.00        2
       11        85.00     934.00     110.00     935.00        2
       12       110.00     935.00     121.00     933.00        2
       13       121.00     933.00     125.00     933.00        2
       14       125.00     933.00     132.00     931.00        2
       15       132.00     931.00     134.00     932.00        2
       16       134.00     932.00     142.00     931.00        2
       17       142.00     931.00     158.00     937.00        2
    User Specified Y-Origin =       880.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0       0.0     30.0    0.00       0.0      0
      2   120.0    125.0       0.0     28.0    0.00       0.0      0
      3   120.0    125.0       0.0     32.0    0.00       0.0      0
      4   110.0    110.0       0.0     18.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1         78.00      915.26
        2        270.00      915.26
    Piezometric Surface No.  2 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
```

```
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1          82.50       126.50       250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     3 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        27.50    924.00   2625.00     1.000
        2        67.50    924.00   2625.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        31.29    926.00   2625.00     1.000
        2        71.29    926.00   2625.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        35.09    928.00   2625.00     1.000
        2        75.09    928.00   2625.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =  10.00(ft)
                                and  X =  27.00(ft)
 Each Surface Terminates Between   X =  83.00(ft)
                               and   X = 110.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   2.609   FS Min =   1.185   FS Ave =   1.883
          Standard Deviation =    0.375   Coefficient of Variation =   19.90 %
       Failure Surface Specified By 18 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         12.453      922.359
           2         17.453      922.299
           3         22.448      922.519
           4         27.423      923.017
           5         32.362      923.792
           6         37.251      924.842
           7         42.073      926.162
           8         46.815      927.750
           9         51.460      929.600
          10         55.995      931.706
          11         60.405      934.061
          12         64.677      936.659
          13         68.798      939.492
          14         72.754      942.550
```

```
   15         76.533      945.823
   16         80.123      949.303
   17         83.514      952.978
   18         83.533      953.000
Circle Center At X =    16.014 ; Y =  1011.862 ; and Radius =    89.575
       Factor of Safety
      ***    1.185   ***
```

Section E - E', Proposed Conditions - Long Term

n:\projects\active 13 projects\13004.01, rt. 340 over cub run\calcs and excel\gstabl\section e-e'-proposed long term.pl2 Run By: Chris McIntyre 11/18/2014 01:33PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	0.0	30.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	0.0	28.0	0.00	0.0	0
SC-C1	3	120.0	125.0	0.0	32.0	0.00	0.0	0
CH-C1	4	110.0	110.0	0.0	18.0	0.00	0.0	0
Rock-C3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=1.94

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                          ** GSTABL7 by Garry H. Gregory, P.E. **
        ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
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    ****************************************************************************
                         SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    ****************************************************************************
    Analysis Run Date:        11/18/2014
    Time of Run:              01:33PM
    Run By:                   Chris McIntyre
    Input Data Filename:      N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section e-e'-proposed long term.in
    Output Filename:          N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section e-e'-proposed long term.OUT
    Unit System:              English
    Plotted Output Filename:  N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section e-e'-proposed long term.PLT
    PROBLEM DESCRIPTION:  Section E - E', Proposed Conditions - Lo
                          ng Term
    BOUNDARY COORDINATES
       10 Top   Boundaries
       14 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00     954.00      18.00     957.00        5
        2         18.00     957.00      26.00     959.00        4
        3         26.00     959.00      64.00     958.00        4
        4         64.00     958.00      78.00     962.00        4
        5         78.00     962.00     107.00     961.00        4
        6        107.00     961.00     128.00     957.00        5
        7        128.00     957.00     144.00     966.00        5
        8        144.00     966.00     154.00     971.00        4
        9        154.00     971.00     172.00     979.00        3
       10        172.00     979.00     220.00     980.00        3
       11        154.00     971.00     220.00     971.00        4
       12        144.00     966.00     220.00     966.00        5
       13         18.00     957.00      64.00     958.00        5
       14         64.00     958.00     107.00     961.00        5
    User Specified Y-Origin =       890.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0       0.0     30.0    0.00       0.0      0
      2   120.0    125.0       0.0     28.0    0.00       0.0      0
      3   120.0    125.0       0.0     32.0    0.00       0.0      0
      4   110.0    110.0       0.0     18.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1         78.00      915.26
        2        270.00      915.26
    Piezometric Surface No.  2 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1          0.00      901.83
```

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     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1          82.50       126.50       250.0           0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED
REINFORCING LAYER(S)
     3 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        27.50    924.00   2625.00     1.000
        2        62.50    924.00   2625.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        31.29    926.00   2625.00     1.000
        2        66.29    926.00   2625.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        35.09    928.00   2625.00     1.000
        2        70.09    928.00   2625.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =  90.00(ft)
                              and  X = 120.00(ft)
 Each Surface Terminates Between   X = 170.00(ft)
                            and   X = 200.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   5.513   FS Min =   1.941   FS Ave =   3.662
          Standard Deviation =    0.698   Coefficient of Variation =   19.06 %
       Failure Surface Specified By 15 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1        110.080      960.413
           2        114.822      958.828
           3        119.694      957.704
           4        124.651      957.053
           5        129.648      956.881
           6        134.639      957.189
           7        139.577      957.974
           8        144.417      959.229
           9        149.114      960.943
          10        153.625      963.099
          11        157.909      965.678
          12        161.925      968.656
          13        165.637      972.006
          14        169.011      975.696
          15        171.239      978.662
       Circle Center At X =   128.943 ; Y =  1008.938 ; and Radius =    52.062
```

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 Factor of Safety
***    1.941   ***
```

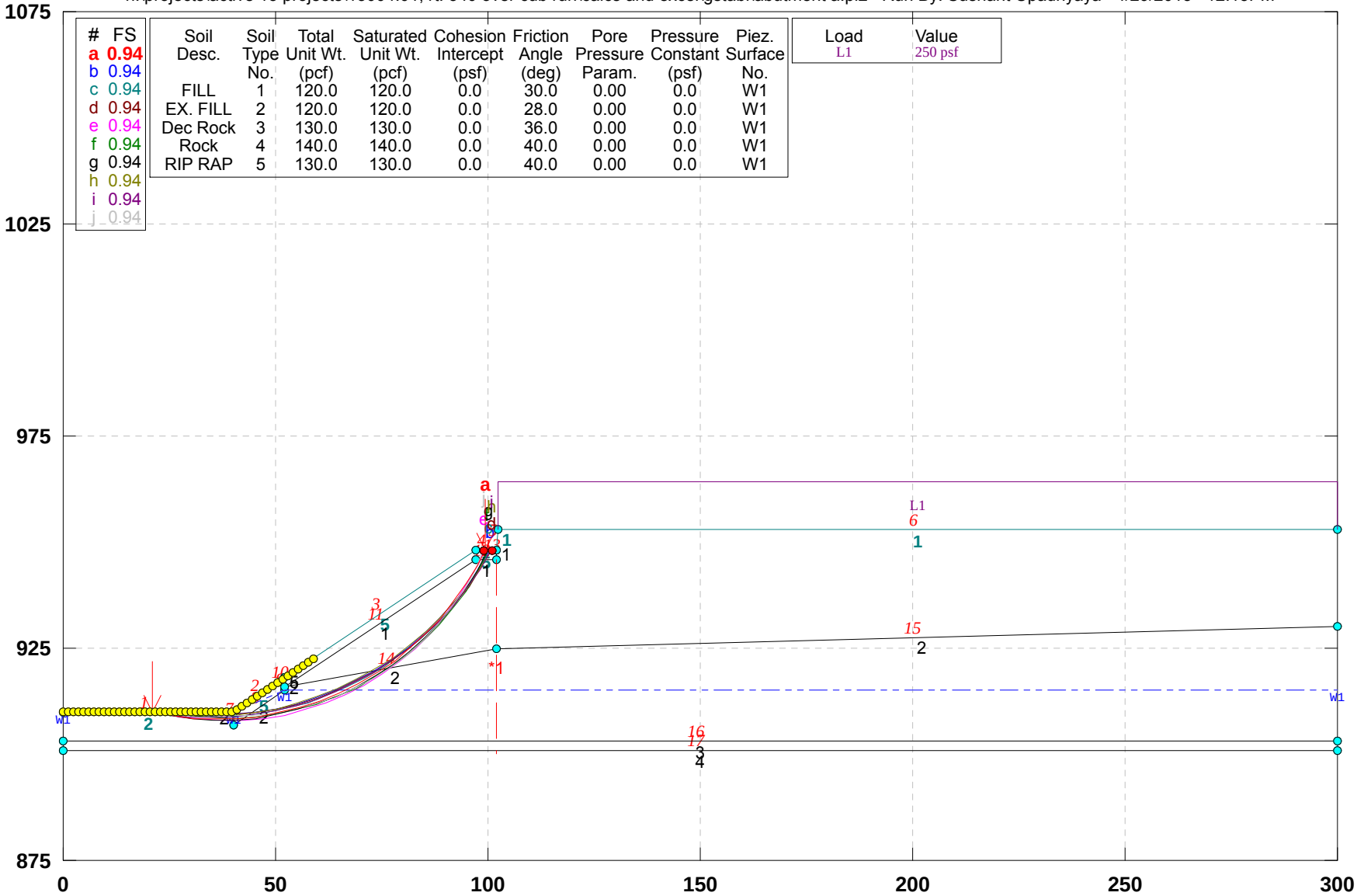
Route 340 over Cub Run Abutment A- Long Term

n:\projects\active 13 projects\13004.01, rt. 340 over cub run\calcs and excel\gstabl\abutment a.pl2 Run By: Sushant Upadhyaya 4/29/2015 12:15PM

#	FS
a	0.94
b	0.94
c	0.94
d	0.94
e	0.94
f	0.94
g	0.94
h	0.94
i	0.94
j	0.94

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
FILL	1	120.0	120.0	0.0	30.0	0.00	0.0	W1
EX. FILL	2	120.0	120.0	0.0	28.0	0.00	0.0	W1
Dec Rock	3	130.0	130.0	0.0	36.0	0.00	0.0	W1
Rock	4	140.0	140.0	0.0	40.0	0.00	0.0	W1
RIP RAP	5	130.0	130.0	0.0	40.0	0.00	0.0	W1

Load	Value
L1	250 psf



GSTABL7 v.2 FSmin=0.94

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
      ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
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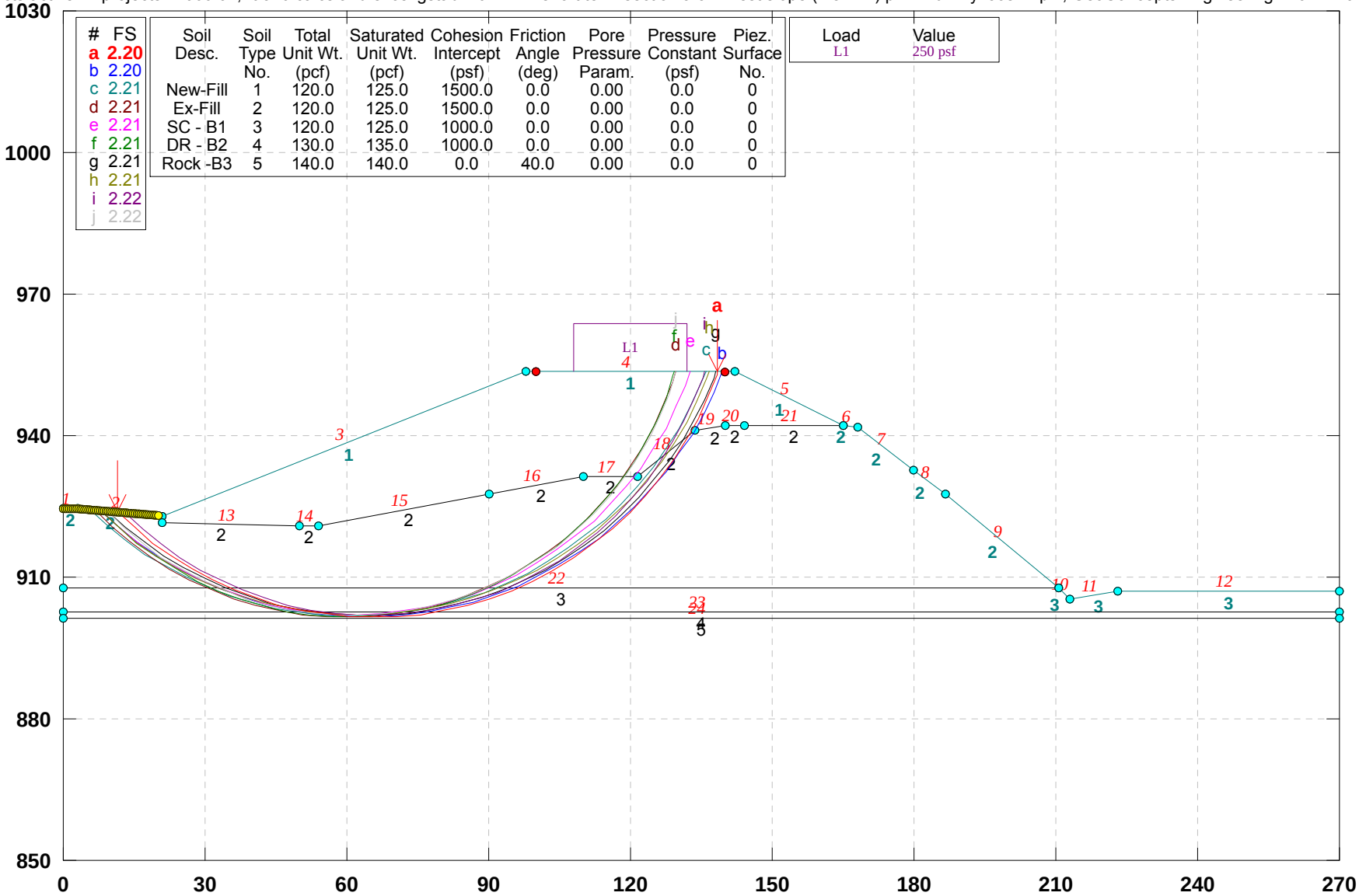
    ******************************************************************************
                        SLOPE STABILITY ANALYSIS SYSTEM
            Modified Bishop, Simplified Janbu, or GLE Method of Slices.
            (Includes Spencer & Morgenstern-Price Type Analysis)
            Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
            Nonlinear Undrained Shear Strength, Curved Phi Envelope,
            Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
            Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    ******************************************************************************
    Analysis Run Date:        4/29/2015
    Time of Run:              12:15PM
    Run By:                   Sushant Upadhyaya
    Input Data Filename:      N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\abutment a.in
    Output Filename:          N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\abutment a.OUT
    Unit System:              English
    Plotted Output Filename:  N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\abutment a.PLT
    PROBLEM DESCRIPTION:  Route 340 over Cub Run
                          Abutment A- Long Term
    BOUNDARY COORDINATES
        6 Top   Boundaries
       17 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1         0.00     910.00      40.10     910.00        2
        2        40.10     910.00      52.20     918.00        5
        3        52.20     918.00      97.00     948.00        5
        4        97.00     948.00     102.10     948.00        5
        5       102.10     948.00     102.20     953.00        1
        6       102.20     953.00     300.00     953.00        1
        7        40.10     910.00      40.20     907.00        2
        8        40.20     907.00      52.00     915.00        2
        9        52.00     915.00      52.10     916.00        2
       10        52.10     916.00      52.20     918.00        5
       11        52.10     916.00      97.00     946.00        1
       12        97.00     946.00     102.00     946.00        1
       13       102.00     946.00     102.10     948.00        1
       14        52.10     916.00     102.00     925.00        2
       15       102.00     925.00     300.00     930.00        2
       16         0.00     903.00     300.00     903.00        3
       17         0.00     901.00     300.00     901.00        4
    User Specified Y-Origin =       875.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    120.0       0.0     30.0    0.00       0.0      1
      2   120.0    120.0       0.0     28.0    0.00       0.0      1
      3   130.0    130.0       0.0     36.0    0.00       0.0      1
      4   140.0    140.0       0.0     40.0    0.00       0.0      1
      5   130.0    130.0       0.0     40.0    0.00       0.0      1
    1 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  4 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1         0.00      910.00
        2        40.10      910.00
        3        52.00      915.00
        4       300.00      915.00
```

```
   BOUNDARY LOAD(S)
        1 Load(s) Specified
    Load        X-Left      X-Right     Intensity     Deflection
     No.         (ft)         (ft)        (psf)          (deg)
      1         102.20       300.00       250.0           0.0
    NOTE - Intensity Is Specified As A Uniformly Distributed
           Force Acting On A Horizontally Projected Surface.
   Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
    Of Which The First  0 Boundaries Will Deflect Surfaces Upward
    Boundary     X-Left     Y-Left    X-Right    Y-Right
       No.        (ft)       (ft)       (ft)       (ft)
        1        102.00     946.00     102.00     900.00
   REINFORCING LAYER(S)
        4 REINFORCING LAYER(S) SPECIFIED
    REINFORCING LAYER NO.   1
      2 POINTS DEFINE THIS LAYER
         POINT     X-COORD   Y-COORD   FORCE   INCLINATION
          NO.                                   FACTOR
           1        63.00    922.00   4000.00     1.000
           2        93.00    922.00   4000.00     1.000
    REINFORCING LAYER NO.   2
      2 POINTS DEFINE THIS LAYER
         POINT     X-COORD   Y-COORD   FORCE   INCLINATION
          NO.                                   FACTOR
           1        63.00    925.00   4000.00     1.000
           2        93.00    925.00   4000.00     1.000
    REINFORCING LAYER NO.   3
      2 POINTS DEFINE THIS LAYER
         POINT     X-COORD   Y-COORD   FORCE   INCLINATION
          NO.                                   FACTOR
           1        67.13    928.00   4000.00     1.000
           2        97.13    928.00   4000.00     1.000
    REINFORCING LAYER NO.   4
      2 POINTS DEFINE THIS LAYER
         POINT     X-COORD   Y-COORD   FORCE   INCLINATION
          NO.                                   FACTOR
           1        71.61    931.00   4000.00     1.000
           2       101.61    931.00   4000.00     1.000
    REINFORCING LAYER DATA HAS BEEN SUPPRESSED
    A Critical Failure Surface Searching Method, Using A Random
    Technique For Generating Circular Surfaces, Has Been Specified.
     500 Trial Surfaces Have Been Generated.
       1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
    Along The Ground Surface Between  X =   0.00(ft)
                                  and  X =  60.00(ft)
    Each Surface Terminates Between   X =  99.00(ft)
                                 and   X = 101.00(ft)
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =      0.00(ft)
     5.00(ft) Line Segments Define Each Trial Failure Surface.
    ****  ERROR - RC11  ****
>>200 attempts to generate failure surface have failed. Revise limitations
    Following Are Displayed The Ten Most Critical Of The Trial
          Failure Surfaces Evaluated. They Are
          Ordered - Most Critical First.
          * * Safety Factors Are Calculated By The Modified Bishop Method * *
          Total Number of Trial Surfaces Attempted =   500
          Number of Failed Attempts to Generate Trial Surface  =  210
          Number of Trial Surfaces With Valid FS =  290
          Percentage of Trial Surfaces With Non-Valid FS Solutions
          of the Total Attempted =  42.0 %
          Statistical Data On All Valid FS Values:
             FS Max =   2.112   FS Min =   0.935   FS Ave =   1.178
             Standard Deviation =    0.206   Coefficient of Variation =   17.52 %
          Failure Surface Specified By 20 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
              1         20.922      910.000
              2         25.834      909.066
              3         30.800      908.487
```

```
     4         35.795      908.266
     5         40.793      908.403
     6         45.769      908.899
     7         50.696      909.750
     8         55.549      910.953
     9         60.304      912.500
    10         64.935      914.385
    11         69.419      916.597
    12         73.733      919.124
    13         77.855      921.955
    14         81.762      925.074
    15         85.437      928.465
    16         88.858      932.111
    17         92.009      935.994
    18         94.874      940.092
    19         97.437      944.385
    20         99.257      948.000
Circle Center At X =    36.386 ; Y =   977.864 ; and Radius =    69.603
       Factor of Safety
      ***    0.935   ***
```

Section A-A' - West Slope Proposed 2.5H:1V - Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - west slope (2.5h-1v).pl2 Run By: Josh April, GeoConcepts Engineering 10/22/2014 05:46PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex-Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock -B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=2.20

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
          ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
              (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
         Modified Bishop, Simplified Janbu, or GLE Method of Slices.
         (Includes Spencer & Morgenstern-Price Type Analysis)
         Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
         Nonlinear Undrained Shear Strength, Curved Phi Envelope,
         Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
         Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/22/2014
Time of Run:              05:46PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - west slope (2.5h-1v).in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - west slope (2.5h-1v).OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - west slope (2.5h-1v).PLT
PROBLEM DESCRIPTION:  Section A-A' - West Slope Proposed 2.5H:
                      1V - Short Term
BOUNDARY COORDINATES
   12 Top   Boundaries
   24 Total Boundaries
```

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	924.50	3.00	924.50	2
2	3.00	924.50	21.00	923.00	2
3	21.00	923.00	98.00	953.58	1
4	98.00	953.58	142.00	953.47	1
5	142.00	953.47	165.00	941.97	1
6	165.00	941.97	168.00	941.96	2
7	168.00	941.96	180.00	932.76	2
8	180.00	932.76	186.50	927.76	2
9	186.50	927.76	210.50	907.60	2
10	210.50	907.60	213.00	905.50	3
11	213.00	905.50	223.00	907.00	3
12	223.00	907.00	270.00	907.00	3
13	21.00	921.58	50.00	921.00	2
14	50.00	921.00	54.00	921.00	2
15	54.00	921.00	90.00	927.76	2
16	90.00	927.76	110.00	931.50	2
17	110.00	931.50	121.50	931.50	2
18	121.50	931.50	133.50	941.00	2
19	133.50	941.00	140.00	942.00	2
20	140.00	942.00	144.00	942.00	2
21	144.00	942.00	165.00	941.97	2
22	0.00	907.60	210.50	907.60	3
23	0.00	902.76	270.00	902.76	4
24	0.00	901.26	270.00	901.26	5

```
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
```

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	125.0	1500.0	0.0	0.00	0.0	0
2	120.0	125.0	1500.0	0.0	0.00	0.0	0
3	120.0	125.0	1000.0	0.0	0.00	0.0	0
4	130.0	135.0	1000.0	0.0	0.00	0.0	0
5	140.0	140.0	0.0	40.0	0.00	0.0	0

```
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
```

```
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      915.26
     2        192.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1        192.00      901.83
     2        270.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         108.00       132.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  20.50(ft)
 Each Surface Terminates Between   X = 100.00(ft)
                               and   X = 140.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   5.959   FS Min =   2.204   FS Ave =   2.916
          Standard Deviation =    0.586   Coefficient of Variation =   20.09 %
       Failure Surface Specified By 33 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         11.421      923.798
           2         15.085      920.396
           3         18.962      917.239
           4         23.036      914.340
           5         27.289      911.711
           6         31.703      909.363
           7         36.261      907.306
           8         40.942      905.550
           9         45.727      904.100
          10         50.597      902.964
          11         55.529      902.146
          12         60.504      901.650
          13         65.501      901.477
          14         70.499      901.629
          15         75.477      902.104
          16         80.413      902.901
          17         85.287      904.016
          18         90.078      905.446
          19         94.767      907.182
          20         99.333      909.220
          21        103.757      911.549
          22        108.021      914.160
          23        112.107      917.042
          24        115.998      920.182
          25        119.676      923.569
          26        123.128      927.187
          27        126.337      931.021
          28        129.291      935.055
```

```
   29        131.977      939.272
   30        134.384      943.654
   31        136.502      948.184
   32        138.322      952.841
   33        138.525      953.479
Circle Center At X =    65.665 ; Y =   978.548 ; and Radius =    77.071
       Factor of Safety
      ***    2.204   ***
```

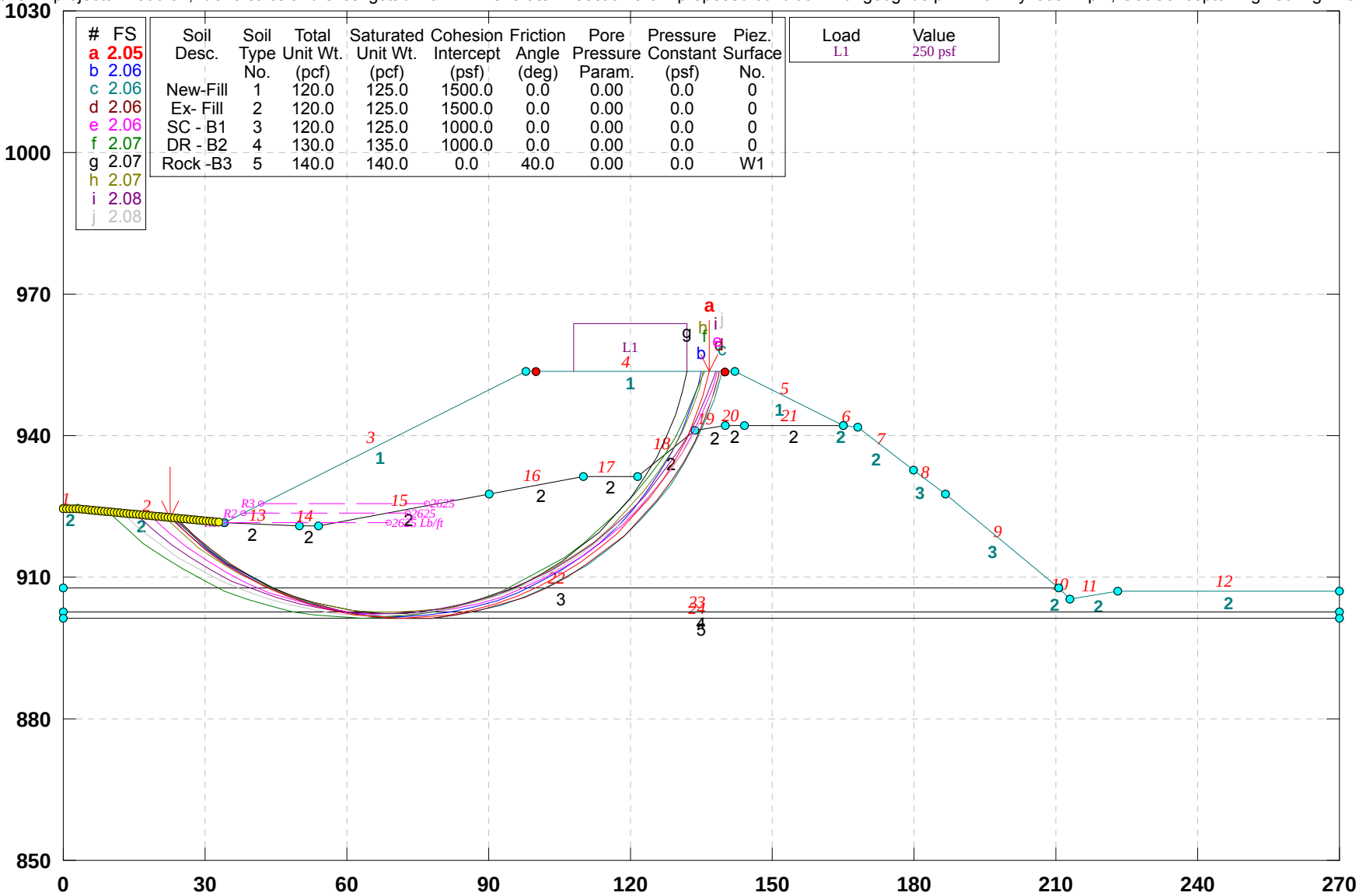
Section A-A'- West Slope Proposed 2H:1V- with Geogrids - Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - proposed condition with geogrids.pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 12:5

#	FS
a	2.05
b	2.06
c	2.06
d	2.06
e	2.06
f	2.07
g	2.07
h	2.07
i	2.08
j	2.08

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock -B3	5	140.0	140.0	0.0	40.0	0.00	0.0	W1

Load	Value
L1	250 psf



GSTABL7 v.2 FSmin=2.05

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
            ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
        Modified Bishop, Simplified Janbu, or GLE Method of Slices.
        (Includes Spencer & Morgenstern-Price Type Analysis)
        Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
        Nonlinear Undrained Shear Strength, Curved Phi Envelope,
        Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
        Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/23/2014
Time of Run:              12:50PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed condition with geogrids.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed condition with geogrids.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed condition with geogrids.PLT
PROBLEM DESCRIPTION:  Section  A-A'- West Slope Proposed 2H:1V
                      - with Geogrids - Short Term
BOUNDARY COORDINATES
   12 Top   Boundaries
   24 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1         0.00     924.50       3.00     924.50        2
    2         3.00     924.50      34.00     921.58        2
    3        34.00     921.58      98.00     953.58        1
    4        98.00     953.58     142.00     953.47        1
    5       142.00     953.47     165.00     941.97        1
    6       165.00     941.97     168.00     941.96        2
    7       168.00     941.96     180.00     932.76        2
    8       180.00     932.76     186.50     927.76        3
    9       186.50     927.76     210.50     907.60        3
   10       210.50     907.60     213.00     905.50        2
   11       213.00     905.50     223.00     907.00        2
   12       223.00     907.00     270.00     907.00        2
   13        34.00     921.58      50.00     921.00        2
   14        50.00     921.00      54.00     921.00        2
   15        54.00     921.00      90.00     927.76        2
   16        90.00     927.76     110.00     931.50        2
   17       110.00     931.50     121.50     931.50        2
   18       121.50     931.50     133.50     941.00        2
   19       133.50     941.00     140.00     942.00        2
   20       140.00     942.00     144.00     942.00        2
   21       144.00     942.00     165.00     941.97        2
   22         0.00     907.60     210.50     907.60        3
   23         0.00     902.76     270.00     902.76        4
   24         0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0    1500.0      0.0    0.00       0.0      0
  2   120.0    125.0    1500.0      0.0    0.00       0.0      0
  3   120.0    125.0    1000.0      0.0    0.00       0.0      0
  4   130.0    135.0    1000.0      0.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      1
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
```

```
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      915.26
     2        192.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1        192.00      901.83
     2        270.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         108.00       132.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     3 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        34.00    921.58   2625.00     1.000
        2        69.00    921.58   2625.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        38.00    923.58   2625.00     1.000
        2        73.00    923.58   2625.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        42.00    925.58   2625.00     1.000
        2        77.00    925.58   2625.00     1.000
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  33.50(ft)
 Each Surface Terminates Between   X = 100.00(ft)
                               and   X = 140.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   6.304   FS Min =   2.051   FS Ave =   2.787
          Standard Deviation =    0.691   Coefficient of Variation =   24.80 %
       Failure Surface Specified By 30 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1        22.624      922.652
           2        26.164      919.120
           3        29.958      915.863
           4        33.984      912.899
           5        38.222      910.245
           6        42.646      907.915
           7        47.231      905.922
           8        51.954      904.279
```

9	56.785	902.993
10	61.700	902.072
11	66.669	901.521
12	71.666	901.344
13	76.662	901.541
14	81.630	902.111
15	86.541	903.051
16	91.367	904.356
17	96.083	906.019
18	100.661	908.029
19	105.075	910.377
20	109.302	913.048
21	113.317	916.028
22	117.098	919.299
23	120.624	922.845
24	123.874	926.644
25	126.831	930.676
26	129.479	934.918
27	131.801	939.346
28	133.786	943.935
29	135.422	948.660
30	136.697	953.483

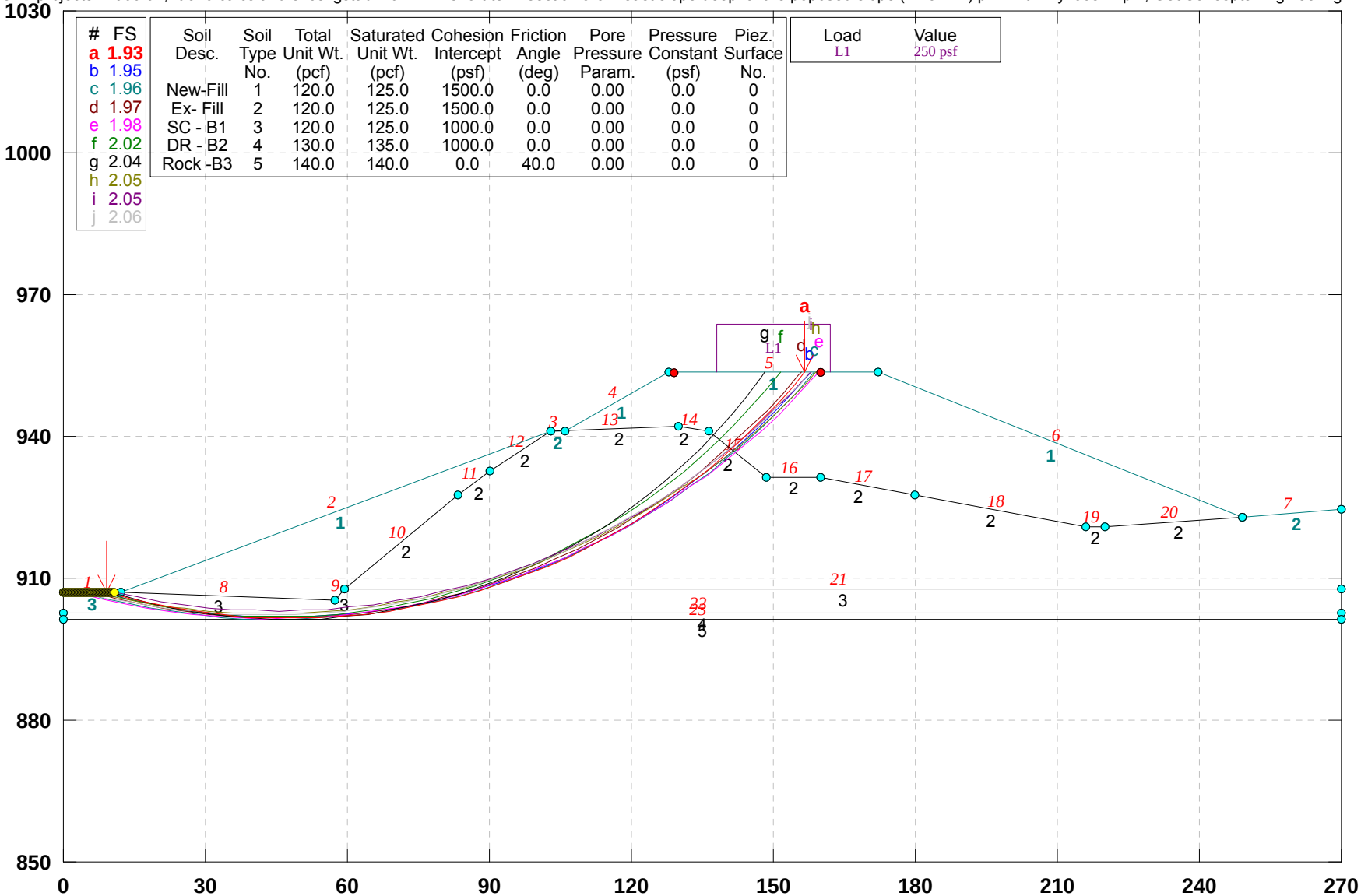
Circle Center At X = 71.534 ; Y = 968.132 ; and Radius = 66.788

Factor of Safety

*** 2.051 ***

Section - A-A'- Proposed East Slope 2.75H:1V - Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - east slope deep failure poposed slope (2.75h-1v).pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 12



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock -B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=1.93

Safety Factors Are Calculated By The Modified Bishop Method

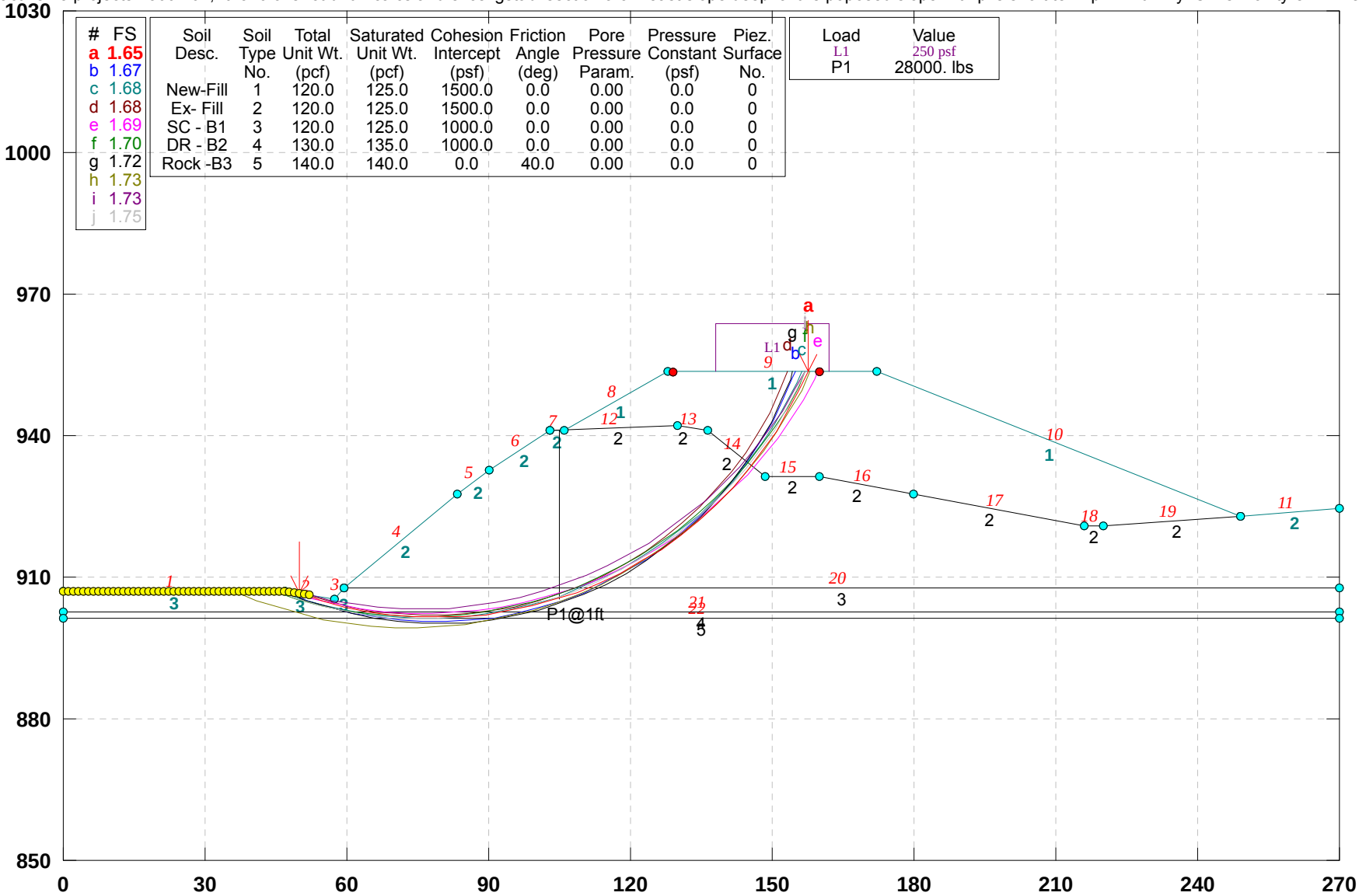
```
                                   ***  GSTABL7  ***
                        ** GSTABL7 by Garry H. Gregory, P.E. **
        ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
                   (All Rights Reserved-Unauthorized Use Prohibited)
    ******************************************************************************
                        SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    ******************************************************************************
    Analysis Run Date:        11/18/2014
    Time of Run:              01:35PM
    Run By:                   Chris McIntyre
    Input Data Filename:      N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section a-a' - east slope deep failure poposed slope with pile short term.i
    Output Filename:          N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section a-a' - east slope deep failure poposed slope with pile short term.O
    Unit System:              English
    Plotted Output Filename:  N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section a-a' - east slope deep failure poposed slope with pile short term.P
    PROBLEM DESCRIPTION:  Section A - A', Proposed East Slope 2H:1
                          V with Pier - Short Term
    BOUNDARY COORDINATES
       11 Top   Boundaries
       22 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00     907.00      47.00     907.00        3
        2         47.00     907.00      57.50     905.50        3
        3         57.50     905.50      59.50     907.60        3
        4         59.50     907.60      83.50     927.76        2
        5         83.50     927.76      90.00     932.76        2
        6         90.00     932.76     103.00     941.26        2
        7        103.00     941.26     106.00     941.26        2
        8        106.00     941.26     128.00     953.47        1
        9        128.00     953.47     172.00     953.59        1
       10        172.00     953.59     249.00     923.00        1
       11        249.00     923.00     270.00     924.50        2
       12        103.00     941.26     130.00     942.00        2
       13        130.00     942.00     136.50     941.00        2
       14        136.50     941.00     148.50     931.50        2
       15        148.50     931.50     160.00     931.50        2
       16        160.00     931.50     180.00     927.76        2
       17        180.00     927.76     216.00     921.00        2
       18        216.00     921.00     220.00     921.00        2
       19        220.00     921.00     249.00     923.00        2
       20         59.50     907.60     270.00     907.60        3
       21          0.00     902.76     270.00     902.76        4
       22          0.00     901.26     270.00     901.26        5
    User Specified Y-Origin =       850.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0    1500.0      0.0    0.00       0.0      0
      2   120.0    125.0    1500.0      0.0    0.00       0.0      0
      3   120.0    125.0    1000.0      0.0    0.00       0.0      0
      4   130.0    135.0    1000.0      0.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
```

```
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        105.00     941.26     105.10     905.26
 SEARCH LIMIT BOUNDARY DATA HAS BEEN SUPPRESSED
PIER/PILE LOAD(S)
     1 Pier/Pile Load(s) Specified
Pier/Pile  X-Pos    Y-Pos     Load    Spacing  Inclination  Length
   No.     (ft)     (ft)      (lbs)     (ft)      (deg)      (ft)
    1     105.00   941.26    28000.0     1.0      90.00       36.0
 NOTE - An Equivalent Line Load Is Calculated For Each Row Of Piers/Piles
        Assuming A Uniform Distribution Of Load Horizontally Between
        Individual Piers/Piles.
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  53.00(ft)
 Each Surface Terminates Between   X = 129.00(ft)
                               and   X = 160.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   3.543   FS Min =   1.650   FS Ave =   2.516
          Standard Deviation =    0.416   Coefficient of Variation =   16.55 %
       Failure Surface Specified By 27 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         49.920      906.583
           2         54.670      905.021
           3         59.503      903.740
           4         64.403      902.744
           5         69.352      902.037
           6         74.335      901.622
           7         79.334      901.499
           8         84.331      901.669
           9         89.309      902.132
          10         94.252      902.885
          11         99.142      903.927
          12        103.963      905.254
          13        108.698      906.861
          14        113.330      908.742
          15        117.844      910.892
          16        122.225      913.303
```

```
      17        126.457      915.966
      18        130.525      918.873
      19        134.416      922.013
      20        138.117      925.375
      21        141.614      928.949
      22        144.895      932.721
      23        147.950      936.680
      24        150.768      940.810
      25        153.339      945.098
      26        155.654      949.530
      27        157.463      953.550
   Circle Center At X =    78.930 ; Y =   986.791 ; and Radius =    85.293
          Factor of Safety
        ***    1.650   ***
```

Section A - A', Proposed East Slope 2H:1V with Pier - Short Term

n:\projects\active 13 projects\13004.01, rt. 340 over cub run\calcs and excel\gstabl\section a-a' - east slope deep failure poposed slope with pile short term.pl2 Run By: Chris McIntyre 11/18/2014 01:35P



#	FS
a	1.65
b	1.67
c	1.68
d	1.68
e	1.69
f	1.70
g	1.72
h	1.73
i	1.73
j	1.75

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock -B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

Load	Value
L1	250 psf
P1	28000. lbs

GSTABL7 v.2 FSmin=1.65

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
          ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
        Modified Bishop, Simplified Janbu, or GLE Method of Slices.
        (Includes Spencer & Morgenstern-Price Type Analysis)
        Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
        Nonlinear Undrained Shear Strength, Curved Phi Envelope,
        Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
        Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/23/2014
Time of Run:              12:47PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope (2.75h-1v).in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope (2.75h-1v).OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope (2.75h-1v).PLT
PROBLEM DESCRIPTION:  Section - A-A'- Proposed East Slope 2.75
                      H:1V - Short Term
BOUNDARY COORDINATES
    7 Top   Boundaries
   23 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1         0.00     907.00      12.00     907.00        3
    2        12.00     907.00     103.00     941.26        1
    3       103.00     941.26     106.00     941.26        2
    4       106.00     941.26     128.00     953.47        1
    5       128.00     953.47     172.00     953.59        1
    6       172.00     953.59     249.00     923.00        1
    7       249.00     923.00     270.00     924.50        2
    8        12.00     907.00      57.50     905.50        3
    9        57.50     905.50      59.50     907.60        3
   10        59.50     907.60      83.50     927.76        2
   11        83.50     927.76      90.00     932.76        2
   12        90.00     932.76     103.00     941.26        2
   13       103.00     941.26     130.00     942.00        2
   14       130.00     942.00     136.50     941.00        2
   15       136.50     941.00     148.50     931.50        2
   16       148.50     931.50     160.00     931.50        2
   17       160.00     931.50     180.00     927.76        2
   18       180.00     927.76     216.00     921.00        2
   19       216.00     921.00     220.00     921.00        2
   20       220.00     921.00     249.00     923.00        2
   21        59.50     907.60     270.00     907.60        3
   22         0.00     902.76     270.00     902.76        4
   23         0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0    1500.0      0.0    0.00       0.0      0
  2   120.0    125.0    1500.0      0.0    0.00       0.0      0
  3   120.0    125.0    1000.0      0.0    0.00       0.0      0
  4   130.0    135.0    1000.0      0.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
```

```
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        105.00     941.26     105.10     906.26
 SEARCH LIMIT BOUNDARY DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  11.00(ft)
 Each Surface Terminates Between   X = 129.00(ft)
                               and   X = 160.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   4.116   FS Min =   1.926   FS Ave =   3.204
          Standard Deviation =    0.627   Coefficient of Variation =   19.56 %
       Failure Surface Specified By 34 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1          9.281      907.000
           2         14.107      905.694
           3         18.977      904.562
           4         23.885      903.606
           5         28.824      902.827
           6         33.788      902.227
           7         38.770      901.805
           8         43.764      901.562
           9         48.764      901.499
          10         53.762      901.617
          11         58.753      901.913
          12         63.731      902.389
          13         68.688      903.044
          14         73.618      903.877
          15         78.515      904.886
          16         83.373      906.070
          17         88.184      907.429
          18         92.944      908.960
          19         97.646      910.661
          20        102.284      912.530
          21        106.851      914.564
          22        111.342      916.761
          23        115.752      919.119
```

24	120.074	921.633
25	124.302	924.301
26	128.432	927.120
27	132.458	930.085
28	136.375	933.193
29	140.177	936.440
30	143.860	939.822
31	147.419	943.333
32	150.850	946.971
33	154.147	950.729
34	156.446	953.548

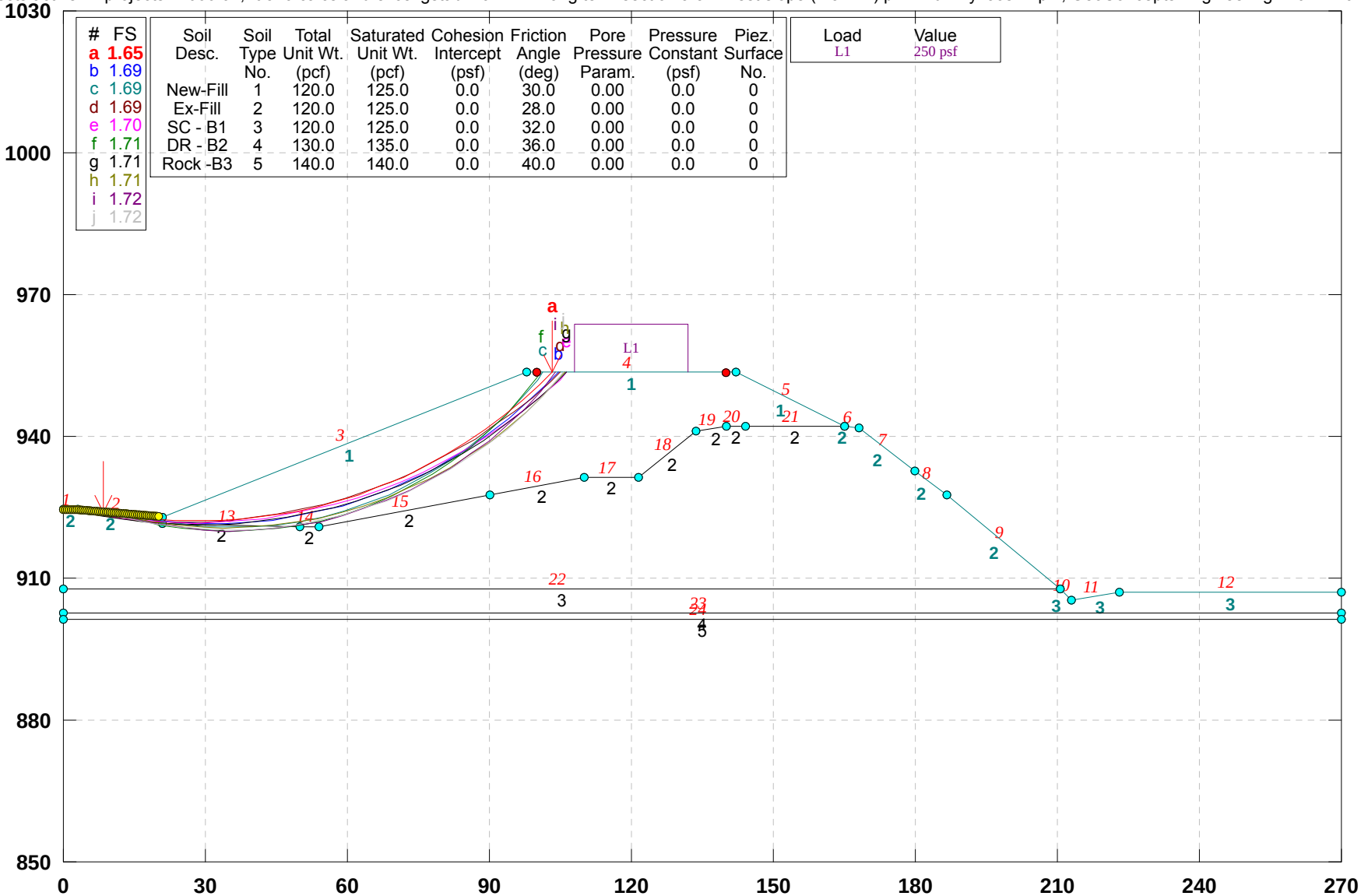
Circle Center At X = 48.008 ; Y = 1040.474 ; and Radius = 138.978

Factor of Safety

*** 1.926 ***

Section A-A' - West Slope Proposed 2.5H:1V - Long Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section a-a' - west slope (2.5h-1v).pl2 Run By: Josh April, GeoConcepts Engineering 10/22/2014 05:00PM



GSTABL7 v.2 FSmin=1.65

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
      ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
                   (All Rights Reserved-Unauthorized Use Prohibited)
   ***************************************************************************
                         SLOPE STABILITY ANALYSIS SYSTEM
          Modified Bishop, Simplified Janbu, or GLE Method of Slices.
          (Includes Spencer & Morgenstern-Price Type Analysis)
          Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
          Nonlinear Undrained Shear Strength, Curved Phi Envelope,
          Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
          Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
   ***************************************************************************
   Analysis Run Date:        10/22/2014
   Time of Run:              05:00PM
   Run By:                   Josh April, GeoConcepts Engineering
   Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - west slope (2.5h-1v).in
   Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - west slope (2.5h-1v).OUT
   Unit System:              English
   Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - west slope (2.5h-1v).PLT
   PROBLEM DESCRIPTION:  Section A-A' - West Slope Proposed 2.5H:
                          1V - Long Term
   BOUNDARY COORDINATES
      12 Top   Boundaries
      24 Total Boundaries
   Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
      No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
       1         0.00     924.50       3.00     924.50        2
       2         3.00     924.50      21.00     923.00        2
       3        21.00     923.00      98.00     953.58        1
       4        98.00     953.58     142.00     953.47        1
       5       142.00     953.47     165.00     941.97        1
       6       165.00     941.97     168.00     941.96        2
       7       168.00     941.96     180.00     932.76        2
       8       180.00     932.76     186.50     927.76        2
       9       186.50     927.76     210.50     907.60        2
      10       210.50     907.60     213.00     905.50        3
      11       213.00     905.50     223.00     907.00        3
      12       223.00     907.00     270.00     907.00        3
      13        21.00     921.58      50.00     921.00        2
      14        50.00     921.00      54.00     921.00        2
      15        54.00     921.00      90.00     927.76        2
      16        90.00     927.76     110.00     931.50        2
      17       110.00     931.50     121.50     931.50        2
      18       121.50     931.50     133.50     941.00        2
      19       133.50     941.00     140.00     942.00        2
      20       140.00     942.00     144.00     942.00        2
      21       144.00     942.00     165.00     941.97        2
      22         0.00     907.60     210.50     907.60        3
      23         0.00     902.76     270.00     902.76        4
      24         0.00     901.26     270.00     901.26        5
   User Specified Y-Origin =       850.00(ft)
   Default X-Plus Value = 0.00(ft)
   Default Y-Plus Value = 0.00(ft)
  ISOTROPIC SOIL PARAMETERS
    5 Type(s) of Soil
   Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
   Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
    No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
     1   120.0    125.0       0.0      30.0    0.00       0.0      0
     2   120.0    125.0       0.0      28.0    0.00       0.0      0
     3   120.0    125.0       0.0      32.0    0.00       0.0      0
     4   130.0    135.0       0.0      36.0    0.00       0.0      0
     5   140.0    140.0       0.0      40.0    0.00       0.0      0
   2 PIEZOMETRIC SURFACE(S) SPECIFIED
   Unit Weight of Water =  62.40 (pcf)
   Piezometric Surface No.  1 Specified by  2 Coordinate Points
```

```
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      915.26
     2        192.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1        192.00      901.83
     2        270.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         108.00       132.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  20.50(ft)
 Each Surface Terminates Between   X = 100.00(ft)
                               and   X = 140.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   3.708   FS Min =   1.647   FS Ave =   2.462
          Standard Deviation =    0.472   Coefficient of Variation =   19.16 %
       Failure Surface Specified By 22 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1          8.340      924.055
           2         13.266      923.201
           3         18.228      922.584
           4         23.214      922.206
           5         28.212      922.068
           6         33.211      922.169
           7         38.199      922.510
           8         43.165      923.091
           9         48.098      923.908
          10         52.986      924.962
          11         57.817      926.249
          12         62.582      927.766
          13         67.267      929.510
          14         71.864      931.477
          15         76.362      933.662
          16         80.749      936.060
          17         85.016      938.667
          18         89.153      941.474
          19         93.151      944.477
          20         97.000      947.669
          21        100.691      951.041
          22        103.202      953.567
       Circle Center At X =    28.601 ; Y =  1026.146 ; and Radius =   104.082
              Factor of Safety
            ***    1.647   ***
```

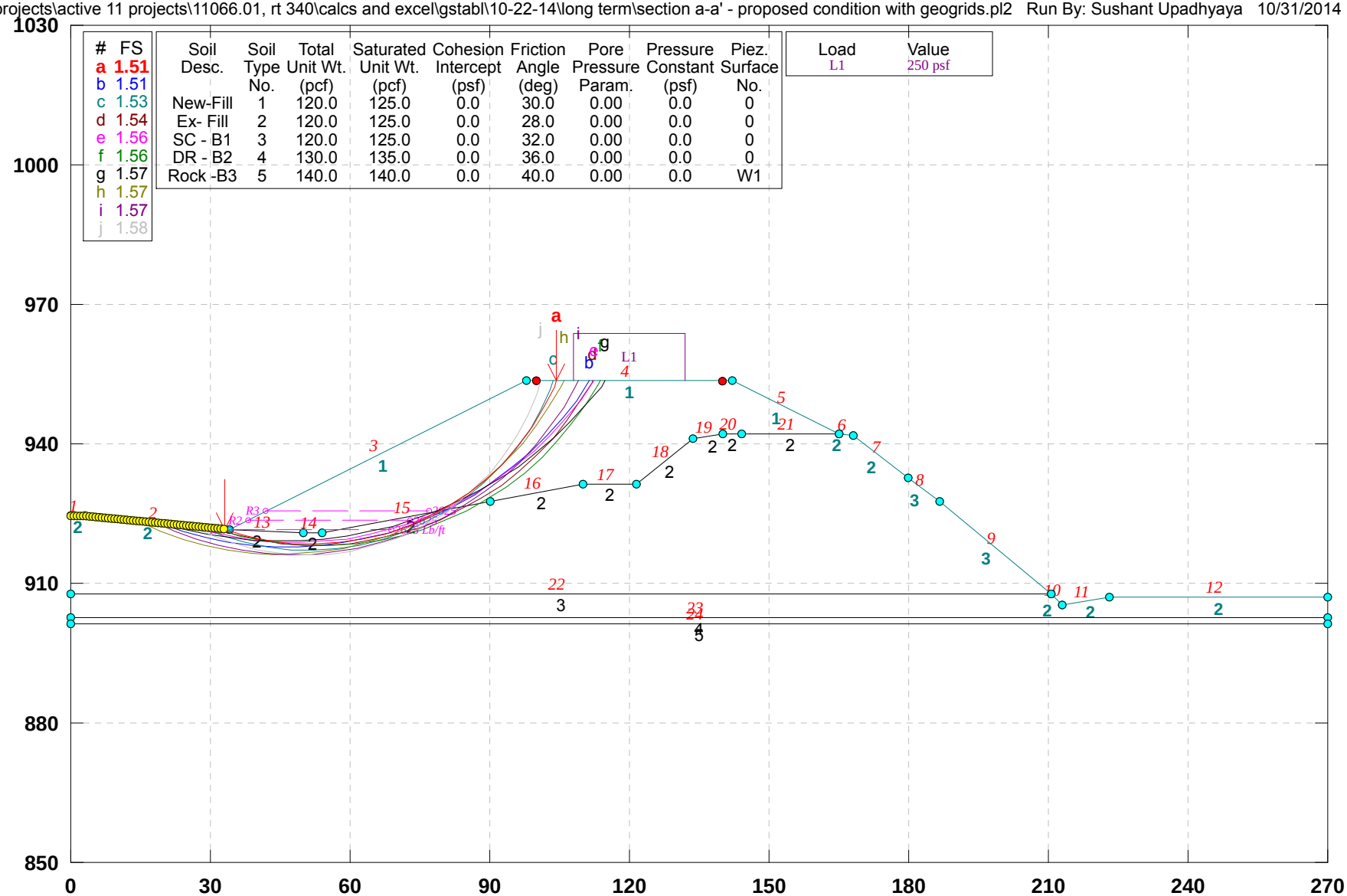
Section A-A'- West Slope Proposed 2H:1V- with Geogrids - Long Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section a-a' - proposed condition with geogrids.pl2 Run By: Sushant Upadhyaya 10/31/2014 09:31AM

#	FS
a	1.51
b	1.51
c	1.53
d	1.54
e	1.56
f	1.56
g	1.57
h	1.57
i	1.57
j	1.58

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	0.0	30.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	0.0	28.0	0.00	0.0	0
SC - B1	3	120.0	125.0	0.0	32.0	0.00	0.0	0
DR - B2	4	130.0	135.0	0.0	36.0	0.00	0.0	0
Rock -B3	5	140.0	140.0	0.0	40.0	0.00	0.0	W1

Load	Value
L1	250 psf



GSTABL7 v.2 FSmin=1.51

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
            ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
        Modified Bishop, Simplified Janbu, or GLE Method of Slices.
        (Includes Spencer & Morgenstern-Price Type Analysis)
        Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
        Nonlinear Undrained Shear Strength, Curved Phi Envelope,
        Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
        Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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Analysis Run Date:        10/31/2014
Time of Run:              09:31AM
Run By:                   Sushant Upadhyaya
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - proposed condition with geogrids.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - proposed condition with geogrids.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - proposed condition with geogrids.PLT
PROBLEM DESCRIPTION:  Section  A-A'- West Slope Proposed 2H:1V
                      - with Geogrids - Long Term
BOUNDARY COORDINATES
   12 Top   Boundaries
   24 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1         0.00     924.50       3.00     924.50        2
    2         3.00     924.50      34.00     921.58        2
    3        34.00     921.58      98.00     953.58        1
    4        98.00     953.58     142.00     953.47        1
    5       142.00     953.47     165.00     941.97        1
    6       165.00     941.97     168.00     941.96        2
    7       168.00     941.96     180.00     932.76        2
    8       180.00     932.76     186.50     927.76        3
    9       186.50     927.76     210.50     907.60        3
   10       210.50     907.60     213.00     905.50        2
   11       213.00     905.50     223.00     907.00        2
   12       223.00     907.00     270.00     907.00        2
   13        34.00     921.58      50.00     921.00        2
   14        50.00     921.00      54.00     921.00        2
   15        54.00     921.00      90.00     927.76        2
   16        90.00     927.76     110.00     931.50        2
   17       110.00     931.50     121.50     931.50        2
   18       121.50     931.50     133.50     941.00        2
   19       133.50     941.00     140.00     942.00        2
   20       140.00     942.00     144.00     942.00        2
   21       144.00     942.00     165.00     941.97        2
   22         0.00     907.60     210.50     907.60        3
   23         0.00     902.76     270.00     902.76        4
   24         0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0       0.0      30.0    0.00       0.0      0
  2   120.0    125.0       0.0      28.0    0.00       0.0      0
  3   120.0    125.0       0.0      32.0    0.00       0.0      0
  4   130.0    135.0       0.0      36.0    0.00       0.0      0
  5   140.0    140.0       0.0      40.0    0.00       0.0      1
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
```

```
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      915.26
     2        192.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1        192.00      901.83
     2        270.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         108.00       132.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     3 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        34.00    921.58   2625.00     1.000
        2        69.00    921.58   2625.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        38.00    923.58   2625.00     1.000
        2        73.00    923.58   2625.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        42.00    925.58   2625.00     1.000
        2        77.00    925.58   2625.00     1.000
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                              and  X =  33.50(ft)
 Each Surface Terminates Between   X = 100.00(ft)
                             and   X = 140.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   3.375   FS Min =   1.506   FS Ave =   2.204
          Standard Deviation =    0.443   Coefficient of Variation =   20.12 %
       Failure Surface Specified By 19 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         32.963      921.678
           2         37.750      920.232
           3         42.644      919.212
           4         47.610      918.624
           5         52.607      918.474
           6         57.599      918.762
           7         62.546      919.486
           8         67.411      920.640
```

9	72.156	922.216
10	76.745	924.202
11	81.142	926.582
12	85.314	929.339
13	89.228	932.449
14	92.855	935.891
15	96.166	939.638
16	99.137	943.660
17	101.744	947.926
18	103.967	952.405
19	104.420	953.564

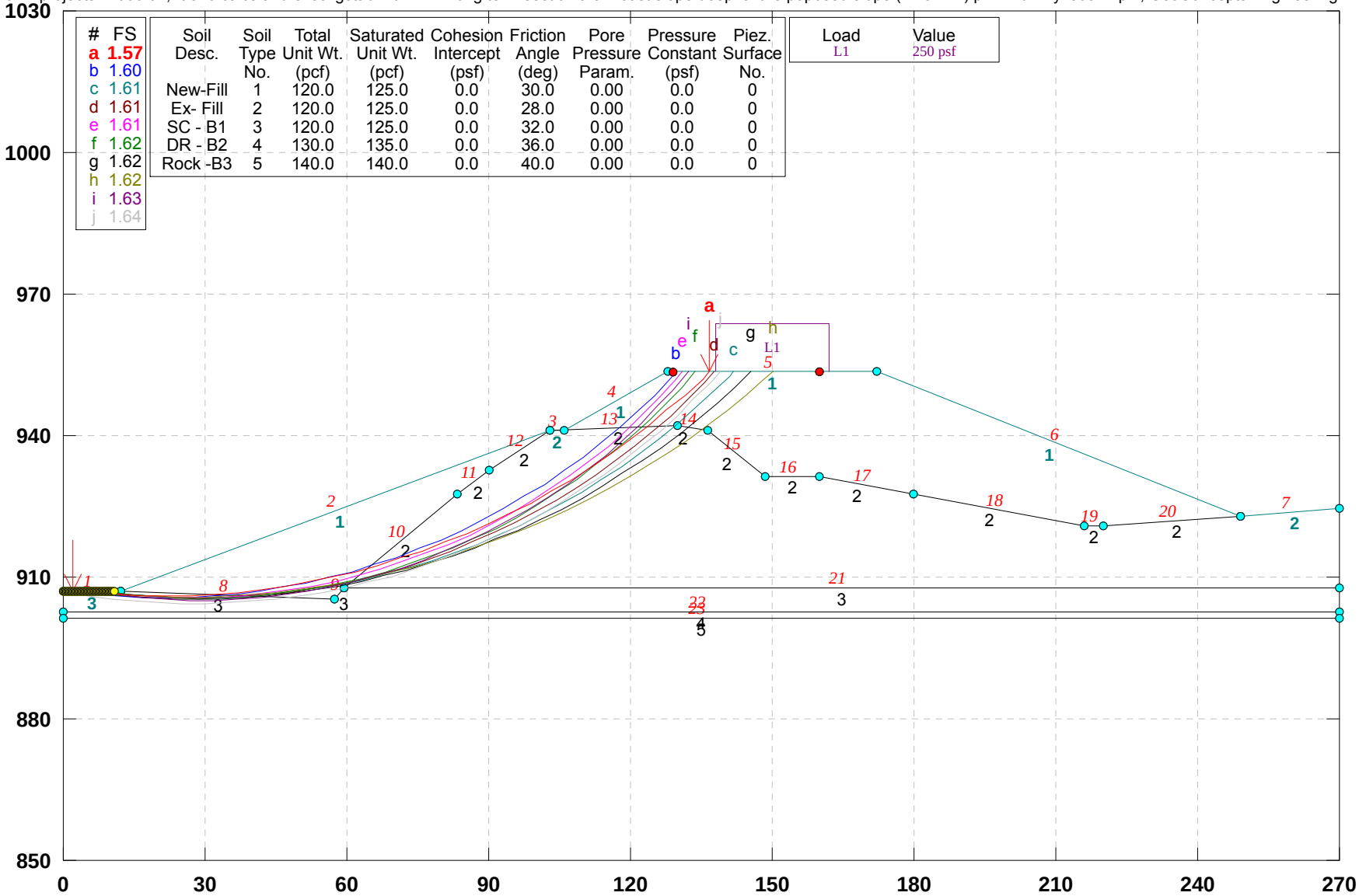
Circle Center At X = 51.824 ; Y = 975.495 ; and Radius = 57.027

Factor of Safety

*** 1.506 ***

Section - A-A'- Proposed East Slope 2.75H:1V - Long Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section a-a' - east slope deep failure poposed slope (2.75h-1v).pl2 Run By: Josh April, GeoConcepts Engineering 10/22/2014 05:



GSTABL7 v.2 FSmin=1.57

Safety Factors Are Calculated By The Modified Bishop Method

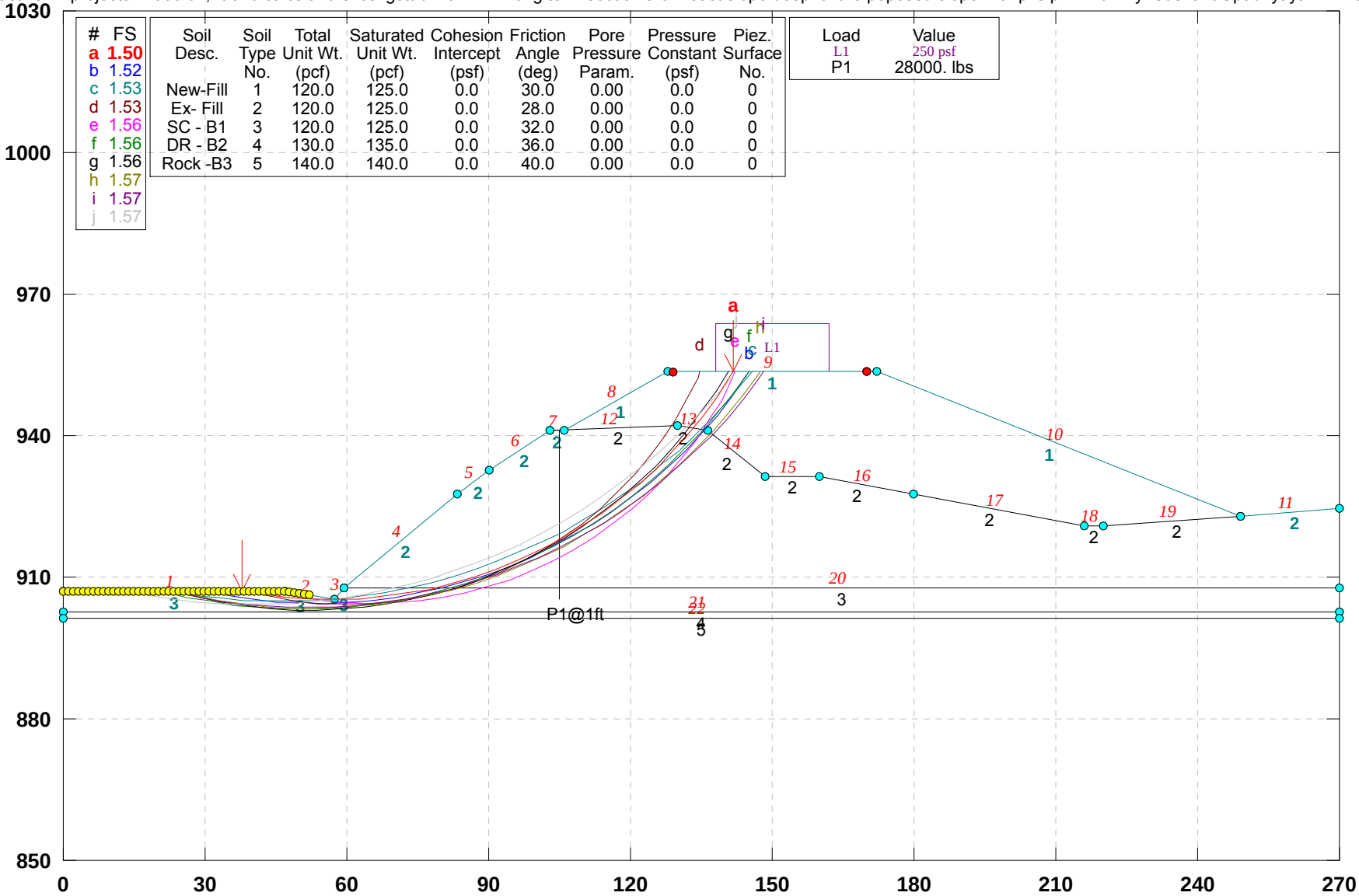
```
                    ***  GSTABL7  ***
          ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
              (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
         Modified Bishop, Simplified Janbu, or GLE Method of Slices.
         (Includes Spencer & Morgenstern-Price Type Analysis)
         Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
         Nonlinear Undrained Shear Strength, Curved Phi Envelope,
         Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
         Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/22/2014
Time of Run:              05:07PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope (2.75h-1v).in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope (2.75h-1v).OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope (2.75h-1v).PLT
PROBLEM DESCRIPTION:  Section - A-A'- Proposed East Slope 2.75
                      H:1V - Long Term
BOUNDARY COORDINATES
    7 Top   Boundaries
   23 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1         0.00     907.00      12.00     907.00        3
    2        12.00     907.00     103.00     941.26        1
    3       103.00     941.26     106.00     941.26        2
    4       106.00     941.26     128.00     953.47        1
    5       128.00     953.47     172.00     953.59        1
    6       172.00     953.59     249.00     923.00        1
    7       249.00     923.00     270.00     924.50        2
    8        12.00     907.00      57.50     905.50        3
    9        57.50     905.50      59.50     907.60        3
   10        59.50     907.60      83.50     927.76        2
   11        83.50     927.76      90.00     932.76        2
   12        90.00     932.76     103.00     941.26        2
   13       103.00     941.26     130.00     942.00        2
   14       130.00     942.00     136.50     941.00        2
   15       136.50     941.00     148.50     931.50        2
   16       148.50     931.50     160.00     931.50        2
   17       160.00     931.50     180.00     927.76        2
   18       180.00     927.76     216.00     921.00        2
   19       216.00     921.00     220.00     921.00        2
   20       220.00     921.00     249.00     923.00        2
   21        59.50     907.60     270.00     907.60        3
   22         0.00     902.76     270.00     902.76        4
   23         0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0       0.0      30.0    0.00       0.0      0
  2   120.0    125.0       0.0      28.0    0.00       0.0      0
  3   120.0    125.0       0.0      32.0    0.00       0.0      0
  4   130.0    135.0       0.0      36.0    0.00       0.0      0
  5   140.0    140.0       0.0      40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
```

```
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        105.00     941.26     105.10     906.26
 SEARCH LIMIT BOUNDARY DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  11.00(ft)
 Each Surface Terminates Between   X = 129.00(ft)
                               and   X = 160.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   4.172   FS Min =   1.573   FS Ave =   3.069
          Standard Deviation =    0.796   Coefficient of Variation =   25.92 %
       Failure Surface Specified By 31 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1          2.116      907.000
           2          7.094      906.532
           3         12.084      906.213
           4         17.081      906.044
           5         22.081      906.025
           6         27.079      906.156
           7         32.072      906.437
           8         37.053      906.868
           9         42.019      907.448
          10         46.966      908.176
          11         51.888      909.053
          12         56.782      910.077
          13         61.643      911.247
          14         66.467      912.563
          15         71.249      914.023
          16         75.986      915.626
          17         80.672      917.370
          18         85.303      919.254
          19         89.876      921.276
          20         94.386      923.434
          21         98.829      925.727
          22        103.202      928.152
          23        107.500      930.707
```

```
   24        111.719      933.390
   25        115.856      936.198
   26        119.907      939.129
   27        123.868      942.180
   28        127.736      945.349
   29        131.506      948.633
   30        135.177      952.028
   31        136.670      953.494
Circle Center At X =    20.212 ; Y =  1072.642 ; and Radius =   166.628
       Factor of Safety
      ***    1.573   ***
```

Section A-A'- Proposed East Slope 2H:1V with Pier - Long Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section a-a' - east slope deep failure poposed slope with pile.pl2 Run By: Sushant Upadhyaya 11/18/2014 02:11P



GSTABL7 v.2 FSmin=1.50

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
            ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
          (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                SLOPE STABILITY ANALYSIS SYSTEM
      Modified Bishop, Simplified Janbu, or GLE Method of Slices.
      (Includes Spencer & Morgenstern-Price Type Analysis)
      Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
      Nonlinear Undrained Shear Strength, Curved Phi Envelope,
      Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
      Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        11/18/2014
Time of Run:              02:11PM
Run By:                   Sushant Upadhyaya
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope with pile.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope with pile.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope with pile.PLT
PROBLEM DESCRIPTION:  Section A-A'- Proposed East Slope 2H:1V
                      with Pier - Long Term
BOUNDARY COORDINATES
   11 Top   Boundaries
   22 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1          0.00     907.00      47.00     907.00        3
    2         47.00     907.00      57.50     905.50        3
    3         57.50     905.50      59.50     907.60        3
    4         59.50     907.60      83.50     927.76        2
    5         83.50     927.76      90.00     932.76        2
    6         90.00     932.76     103.00     941.26        2
    7        103.00     941.26     106.00     941.26        2
    8        106.00     941.26     128.00     953.47        1
    9        128.00     953.47     172.00     953.59        1
   10        172.00     953.59     249.00     923.00        1
   11        249.00     923.00     270.00     924.50        2
   12        103.00     941.26     130.00     942.00        2
   13        130.00     942.00     136.50     941.00        2
   14        136.50     941.00     148.50     931.50        2
   15        148.50     931.50     160.00     931.50        2
   16        160.00     931.50     180.00     927.76        2
   17        180.00     927.76     216.00     921.00        2
   18        216.00     921.00     220.00     921.00        2
   19        220.00     921.00     249.00     923.00        2
   20         59.50     907.60     270.00     907.60        3
   21          0.00     902.76     270.00     902.76        4
   22          0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0       0.0     30.0    0.00       0.0      0
  2   120.0    125.0       0.0     28.0    0.00       0.0      0
  3   120.0    125.0       0.0     32.0    0.00       0.0      0
  4   130.0    135.0       0.0     36.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
  Point      X-Water     Y-Water
```

```
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        105.00     941.26     105.10     906.26
 SEARCH LIMIT BOUNDARY DATA HAS BEEN SUPPRESSED
PIER/PILE LOAD(S)
     1 Pier/Pile Load(s) Specified
Pier/Pile  X-Pos    Y-Pos     Load    Spacing  Inclination  Length
   No.     (ft)     (ft)      (lbs)     (ft)      (deg)      (ft)
    1     105.00   941.26    28000.0     1.0      90.00       36.0
 NOTE - An Equivalent Line Load Is Calculated For Each Row Of Piers/Piles
        Assuming A Uniform Distribution Of Load Horizontally Between
        Individual Piers/Piles.
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  53.00(ft)
 Each Surface Terminates Between   X = 129.00(ft)
                               and   X = 170.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   3.708   FS Min =   1.504   FS Ave =   2.499
          Standard Deviation =    0.581   Coefficient of Variation =   23.25 %
       Failure Surface Specified By 26 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         37.812      907.000
           2         42.747      906.195
           3         47.715      905.639
           4         52.706      905.332
           5         57.706      905.275
           6         62.702      905.468
           7         67.682      905.911
           8         72.634      906.603
           9         77.545      907.542
          10         82.403      908.725
          11         87.196      910.151
          12         91.911      911.814
          13         96.537      913.711
          14        101.062      915.837
          15        105.476      918.187
          16        109.766      920.756
```

17	113.922	923.535
18	117.934	926.519
19	121.791	929.701
20	125.484	933.071
21	129.005	936.622
22	132.342	940.345
23	135.490	944.230
24	138.439	948.267
25	141.182	952.448
26	141.804	953.508

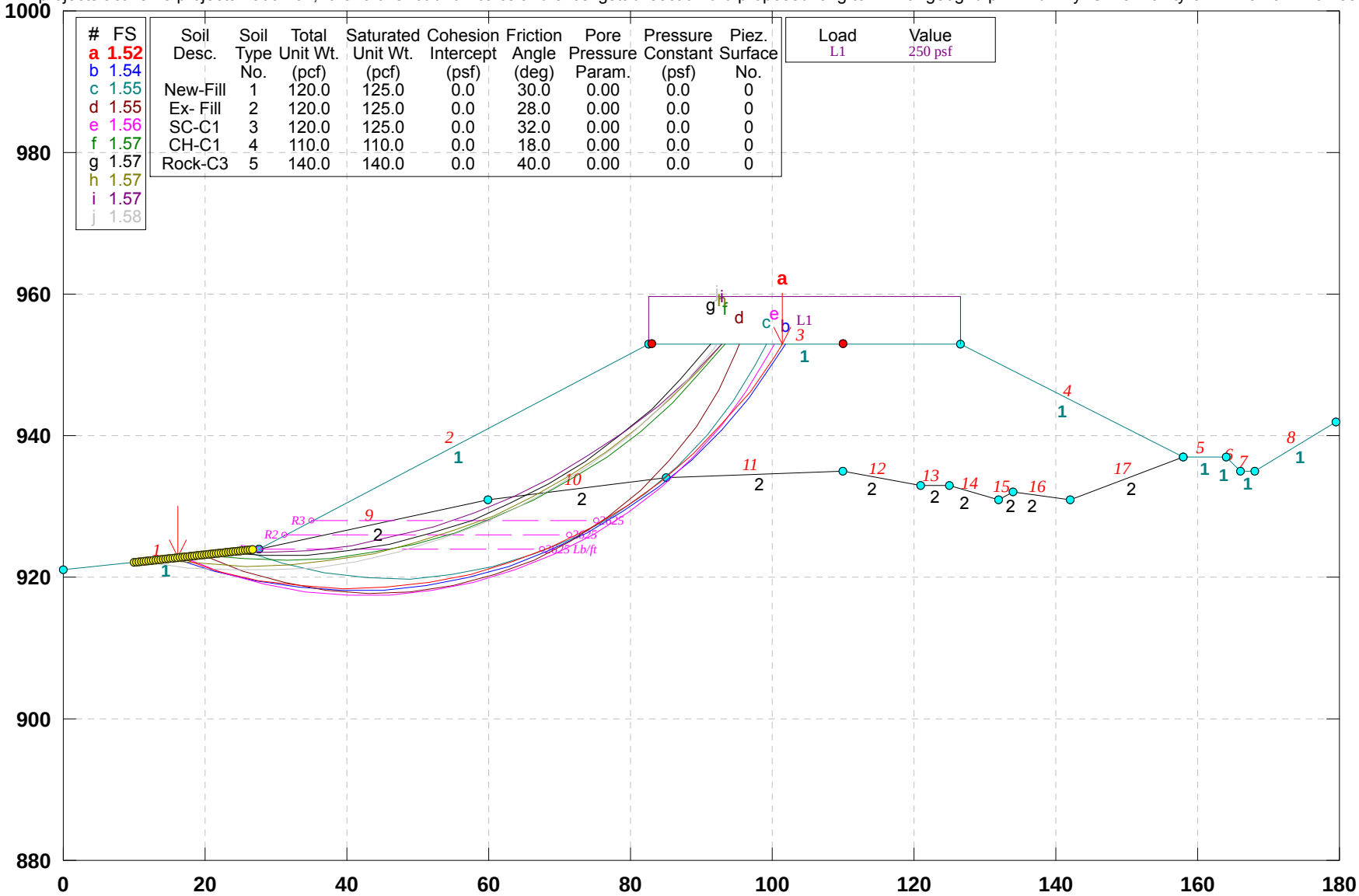
Circle Center At X = 56.352 ; Y = 1005.063 ; and Radius = 99.800

Factor of Safety

*** 1.504 ***

Section D - D', Proposed Slope with Geogrid - Long Term

n:\projects\active 13 projects\13004.01, rt. 340 over cub run\calcs and excel\gstabl\section d-d proposed long term with geogrid.pl2 Run By: Chris McIntyre 11/18/2014 01:38PM



GSTABL7 v.2 FSmin=1.52

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                        ** GSTABL7 by Garry H. Gregory, P.E. **
      ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
                  (All Rights Reserved-Unauthorized Use Prohibited)
    ******************************************************************************
                        SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    ******************************************************************************
    Analysis Run Date:        11/18/2014
    Time of Run:              01:38PM
    Run By:                   Chris McIntyre
    Input Data Filename:      N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section d-d proposed long term with geogrid.in
    Output Filename:          N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section d-d proposed long term with geogrid.OUT
    Unit System:              English
    Plotted Output Filename:  N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\section d-d proposed long term with geogrid.PLT
    PROBLEM DESCRIPTION:  Section D - D', Proposed Slope with Geog
                          rid - Long Term
    BOUNDARY COORDINATES
        8 Top   Boundaries
       17 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1         0.00     921.00      27.50     924.00        1
        2        27.50     924.00      82.50     953.00        1
        3        82.50     953.00     126.50     953.00        1
        4       126.50     953.00     158.00     937.00        1
        5       158.00     937.00     164.00     937.00        1
        6       164.00     937.00     166.00     935.00        1
        7       166.00     935.00     168.00     935.00        1
        8       168.00     935.00     179.50     942.00        1
        9        27.50     924.00      60.00     931.00        2
       10        60.00     931.00      85.00     934.00        2
       11        85.00     934.00     110.00     935.00        2
       12       110.00     935.00     121.00     933.00        2
       13       121.00     933.00     125.00     933.00        2
       14       125.00     933.00     132.00     931.00        2
       15       132.00     931.00     134.00     932.00        2
       16       134.00     932.00     142.00     931.00        2
       17       142.00     931.00     158.00     937.00        2
    User Specified Y-Origin =       880.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0       0.0     30.0    0.00       0.0      0
      2   120.0    125.0       0.0     28.0    0.00       0.0      0
      3   120.0    125.0       0.0     32.0    0.00       0.0      0
      4   110.0    110.0       0.0     18.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1         78.00      915.26
        2        270.00      915.26
    Piezometric Surface No.  2 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
```

```
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1          82.50       126.50       250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     3 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        27.50    924.00   2625.00     1.000
        2        67.50    924.00   2625.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        31.29    926.00   2625.00     1.000
        2        71.29    926.00   2625.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        35.09    928.00   2625.00     1.000
        2        75.09    928.00   2625.00     1.000
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =  10.00(ft)
                                and  X =  27.00(ft)
 Each Surface Terminates Between   X =  83.00(ft)
                                and   X = 110.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  6.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   2.636   FS Min =   1.520   FS Ave =   1.965
          Standard Deviation =    0.304   Coefficient of Variation =   15.47 %
       Failure Surface Specified By 18 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         16.064      922.752
           2         21.780      920.927
           3         27.629      919.590
           4         33.570      918.752
           5         39.561      918.419
           6         45.558      918.594
           7         51.520      919.274
           8         57.402      920.456
           9         63.164      922.130
          10         68.763      924.285
          11         74.161      926.905
          12         79.318      929.972
          13         84.198      933.463
          14         88.765      937.354
          15         92.987      941.617
```

```
   16         96.834      946.222
   17        100.278      951.135
   18        101.363      953.000
Circle Center At X =    40.497 ; Y =   989.247 ; and Radius =    70.842
       Factor of Safety
      ***    1.520   ***
```

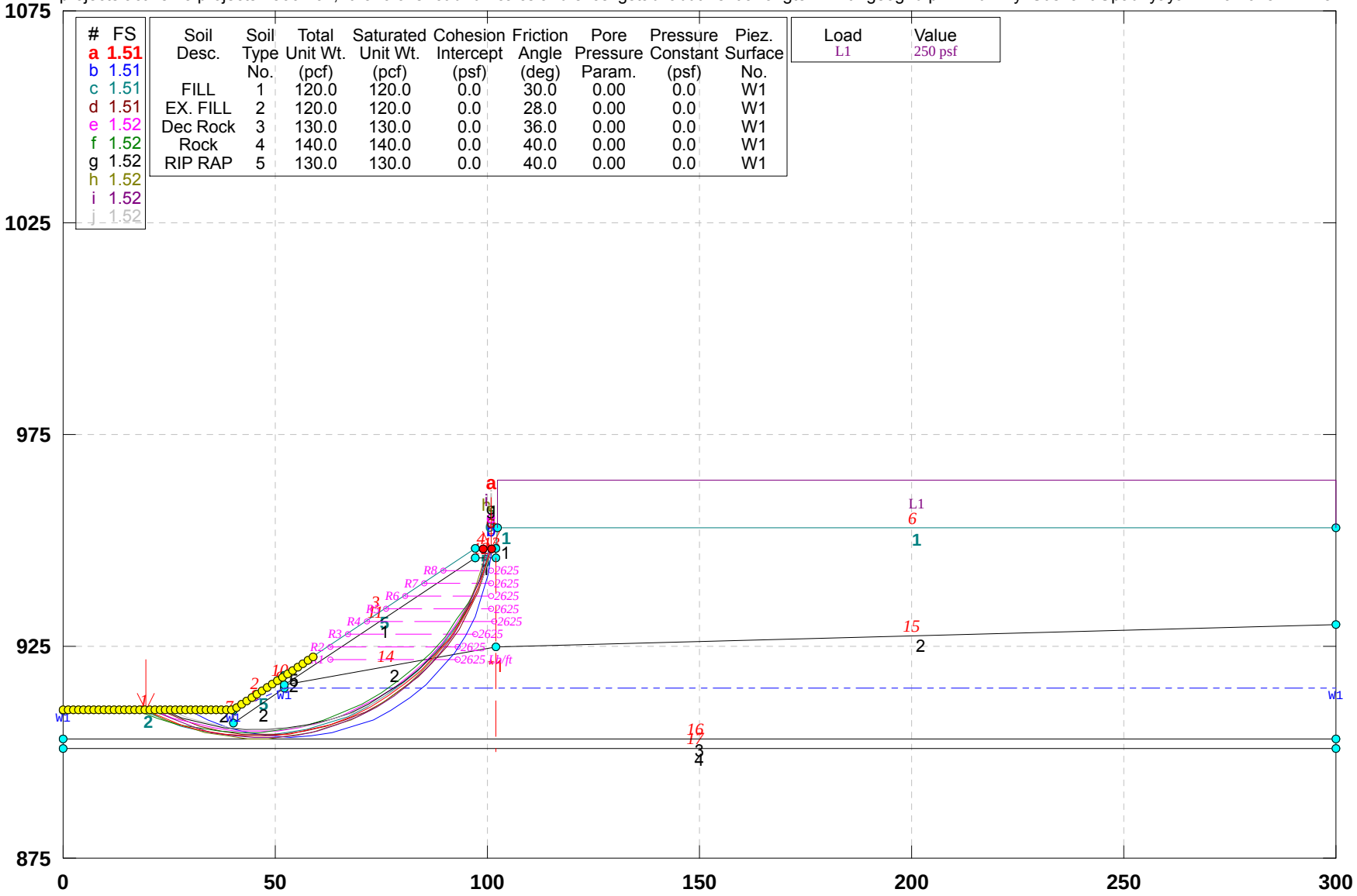
Route 340 over Cub Run Abutment A- Long Term - Geogrid

n:\projects\active 13 projects\13004.01, rt. 340 over cub run\calcs and excel\gstabl\abutment a-longterm with geogrid.pl2 Run By: Sushant Upadhyaya 4/29/2015 12:15PM

#	FS
a	1.51
b	1.51
c	1.51
d	1.51
e	1.52
f	1.52
g	1.52
h	1.52
i	1.52
j	1.52

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
FILL	1	120.0	120.0	0.0	30.0	0.00	0.0	W1
EX. FILL	2	120.0	120.0	0.0	28.0	0.00	0.0	W1
Dec Rock	3	130.0	130.0	0.0	36.0	0.00	0.0	W1
Rock	4	140.0	140.0	0.0	40.0	0.00	0.0	W1
RIP RAP	5	130.0	130.0	0.0	40.0	0.00	0.0	W1

Load	Value
L1	250 psf



GSTABL7 v.2 FSmin=1.51

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                          ** GSTABL7 by Garry H. Gregory, P.E. **
      ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
                  (All Rights Reserved-Unauthorized Use Prohibited)
    ******************************************************************************
                        SLOPE STABILITY ANALYSIS SYSTEM
            Modified Bishop, Simplified Janbu, or GLE Method of Slices.
            (Includes Spencer & Morgenstern-Price Type Analysis)
            Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
            Nonlinear Undrained Shear Strength, Curved Phi Envelope,
            Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
            Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    ******************************************************************************
    Analysis Run Date:        4/29/2015
    Time of Run:              12:15PM
    Run By:                   Sushant Upadhyaya
    Input Data Filename:      N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\abutment a-longterm with geogrid.in
    Output Filename:          N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\abutment a-longterm with geogrid.OUT
    Unit System:              English
    Plotted Output Filename:  N:\PROJECTS\Active 13 Projects\13004.01, Rt. 340 over Cub Ru
n\Calcs and Excel\GSTABL\abutment a-longterm with geogrid.PLT
    PROBLEM DESCRIPTION:  Route 340 over Cub Run
                          Abutment A- Long Term - Geogrid
    BOUNDARY COORDINATES
        6 Top   Boundaries
       17 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1         0.00     910.00      40.10     910.00        2
        2        40.10     910.00      52.20     918.00        5
        3        52.20     918.00      97.00     948.00        5
        4        97.00     948.00     102.10     948.00        5
        5       102.10     948.00     102.20     953.00        1
        6       102.20     953.00     300.00     953.00        1
        7        40.10     910.00      40.20     907.00        2
        8        40.20     907.00      52.00     915.00        2
        9        52.00     915.00      52.10     916.00        2
       10        52.10     916.00      52.20     918.00        5
       11        52.10     916.00      97.00     946.00        1
       12        97.00     946.00     102.00     946.00        1
       13       102.00     946.00     102.10     948.00        1
       14        52.10     916.00     102.00     925.00        2
       15       102.00     925.00     300.00     930.00        2
       16         0.00     903.00     300.00     903.00        3
       17         0.00     901.00     300.00     901.00        4
    User Specified Y-Origin =       875.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    120.0       0.0     30.0    0.00       0.0      1
      2   120.0    120.0       0.0     28.0    0.00       0.0      1
      3   130.0    130.0       0.0     36.0    0.00       0.0      1
      4   140.0    140.0       0.0     40.0    0.00       0.0      1
      5   130.0    130.0       0.0     40.0    0.00       0.0      1
    1 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  4 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1         0.00      910.00
        2        40.10      910.00
        3        52.00      915.00
        4       300.00      915.00
```

```
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         102.20       300.00       250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        102.00     946.00     102.00     900.00
REINFORCING LAYER(S)
     8 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        63.00    922.00   2625.00     1.000
        2        93.00    922.00   2625.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        63.00    925.00   2625.00     1.000
        2        93.00    925.00   2625.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        67.13    928.00   2625.00     1.000
        2        97.13    928.00   2625.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        71.61    931.00   2625.00     1.000
        2       101.61    931.00   2625.00     1.000
 REINFORCING LAYER NO.   5
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        76.09    934.00   2625.00     1.000
        2       101.00    934.00   2625.00     1.000
 REINFORCING LAYER NO.   6
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        80.57    937.00   2625.00     1.000
        2       101.00    937.00   2625.00     1.000
 REINFORCING LAYER NO.   7
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        85.05    940.00   2625.00     1.000
        2       101.00    940.00   2625.00     1.000
 REINFORCING LAYER NO.   8
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        89.53    943.00   2625.00     1.000
        2       101.00    943.00   2625.00     1.000
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  60.00(ft)
 Each Surface Terminates Between   X =  99.00(ft)
                               and   X = 101.00(ft)
```

```
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =      0.00(ft)
     5.00(ft) Line Segments Define Each Trial Failure Surface.
    ****  ERROR - RC11  ****
>>200 attempts to generate failure surface have failed. Revise limitations
    Following Are Displayed The Ten Most Critical Of The Trial
          Failure Surfaces Evaluated. They Are
          Ordered - Most Critical First.
          * * Safety Factors Are Calculated By The Modified Bishop Method * *
          Total Number of Trial Surfaces Attempted =   500
          Number of Failed Attempts to Generate Trial Surface  =  210
          Number of Trial Surfaces With Valid FS =  290
          Percentage of Trial Surfaces With Non-Valid FS Solutions
          of the Total Attempted =  42.0 %
          Statistical Data On All Valid FS Values:
             FS Max =   2.219   FS Min =   1.508   FS Ave =   1.687
             Standard Deviation =    0.128   Coefficient of Variation =    7.61 %
          Failure Surface Specified By 22 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
              1         19.359      910.000
              2         23.911      907.932
              3         28.627      906.270
              4         33.470      905.027
              5         38.403      904.213
              6         43.389      903.835
              7         48.388      903.893
              8         53.364      904.390
              9         58.276      905.320
             10         63.089      906.676
             11         67.764      908.449
             12         72.266      910.624
             13         76.561      913.185
             14         80.614      916.112
             15         84.396      919.382
             16         87.878      922.971
             17         91.031      926.852
             18         93.833      930.993
             19         96.262      935.363
             20         98.298      939.930
             21         99.927      944.657
             22        100.761      948.000
          Circle Center At X =    45.214 ; Y =   960.802 ; and Radius =    57.003
                 Factor of Safety
                ***    1.508   ***
```

GeoConcepts Engineering, Inc.

Appendix F
Preliminary Soil Survey Report

Revised Preliminary Soil Survey Report, Route 340 Bridge Replacement and Approaches over Cub Run, Rockingham County, Virginia, Dated November 4, 2014 (173 pages)

November 4, 2014

Revised Preliminary Soil Survey Report

Route 340 Bridge Replacement and Approaches over Cub Run, Page County, Virginia (VDOT Project No. 0340-069-777, B611, UPC No. 90187)

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November 4, 2014

Mr. James D. Davidson, PE, DBIA
Dewberry
8401 Arlington Blvd.
Fairfax, Virginia 22031

Subject: **Revised Preliminary Soil Survey Report, Route 340 Bridge Replacement and Approaches Over Cub Run, Page County, Virginia (VDOT Project No. 0340-069-777, B611, UPC NO. 90187) (GeoConcepts Project No. 11066.01)**

Dear Mr. Davidson:

GeoConcepts Engineering is pleased to present the following revised preliminary soil survey report prepared for the Route 340 Bridge Replacement and Approaches over Cub Run located in Page County, Virginia. This revised report has been prepared to address the comments from Staunton Materials Section of Virginia Department of Transportation (VDOT).

We appreciate the opportunity to serve as your geotechnical consultant on this project. Please do not hesitate to contact me if you have any questions or want to meet to discuss the findings and recommendations contained in the report.

Sincerely,

GEOCONCEPTS ENGINEERING, INC.

Sushant Upadhyaya, PhD, PE, PMP
Senior Engineer
supadhyaya@geoconcepts-eng.com

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1.0 Introduction

This Preliminary Soil Survey Report (PSSR) summarizes the preliminary recommendations for the proposed Route 340 Bridge Replacement and Approaches over Cub Run located in Page County, Virginia. The project site is located approximately 0.17 to 0.44 miles south of the intersection of Route 685 and Route 340. The project length is approximately 0.27 miles. A site vicinity map as presented in Figure 1 at the end of this report.

The preliminary recommendations presented in this PSSR are based on a review of existing bridge plans of various dates, proposed bridge plan dated August 1, 2012, available databases, maps and literature pertaining to the local geology, geologic hazard maps, soils, traffic, and pavement. A site visit was also completed to define more accurately geologic features, existing utilities, and pavement conditions.

2.0 Project Description

The purpose of this project is to replace the existing two lane bridge of Route 340 over Cub Run. The proposed bridge will be constructed west of the existing bridge. The traffic will be maintained on the existing bridge while constructing the new bridge. In order to maintain traffic on the existing bridge, temporary shoring will be required approximately between Stations 17+50 and 18+50 on the west side of the existing roadway.

Based on plans and information provided to us, the proposed construction will include replacement of the existing five-span bridge with a new two-span bridge. The proposed bridge is approximately 44 feet wide and 243 feet long, with 121.5 feet long spans. Further, the proposed construction will include the realignment of existing approaches to Route 340 and also widening of the travel lanes from 10 feet to 12 feet within the project limits. Maximum cuts and fills of about 15 feet and 22 feet, respectively, will be required for the proposed construction.

2.1 Existing Conditions

Route 340 is a rural minor arterial primary route in Page County, Virginia. An overhead power line runs along the western side of the existing bridge (Figure 2). The vegetation at the site consists mainly of grass, shrubbery, and clusters of small- to medium-sized trees on both the east and west sides of the bridge. Farmland and dwelling units are located adjacent to the existing bridge approaches. A cemetery and a church are located at the southern limit of the project. The topography at the site slopes down from the north and south towards Cub Run. The lowest elevation at Cub Run is at about elevation (EL) 900. Existing slope gradients adjacent to Cub Run in front of the abutment are about 1.5H:1V. Side slopes of approach embankments are covered with grass and shrubbery. According to the Preliminary Field Inspection (PFI) plans provided to us by Dewberry, the normal and high water elevations at Cub Run are at EL 901.83 and EL 909.68 feet, respectively.

Rock outcrops were not observed during our site visit. Existing side slope gradients in the vicinity of the abutments range from 1.5H:1V to 2H:1V. Side slopes of approach embankments are covered with grass and shrubbery. The existing slopes appeared to be stable and we did not observe surface failures at embankment and approach slopes.

The staging area will be off the road and may require grading to provide enough staging area for equipment. The final decision about using an area for staging should be made by the contractor after visiting the site and consulting with the regulatory agencies and nearby landowners. While selecting a staging area, consideration should also be given to the impact of the staging area on the adjacent Cub Run, wetland, and flood plain.

2.2 Existing Bridge Conditions

According to the existing bridge plan dated January 8, 1980, the existing bridge is approximately 197 feet long and 23 feet wide. The existing bridge has five reinforced concrete beam spans and an asphalt overlay. According to the bridge plan dated October 22, 1968, the finished grade elevation of the existing bridge is at approximately EL 539. Further, the existing bridge abutments and piers are founded on shallow foundations. Figures 3 and 4 at the end of this report show existing bridge conditions. Side slopes of approach embankments are covered with grass and shrubbery. During our site visit we observed a small hole on the southern embankment where soil is raveling down between fill boulders and rip-rap, as shown in Figure 5.

Based on the site reconnaissance, signs of significant scour were not observed, which is also supported by the review of the Structure Inspection Report-Summary dated May 23, 2011 (structure report), provided by VDOT. According to the VDOT structure report, no significant scour problems were observed.

2.3 Anticipated Restrictions For Subsurface Investigations

During the preliminary soil survey subsurface investigation, test borings were performed at the temporary shoring locations. However, during the final soil survey subsurface investigation, test borings will be required at each bridge abutment and pier locations. In addition to bridge structure, test borings will also be required at the proposed bridge approaches. Anticipated restrictions for the proposed bridge subsurface investigation are summarized below:

- The proposed bridge will be constructed over Cub Run and in-stream drilling may be necessary.
- Flood plain deposits with gravel and boulders were observed in the project vicinity and this stratigraphy generally slows down the drilling progress.
- Environmental and other permits may be required for drilling at the proposed pier locations.
- For test borings at the proposed southern abutment locations, drilling will be required at the side slope of an existing approach embankment and earthwork for benching may be required to make access for the drill rig (Figure 4).

3.0 Literature Review

This section summarizes the results of our literature review about the geologic setting and soils in the project vicinity.

3.1 Geologic Units and Features

The Route 340 project is located in Staunton District, Page County, Virginia. Based on the Geological Map of Virginia, the site is located within the Valley and Ridge Physiographic Province. The Valley and Ridge forms a broad arc that is bounded on the east by the Blue Ridge Province and on the west by the Appalachian Plateau Province. The entire Valley and Ridge is underlain by folded and faulted sedimentary rocks dating from the Paleozoic Geologic Era. Igneous intrusive rocks of the Paleogene Geologic Period are present at scattered locations throughout the region, and more recent alluvial deposits typically floor the river valleys. Colluvial gravels are also present on the flanks of the steeper ridges.

The geography of the Province consists of parallel, strike-controlled linear ridges of resistant rock such as sandstone, conglomerate, and well-indurated carbonates, with intervening valleys floored by less resistant, poorly indurated clastic and carbonate rocks. The river systems of the Province form a trellis pattern, following the valley bottoms and passing through numerous structurally controlled “gaps” and canyons in the mountain ridges.

The Valley and Ridge is often divided into two sections: an eastern "Great Valley" Section; and a western "Allegheny Highlands" Section. The Great Valley is a topographic lowland, bounded on the east by the Blue Ridge Massif and on the west by the closely packed ridges of the Allegheny Highlands. The Allegheny Highlands extend from northeast to southwest, forming the western edge of the Great Valley. The parallel ridges gradually rise in summit elevations, eventually transitioning on their western edge to the gently folded upland of the Appalachian Plateau Province.

The site is located in the eastern part of the Great Valley Subsection of the Ridge and Valley Province, locally known as the "Page Valley". Specifically, the site is mapped as underlain by the Beekmantown Dolomite (Map Symbol - Ob) of the Lower Ordovician Geologic Period (Figure 6). The unit is a thick-bedded carbonate with dolostone, limestone, and chert nodules scattered throughout. In the incised valley of the Cub Run, the Beekmantown Dolomite is exposed; however it is flanked by a stratum of Quaternary colluvial gravels to the north and south.

The contact between the Beekmantown Dolomite and the overlying Middle Ordovician Limestone's (Map symbol - Oeln) is located approximately 580 feet upstream (west) of the bridge alignment. The contact between the Beekmantown and the overlying Middle Ordovician Limestone's is unconformable, and represents an erosional surface. The Oeln consists of (from top to bottom) the Edinburg, Lincolnshire, and New Market Formations, respectively. They are typically mapped as one unit.

There are no significant geologic faults mapped at this site. Nevertheless, as in any area underlain by soluble bedrock such as the Beekmantown Dolomite, the site is prone to the development of a karst terrain, characterized by the presence of pinnacled bedrock, sinkholes, caves, and large springs. However, no obvious surface karst features (e.g. sinkholes) were observed in the immediate vicinity of the bridge or the approach roadways. Karst features are further discussed in Section 3.3 of this report.

3.2 Mapped Soil Units and Properties

Based on our review of the United States Department of Agriculture's Natural Resources Conservation Services (NRCS) Web Soil Survey 2.0, four soil units were mapped in the project vicinity. The mapped soil units are 6C, 25D, 37E, and 49C as shown in Custom Soil Resource Report for Page County in Appendix A.

Table 1 below summarizes soil units and selected properties based on the published information summarized in the NRCS Web Soil Survey 2.0, NRCS 2011. Additional general soils information is available in Appendix A. More detailed information will be provided with the Final Soil Survey Report (FSSR). It is important to note that the properties described herein are general in nature. The final soil survey should be carried out to assess subsurface conditions and engineering characteristics of the soils along the project alignment.

Table 1: Summary of Soil Units and Selected Properties (Summarized from NRCS Web Soil Survey 2.0 NRCS 2011)

Summary of Soil Units				
Soil Map Unit Symbol	6C	25D	37E	49C
Soil Map Unit Name	Carbo-Rock outcrop complex, 2-15% slopes	Jefferson fine sandy loam, 15-35% slopes	Oaklet-Carbo complex, 15-35% slopes, very rocky	Unison fine sandy loam, 7-15% slopes
Summary of Soil Properties				
Unified Soil Classification Symbols	CL, CH	GC-GM, SC, CL, CL-ML	CL, CH	SC, CL, CL-ML, CH

Summary of Soil Properties				
AASHTO Soil Classification Symbols	A-6, A-7	A-2, A-4, A-6	A-6, A-7	A-4, A-6 , A-7
Liquid Limit (%)	30-80	21-43	30-87	22-76
Plasticity Index (%)	10-55	4-21	10-59	6-51
Corrosion of Concrete	Low	High	Moderate	Moderate
Corrosion of Steel	High	Moderate	High	High

3.3 Karst Features

Published karst feature information for the project vicinity includes the Virginia Division of Mineral Resources' map for the Northern Valley and Ridge Province (Hubbard, 1983) (Figure 7). Cave location data was derived from the proprietary database of the Virginia Speleological Survey (VSS, 2012). A 2-foot contour map of the site derived from triangulated irregular network (TIN) maps provided by the Virginia County Data Series of Virginia Tech.

The project is mapped as underlain by Quaternary age colluvium which mantles the Beekmantown Dolomite below. The dolomite is only well exposed in the stream valley and in scattered outcrops along the flanks of the valley. Based on our on-site reconnaissance, review of available literature, mapping, and databases, there are no sinkholes, closed depressions, filled or un-filled cavities, or caves located within the project area. However, the Beekmantown Dolomite is known for the development of karst features, many of which are concealed beneath the regional colluvial gravel mantle. It should be noted that based on data obtained from the Virginia Speleological Survey, a small cave (Huffman's Cave) is located approximately 350 feet upstream from the bridge in the bluff above Cub Run. Thus, although there are no surface karst features located within the immediate project bounds, regionally the project is located in an area that should be considered as having known karst development.

The following note should be added to the plans: "In the event a cave, sinkhole, spring, blowhole, swallet or other karst feature is observed within the project limits or is encountered during construction, the Contractor shall immediately contact the VDOT Project Inspector and the VDOT District Environmental Manager at (540) 332-9101."

In the event the subsequent soil survey investigation encounters karst features, this will be addressed in the final soil survey report.

3.4 Groundwater Conditions

Due to the proximity of surface water bodies, groundwater is expected at depths coinciding with the elevations of Cub Run, which will influence excavations such as for the pier foundations. Specific groundwater information will be provided in the final soil survey report.

3.5 Wetland and Flood Data

Based on our review of the United States Fish and Wildlife Service's National Wetland Inventory website, there are no wetlands which will be impacted by the project. An excerpt of the National Wetlands Inventory is included as Figure 8.

Referencing the FEMA-FIRM floodplain maps and the Page County GIS mapping system, there are no mapped or measured floodplains within the project area. The closest 100-year floodplain is located

downstream on Cub Run, near its confluence with the Shenandoah River. An excerpt of the Page County Floodplain Map is included as Figure 9.

3.6 Scour

As indicated in Section 3.1 of this report, the site is underlain by soluble Beekmantown Dolomite bedrock, and sinkholes, closed depressions, filled or un-filled cavities, or caves are not located within the project limits. According to Section 3.7.2.1 of NCHRP report 717, the presence of soluble bedrock at the project site indicates a potential for soluble rock scour.

4.0 Subsurface Conditions

This section summarizes the geologic setting and soils in the project vicinity. Subsurface conditions were investigated by drilling three test borings in the temporary shoring area.

4.1 Field Exploration

On October 26, 2012, GeoConcepts monitored the drilling of three test borings (designated B-1, B-2, and B-3) at the temporary shoring location. The test borings were drilled to depths of about 50 feet using a truck-mounted drill rig, by a drilling subcontractor to GeoConcepts. Rock coring was performed in two test borings. Soil samples were obtained at select intervals. Soil and rock samples were taken to our laboratory for further examination and physical testing. The test boring stakeout was provided by Dewberry. A detailed description of the field exploration method is included in Appendix B.

Test boring logs, rock core and pavement core photos, and a boring location plan (Figure B-1) are presented in Appendix B of this report.

4.2 Stratification

The subsurface materials encountered have been stratified for purposes of our discussions herein. These stratum designations do not imply that the materials encountered are continuous across the site. Stratum designations have been established to characterize similar subsurface conditions based on material gradations and parent geology. The subsurface materials encountered in the test borings completed at the site have been assigned to the following strata:

Stratum A (Existing Fill)	loose to medium dense, clayey sand, silty gravel, clayey gravel FILL, moist, brown soft to very stiff, lean clay FILL with gravel and sand, moist, brown
Stratum B1 (Residual Dolostone)	medium dense, clayey SAND (SC), with gravel, moist brown
Stratum B2 (Decomposed Dolostone)	very dense, POORLY GRADED GRAVEL (GP), moist, gray
Stratum B3 (Dolostone Rock)	Highly weathered to moderately weathered , hard, thinly bedded, slightly to moderately fractures, DOLOSTONE ROCK (top of dolostone bedrock varies approximately between 2 and 40 feet)

No slickensides were observed in the rock cores. Thin veins of calcite were consistently observed throughout the rock core. Specific descriptions for the sediments and dolostone rock are included on the boring logs in Appendix B.

The two letter designations included in the strata descriptions presented above and on the test boring logs represent the Unified Soil Classification System (USCS) group symbol and group name for the samples based on laboratory testing per ASTM D-2487 and visual classifications per ASTM D-2488. It should be noted that visual classifications per ASTM D-2488 may not match classifications determined by laboratory testing per ASTM D-2487.

4.3 Pavement Cores

GeoConcepts completed two pavement cores in the existing roadway. Photos of the pavement cores are presented in Appendix B of this report. The approximate core locations are shown on the boring location plan in Appendix B, and the measured pavement layer thicknesses are presented below in Table 2.

Table 2: Existing Pavement Thickness

Pavement Core Location	Pavement Core Number	Asphalt Pavement Thickness (inch)	Gravel Base (inch)
Route 340	C-1	22	8
	C-2	18	12

4.4 Groundwater Conditions

Groundwater level observations were made in the field during drilling of the test borings. We did not make 24-hour water level observations as boreholes were backfilled upon completion for safety concerns. A summary of the water level readings rounded to 0.5 feet is presented in Table 3 below.

Table 3: Groundwater Data

Test Boring No.	Depth to Groundwater (feet)	Groundwater Elevation (feet)
B-1	Dry	---
B-2	Dry	---
B-3	26.0	915.5

The groundwater observations presented herein are considered to be an indication of the groundwater levels at the dates and times indicated. Where more impervious Stratum B1 clay soils are encountered, the amount of water seepage into the borings is limited, and it is generally not possible to establish the location of the groundwater table through short term water level observations. Accordingly, the groundwater information presented herein should be used with caution. Also, fluctuations in groundwater levels should be expected with seasons of the year, construction activity, changes to surface grades, precipitation, or other similar factors.

4.5 Soil and Rock Laboratory Test Results

Selected soil samples obtained from the field investigation were tested for grain size distribution (with hydrometer), Atterberg limits, compaction characteristics using standard effort, California Bearing Ratio (CBR), A summary of soil laboratory test results is presented in Appendix C. The results of natural moisture content tests are presented on the test boring logs in Appendix B.

4.5.1 Classification Test Results

A summary of the maximum and minimum values of percent fines passing the US Standard No. 200 sieve, liquid limits, and plasticity indices for each stratum are summarized below in Table 4.

Table 4: Soil Classification Test Results

Stratum	USCS Group Name and Symbol	% Range of #200 Passing	Range of Liquid Limit	Range of Plasticity Index
Stratum A (Existing Fill)	lean CLAY (CL) with sand, sandy lean CLAY (CL) with gravel, clayey SAND (SC), clayey SAND (SC) with gravel (SC), and silty GRAVEL (GM) with sand	14.7 to 84.3	NP to 55	NP to 37
Stratum B1* (Residual-Dolostone)	Clayey SAND (SC) with gravel	25.3	25	10

* Only one sample was tested from this stratum

4.5.2 Standard Proctor and California Bearing Ratio Test (CBR) Results

One standard proctor test per VTM-1 and one CBR test per VTM-8 were performed on a bulk sample collected at test boring B-1. The standard proctor and CBR test results are presented below in Table 5.

Table 5: Standard Proctor and CBR Test Results

Test Boring No.	Sample Depth (feet)	USCS Symbol	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	CBR Value (%)
B-1	0.0-5.0	CL	116	14	4.2

4.5.3 Metal Corrosion/Concrete Attack Test Results

In addition to standard geotechnical soil laboratory testing, a sample from test boring B-3 was submitted to an analytical laboratory for metal corrosion and concrete attack testing. Corrosion testing consisted of analysis for moisture content (ASTM D-2216), pH (CA643), resistivity (ASTM G187), sulfides (water soluble EPA 376.2), and reduction-oxidation potential (Electrode). The results of these tests are presented below in Table 6:

Table 6: Metal Corrosion Test Results

Test Boring No.	Sample Depth (feet)	Moisture Content (%)	pH	Resistivity (ohm – cm)	Sulfides (ppm)	Red-ox Potential (mV)
B-3	6.5-10.5	30.9	7.5	900	<1.2	+154

The types of pipes should be selected based on the allowable pH and resistivity ranges presented in Standard PC-1 (page 107.21) of Section 100 of VDOT Road and Bridge Standard.

Sulfate (Water soluble CA417) tests were performed on selected soil samples to determine the severity of sulfate attack on concrete structures. The results of sulfate testing are presented below in Table 7.

Table 7: Sulfate Results

Test Boring No.	Sample Depth (feet)	Sulfate Concentration (ppm)
B-3	6.5-10.5	48

Based on correlations between sulfate concentrations and severity of sulfate attack as presented in American Concrete Institute (ACI) 318, the above sulfate concentrations are considered to pose a negligible threat of sulfate attack on concrete.

4.5.4 Rock Unconfined Compressive Strength Test Results

Unconfined compressive strength tests were conducted on core specimens of the Dolostone rock. The results of the unconfined compressive strength tests are summarized below in Table 8.

Table 8: Rock Unconfined Compressive Strength

Test Boring No.	Rock Type	Sample Depth (feet)	Unconfined Compressive Strength (psi)
B-1	Dolostone	6.5-6.83	4,591
B-3	Dolostone	42.0-42.33	3,466
B-3	Dolostone	46.0-46.33	4,257

Based on our observation of rock cores and based on Rock Quality Designation (RQD) and unconfined compressive strength values, Dolostone rock at the site is considered to have very poor to good condition.

5.0 Geotechnical Recommendations

Geotechnical recommendations are presented below for pavements, earthwork, unsuitable materials, bridge foundation, earth retaining structures, slope design, and stormwater management basins.

5.1 Pavements

Recommendations regarding existing pavements and pavement design sections are presented below.

5.1.1 Existing Pavements

The existing northern and southern approach pavement in the vicinity of the existing bridge is in good condition (Figures 10 and 11); however, there is a separation crack where the northern approach meets the bridge deck as shown in Figure 10. The existing pavement structure within the project limits of Route 340 will be evaluated during final soil survey and will be presented in the final soil survey report.

The VDOT Staunton district office provided us the information regarding the past maintenance history for Route 340. In 1978, 0.2 inches of slurry Seal-Type B was used to protect the pavement. The most recent pavement maintenance for Route 340 was completed in 2007, where the pavement was resurfaced with 1.5 inches of SM-12.5A.

5.1.2 Traffic Analysis Summary

A preliminary pavement design was performed using the traffic data and information provided in the Field Review and Scoping Report dated November 3, 2010 by the VDOT Project Management Office. Based on the traffic data, the proposed roadway is classified as a high volume secondary route. The proposed bridge and approaches will be two lanes, one 10 feet wide lane in each direction, with 2 feet wide shoulders. We have used the traffic data presented below in Table 9 for the preliminary pavement section design.

Table 9: Summary of Traffic Data

Traffic Data	Value
Highway Classification	Undivided Primary - Rural*
Design Years	20*
Two Way ADT (2017)	5,838***
Percent Trucks (Class 5 or Greater)	4.8**
Annual Truck Growth Rate (%)	1.3***
Number of Lanes in Design Direction	1**
Average Initial Truck factor (ESALs/Truck)	1.05*

* Values from VDOT Pavement Design Manual
** Information provided by VDOT
*** Value calculated from information provided by VDOT

Based on traffic data presented in Table 9 above, design ESALs of 1,218,368 were developed for the design lane for a 20-year pavement service life.

5.1.3 Pavement Design Recommendations

5.1.3.1 New Pavement Section

Pavement sections were designed based on the 1993 AASHTO Guide for Design of Pavement Structures and Section 604.02 of VDOT Manual of Instructions Chapter VI Pavement Evaluation and Design. Pavement recommendations for the new flexible pavement were developed based on an assumed laboratory CBR value of 5. Based on a design CBR value of 5.0, a design roadbed soil resilient modulus of 7,500 psi is used for pavement design. Design parameters used in the AASHTO Design Equation for the flexible pavement are presented below in Table 10.

Table 10: Design Parameters

Design Parameter	Design Value – Flexible Pavements
Initial Serviceability	4.2
Terminal Serviceability	2.8
Standard Deviation	0.49
Reliability	85%

Table 11 herein presents the recommended flexible pavement section for the approaches of the proposed bridge. Pavement design calculations are presented in Appendix D of this report.

Table 11: Recommended Flexible Pavement Section – Mainline and Shoulder

Flexible Pavement Layer
165 lbs/sq. yd. Asphalt Concrete, Type SM-9.5A
5.0-inch Asphalt Concrete Base Course, Type BM-25.0A
8.0-inch Aggregate Base Material, Type I, No. 21-B

Proper drainage is imperative in the design and construction of flexible pavements. The aggregate base material, Type I, size No. 21-B should be daylighted to provide for positive lateral drainage. Depending on the bridge profile, a transverse cross-drain (CD-2) may also be placed at the bridge approaches. The roadway shoulder or adjacent ground should be graded so that surface drainage runs away from the pavement and does not stand on the pavement's edge. The overall pavement design should also include diversion structures for collecting surface runoff and to limit excessive ponding on paved surfaces.

Construction loading conditions may be more severe than post-construction conditions and typically occurs prior to placement of the total pavement sections. Construction traffic activity on partially constructed pavement sections may result in subgrade and pavement failures due to the reduced support qualities of a partial section and the relatively heavy loads associated with construction traffic. Accordingly, consideration should be given to the construction of designated haul roads where the thickness of the granular subbase and/or asphalt base course has been increased to account for the heavier-loaded construction traffic. We suggest that placement of the asphalt surface course not occur until all the major construction has been completed for pavement areas subjected to construction traffic.

5.1.3.2 Temporary Pavement Section

Temporary bridge approaches will be required for the proposed construction. A temporary asphalt pavement section is provided in Table 12 below based on the assumption that the design life for the temporary asphalt pavement is 2 years and that all other design parameters used in the AASHTO Design Equation for the permanent flexible pavement remain the same. Temporary pavement design calculations are presented in Appendix D of this report.

Table 12: Recommended Flexible Pavement Section – Temporary Pavement

Flexible Pavement Layer
165 lbs/sq. yd. Asphalt Concrete, Type IM-19.0A
2.5-inch Asphalt Concrete Base Course, Type BM-25.0A
6.0-inch Aggregate Base Material Type I, No. 21-B

5.1.4 Pavement Sawcuts

Sawcut will be required at the project limits. Since the existing pavement structure is not available, the anticipated depth of sawcut is not furnished in this report. However this estimate will be reviewed in the final soil survey report.

Full-depth sawcuts will be required where existing and proposed pavements join to create a clean, vertical joint for quality construction. Existing pavements along mainline and connectors shall be milled to a depth of 1.5 inches for a minimum distance beyond the sawcut as shown in the project roadway plans.

5.2 Earthwork

All earthwork procedures should conform to Section 303 of the VDOT Road and Bridge Specifications. Unsuitable existing fill, soft or loose natural soils, organic material, etc. should be stripped to approved subgrades as determined by the geotechnical engineer. The actual depth of stripping necessary to provide a suitable base for placement and compaction of earthwork may include topsoil and other soft surficial layers with or without organic matter. All subgrades should be proofrolled with a minimum 20 ton, loaded dump truck or suitable rubber tire construction equipment approved by the geotechnical engineer, prior to the placement of new fill. Detailed recommendations for the subgrade preparation will be included in the FSSR.

There may be some areas of deeper subcutting for removal of soft wet soils, particularly along seasonal creeks or drainage channels on the site. Actual undercutting requirements may also depend on groundwater conditions at the time of construction.

The majority of excavations to reach proposed footing elevation and pavement grades should generally be feasible using normal earth moving equipment. However, the final decision whether rock excavation will be required will depend on the final footing subgrade elevations and subsurface exploration to be provided in the FSSR.

5.3 Unsuitable Soils

Approximately 2-inches of topsoil was encountered in test boring B-2. Topsoil depths presented herein should not be considered as stripping depths, as topsoil depths may vary widely across the site. Stripping depths will probably extend to greater depths than the topsoil depths indicated herein due to the presence of minor amounts of organics, roots, and other surficial materials that will require removal as a part of the stripping operations. Further, in areas with mature trees, root balls may extend deeper than the topsoil depths presented herein. In these areas, the root balls may extend up to two feet and will require additional stripping depth up to two feet in localized areas to completely remove organics. In addition, seasonal soil moisture variations can affect stripping depths. In general, less stripping may occur during summer months when drier weather conditions can be expected.

Soft or loose soils ($N \leq 4$), soils with a liquid limit greater than 45 and a plasticity index greater than 25, soils with a CBR value less than 5, and soils with a swell greater than 5 percent are not considered suitable for direct support of the proposed bridge approaches and associated structures. Location of unsuitable materials encountered during investigation will be provided in the FSSR. Removal and replacement of these unsuitable soils will be required to limit potential total and differential settlement of structures.

Pursuant to Section 303.04(h) of the VDOT Road and Bridge Specifications, all borrow material and fill material for the embankments for this project shall have a minimum CBR of 5, shall not include USCS CH or MH soils unless stabilized with lime (per VTM-11) or cement (per VTM-72), and shall be in accordance with Section 303.04(h) of the 2007 Road and Bridge Specifications or as approved by the District Materials Engineer.

Location of unsuitable soil materials if encountered during final soil survey investigation will be provided in the FSSR.

5.4 Bridge Foundation

Based on the information provided to us, we understand that the project team is considering fully integral abutments for the proposed bridge. Further, the project team is considering using a single row of H-piles and spread footings for the support of abutments and piers, respectively. Based on our review of the

existing bridge plans, area geology maps, and soil maps, we believe that the H-piles and spread footings will be suitable for the support of the proposed new bridge.

Detailed characterization and evaluation of the rock conditions below each spread footing and H-pile bearing elevations will be required to determine factored resistance. Strict quality control will be required for foundation construction.

Detailed recommendations for the bridge abutment and pier foundations will be provided in the FSSR. A scour analysis should be performed by the project hydraulics engineer to determine maximum scour depth, as the anticipated scour depth will be required for the FSSR preparation.

5.5 Permanent Earth Retaining Structures

No specific locations for permanent retaining structures were provided at the time of writing this report. Recommendations about earth retaining structures, if applicable, will be provided in the FSSR

5.6 Temporary Shoring System

According to the project plans provided to us, temporary shoring will be required between Stations 15+50 and 18+50 on the west side of existing Route 340. Concrete gravity retaining wall (VDOT RW-3) is considered a feasible option for the temporary support system for Route 340. The maximum height of the temporary shoring VDOT RW-3 wall will be about 7 feet with a backfill slope 1.5(H):1(V) at about Station 18+50.

Concrete gravity retaining wall dimensions and porous backfill shall be as specified in Section 400 of VDOT Road and Bridge Standards. Recommended design parameters and drainage requirements for concrete gravity retaining wall are presented below. For concrete gravity retaining wall, backfill against the wall (i.e., specified backfill) should consist of materials classified as SC, SM, or more granular per ASTM D-2487, with a maximum particle size of 3 inches and a liquid limit and plasticity index less than 40 and 15, respectively. The minimum embedment for concrete gravity retaining wall should be 2.0 feet below the final grade in front of the wall, for frost protection. The upper 1.5 feet of soil at the base of wall should not be included in the design of passive soil resistance. Recommended soil design parameters for concrete gravity retaining wall backfill material are summarized below in Table 13.

Table 13: Recommended Soil Design Parameters for Concrete Gravity Retaining Wall

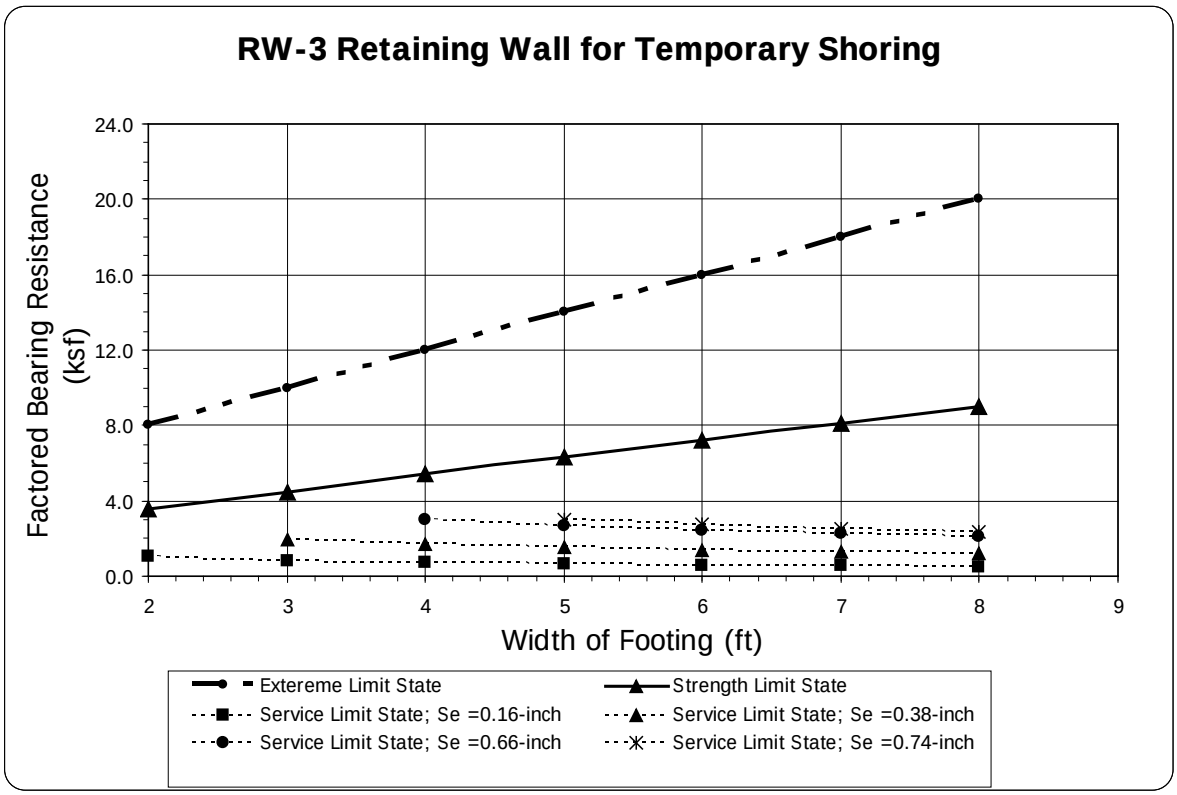
Material	Description	γ (pcf)	ϕ (degrees)	c (psf)	Coefficient of Base Sliding
Foundation Soils	Suitable Existing Fill or New Compacted Fill	120	28	0	0.35
Specified Backfill (VDOT RW-3)	Compacted Backfill (SC, SM, or more granular)	120	30	0	N/A

Notes: (1) Minimum required wall embedment = 2.0 ft.
(2) Key to abbreviations: N/A = not applicable; γ = Moist Unit Weight, ϕ= Friction Angle, and **c** = Cohesion.

We have performed global stability of the concrete gravity retaining wall and the results of the global stability analysis are presented in Section 5.7 of this report.

Spread footings supported on suitable existing fill or new compacted fill are considered suitable for support of concrete gravity retaining wall. A coefficient of sliding of 0.35 may be used to evaluate the average frictional resistance along the bottom of the wall. We have computed the bearing resistance for concrete gravity retaining wall when supported on suitable existing fill or new compacted fill. The factored bearing resistance at the strength limit state is calculated using a resistance factor of 0.45. For

the service and extreme event limit states, resistance factors of 1.0 are used in the calculations. Bearing resistances for strength limit, service limit, and extreme limit states are plotted in the following figure below and calculations are presented in Appendix E at the end of this report. Bearing resistance values as shown in the following figure were calculated assuming a construction joint will be provided at least at 100 feet interval.



Factored Bearing Resistance for a Footing of Length L'=L=100 ft (no eccentricity) and Depth of Embedment D_f= 2.0 ft. ("Se" in legend refers to immediate settlement; L=length of footing; L'=effective length of footing).

Footing subgrades should be observed and approved prior to placement of concrete, to ascertain that footings are placed on suitable bearing soils as recommended herein. Footings should be excavated and concrete placed the same day in order to avoid disturbance from water or weather. Disturbance of footing subgrades by exposure to water seepage or weather conditions should be avoided. Any existing fill, disturbed, frozen, or soft subgrade soils should be removed prior to placing footing concrete. Forms may be used if necessary, but less subgrade disturbance is anticipated if excavations are made to the required dimensions and concrete placed against the soil. If footings are formed, the forms should be removed and the excavation backfilled as soon as possible. Water should not be allowed to pond along the outside of footings for long periods of time.

5.7 Global and Slope Stability Analyses

We have performed stability analyses for the planned cuts and fills in the temporary shoring area. The critical slope section analyzed is shown on Figure B-1 in Appendix B. A travel lane surcharge of 250 psf was used for the stability analysis.

5.7.1 Soil Shear Strength Parameters

Soil strength parameters used in the stability analysis were assumed based on soil laboratory testing, VDOT Staunton District's Geotechnical Design Parameters for Retaining Walls, Sound Barrier Walls and Non-Critical slopes, and our experience with similar soil materials and geologic conditions, and are considered a conservative estimation of the actual shear strength characteristics. A summary of the shear strength parameters used in the stability analyses are presented in Table 14.

Table 14: Soil Parameters

Material Description	γ (pcf)	Short Term Analysis		Long Term Analysis	
		Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Cohesion, c (psf)	Friction Angle, ϕ (degrees)
New Compacted Fill	120	1500	0	0	30
Existing Fill (Stratum A)	120	1500	0	0	28
Stratum B1 (Residual Dolostone)	120	1000	0	0	32
Stratum B2 (Decomposed Dolostone)	130	1000	0	0	36
Stratum B3 (Dolostone Rock)	140	0	40	0	40

Key to abbreviations: **γ** = Moist Unit Weight, **ϕ** = Friction Angle, and **c** = Cohesion

5.7.2 Global and Slope Stability Analysis

Stability calculations were made using the Modified Bishop Method for circular failure surfaces using the GSTABL software. This computer program has been used to generate potential failure surfaces with randomly selected radii and centers. The stability analysis was performed assuming static loading and drained soil conditions. A search for the most critical potential failure surfaces occurring within earth materials in the proposed slopes were performed using circular failure modes as calculated by the Modified Bishop Method. A factor of safety of 1.5 is considered satisfactory for the proposed slopes for both short-term and long-term conditions. A factor of safety 1.3 is considered satisfactory for temporary shoring. Slope stability calculations are presented in Appendix F and are summarized below in Table 15.

Table 15: Stability Analysis of Proposed Slopes

Slope Stability Section	Slope Details	Factor of Safety		Remarks
		Short Term	Long Term	
A-A' (west slope)	Proposed 2H:1V Fill Slope; Height of slope =32.5 feet	2.05	1.34	Not Satisfactory
A-A' (east slope)	Proposed 2H:1V Fill Slope; Height of slope = 49 feet	1.42	1.06	Not Satisfactory
A-A' (east slope)	Temporary Shoring with RW-3 wall; Height of slope = 49 feet	1.45	--	Satisfactory
A-A' (east slope)	Temporary Shoring with RW-3 wall ; Height of slope = 12 feet	4.75	--	Satisfactory

Slope Stability Section	Slope Details	Factor of Safety		Remarks
		Short Term	Long Term	
B-B'	2H:1V Fill Slope; Height of slope = 10 feet	4.80	1.44	Satisfactory
C-C'	2H:1V Cut Slope; Height of slope = 7 feet	3.41	2.56	Satisfactory

The stability of the west slope at Section A-A' can be improved by flattening the slope to 2.5H:1V. As an alternative to flattening the slope, three layers of Synteen SF-55 or equivalent geogrids with long term design strength (LTDS) of 2,625 lb/ft and 35 feet long can be used to improve the stability of west slope of Section A-A'. The geogrids should be placed at 2 feet vertical distance starting from the subgrade. The results of slope stability analyses with different slope stability options are presented below in Table 16. Please note that the slope stabilizing measures presented herein will be required only approximately between Stations 17+50 and 18+50.

Table 16: Stability Analysis of Proposed Slopes with Slope Stabilization

Slope Stability Section	Slope Details	Factor of Safety		Remarks
		Short Term	Long Term	
West Slope				
Option 1: Flattening of Slope A-A' (west slope)	2.5H:1V Fill Slope; Height of slope =32.5 feet	2.20	1.65	Satisfactory
Option 2: 2H:1V with Geogrids A-A' (west slope)	2.0H:1V Fill Slope; 3 layers of geogrids 35 feet long at 2 feet vertical distance with LTDS = 2625 lb/ft; Height of slope =32.5 feet	2.05	1.51	Satisfactory
East Slope				
Option 1: Flattening of Slope A-A' (east slope)	2.75H:1V Fill Slope Height of slope = 49 feet	1.93	1.57	Satisfactory
Option 2: Stabilizing Pier A-A' (east slope)	2H:1V Fill Slope; with a 35 feet deep stabilizing pier Height of slope = 49 feet	1.38	1.63	Satisfactory

Additional stability analyses will be required if the design team selects the option of stabilizing piers for east slope. The additional stability analyses will be presented in the FSSR to determine the magnitude of unbalanced forces acting on the stabilizing drilled piers. Structural analysis and design of the drilled piers will also be presented in the FSSR.

5.8 Slope Design - General

Slope inclinations must be in accordance with the OSHA regulations. According to the project plans and cross-sections provided to us, the majority of embankments will be less than 20 feet in height and constructed over level ground. GeoConcepts will provide the fill and cut slope designs based on the

borings to be drilled for the FSSR. Generally, cut and fill slopes in rock and soil should be no steeper than 2H:1V and 3H:1V, respectively, unless supported by engineering analyses based on site specific field investigation and site specific laboratory strength testing. Slopes steeper than 2H:1V must be approved by VDOT.

5.9 Stormwater Management Basins/Minor Foundations

Information about any drainage structures was not available at the time of writing this report. We recommend that the VDOT Drainage Manual should be followed for the design of Stormwater Management (SWM) Basins, and PB-1 Standards should be followed for pipe culverts. Recommendations for SWM basins and minor structures, if applicable, will be presented in the FSSR. Potential soil corrosion of steel and concrete will also be addressed in the FSSR.

6.0 Recommendations for Additional Studies

This preliminary PSSR is not adequate to use for final design. It will be necessary to conduct a comprehensive geotechnical engineering analysis and reporting for this project. The field investigation for the final design phase study should consist of test borings and an electrical resistivity imaging survey. During the final soil survey subsurface investigation, two test borings should be drilled at each bridge abutment and pier locations. The depth of the test borings should be determined after the final design of the bridge. Test borings will also be required in the areas of full depth pavement reconstruction and bridge approaches. The depth of roadway borings should be determined after the final roadway cross-sections have been developed. However, if roadway improvements include at grade construction, test borings to a maximum depth of 10 feet or prior auger refusal are considered feasible. If cavities and voids are encountered during the final soil survey subsurface investigation, air track probes may be required to locate the limits of the cavities and voids within the project limits. Soil laboratory tests consisting of classification tests should be performed to determine physical and engineering properties of the bearing soils, and on-site soils for re-use as compacted fill. The comprehensive geotechnical engineering analysis and report should contain foundation recommendations for support of the bridge based on final bridge layouts and structural loads. The report should also include recommendations for pavements, earth retaining structures, rock excavation, global/slope stability, stormwater management basin, and karst features.

This report was prepared in accordance with generally accepted geotechnical engineering practices. No warranties, expressed or implied, are made as to the professional services included in this report.

We appreciate the opportunity to be of service for this project. Please contact the undersigned if you require clarification of any aspect of this report.

Sincerely,

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KF/JA/shm
N:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Final\Revised Report 10-24-14\Revised VDOT Soil Survey Preliminary Report.doc

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Figure 9: Floodplain Map
Figure 10: Existing Northern Approach Pavement
Figure 11: Existing Southern Approach Pavement

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ROUTE 340 REPLACEMENT AND APPROACHES OVER CUB RUN, PAGE COUNTY, VIRGINIA

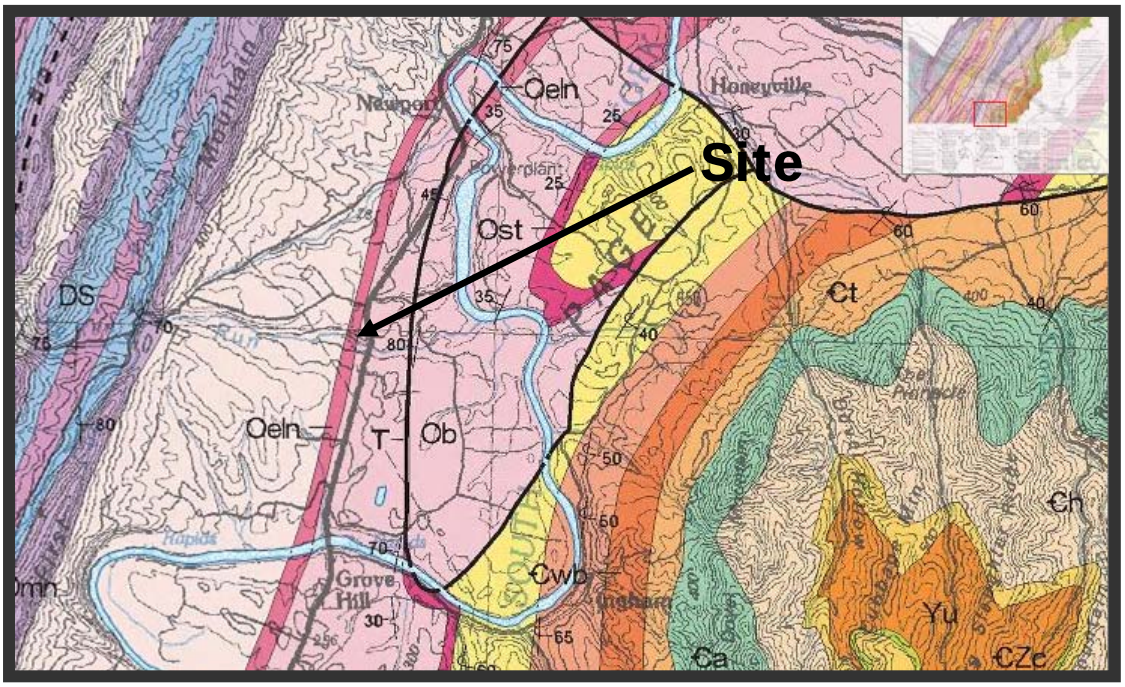
SITE VICINITY MAP		Scale: N.T.S	Fig. 1
Date: NOV.2012	Checked By: T.H.	Project No.: 11066.01	

Figure 2: Existing Overhead Utility line

Figure 3: Existing Piers and Guardrail

Figure 4: Existing Approach Embankment

Figure 5: A Small Hole on Southern Embankment



Oeln **Edinburg Formation, Lincolnshire Limestone, and New Market Limestone, undivided**

Edinburg Formation: black, fine-grained to aphanic limestone with black shale partings, pyrite common (Liberty Hall lithofacies of Cooper and Cooper, 1946), and medium- to light-gray, fine- to coarse-grained, nodular limestone with thin black shale partings (Lantz Mill lithofacies of Cooper and Cooper, 1946). Top of the Edinburg marked by a 30- to 60-foot thick very-fine-grained, medium-gray, thick-bedded limestone (St. Luke Member). East of Little North Mountain a greenish-gray siltstone occurs about 15 feet above the base of the Edinburg (Tumbling Run Siltstone Member). K-bentonites, some with basal chert or silicified zones, common, particularly near the base and top. Fossiliferous. Thickness: 425 to 500 feet. **Lincolnshire Limestone:** limestone, light- to very-dark-gray, fine- to coarse-grained, medium- to very-thick-bedded; dark-colored limestone with black chert nodules, generally parallel to bedding; light-colored, coarse-grained limestone, generally at the top of the formation, composed of fossil fragments (Murat Limestone Member). Upper contact gradational with the overlying Edinburg; lower contact unconformable with the underlying New Market. Thickness: 25 to 250 feet. **Unconformity. New Market Limestone:** lower unit: medium- to dark-gray, fine-grained, thin-bedded, argillaceous, in part dolomitic, bioturbated limestone, carbonate pebble conglomerate common at base; upper unit: medium-gray, aphanic, thick-bedded limestone with scattered, rhomboid-shaped sparry calcite crystals; high-calcium limestone quarried in the area. Thickness: 0 to 200+ feet.

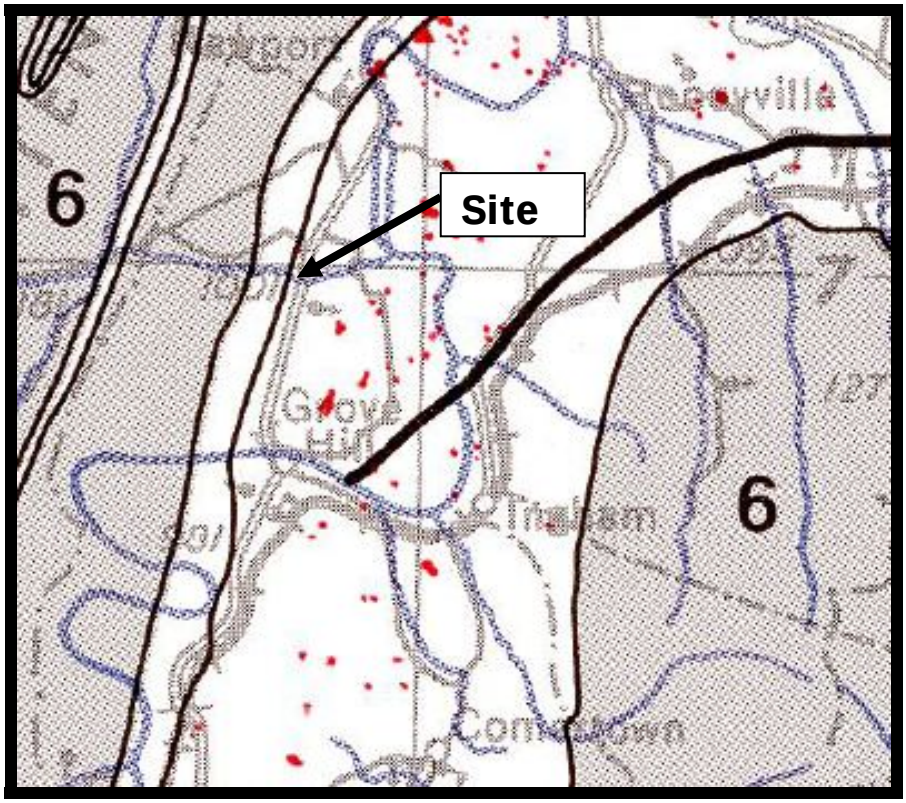
unconformity

Ob **Beekmantown Formation**

Dolostone, medium- to light-gray, weathers very-light-gray, fine-grained; medium- to thick-bedded, weathered surfaces exhibit a "butcher-block" structure, sparse fossils; limestone, medium-gray, fine-grained, fossiliferous limestone; light- to medium-gray, fine-grained, laminated dolomitic limestone and dolostone with mottled beds; lenses and beds of gray chert common. Upper contact unconformable; lower contact placed at the oldest thick-bedded dolomite overlying dark-gray limestone of the Stonehenge Limestone. Thickness: 2200 to 2400 feet.

Figure 6: Mapped Geologic Units

(Source: Geologic Map of The Front Royal 30 X 60 Minutes Quadrangle: Portions of Clarke, Page, Rockingham, Shenandoah, and Warren Counties, Virginia (Rader, E.K., Gathright II, T.M., 2001)



KEY

Sinkholes

Cave entrance

Multiple cave entrances

Contact line

Fault; tick mark and "T" indicate direction and dip of major overthrust sheets

Major drainage divides; see inset map for drainage basin names

Figure 7: Karst Features
(Source: Selected Karst Features of Northern Valley and Ridge Province (Hubbard, Jr. D.A ., 1983)

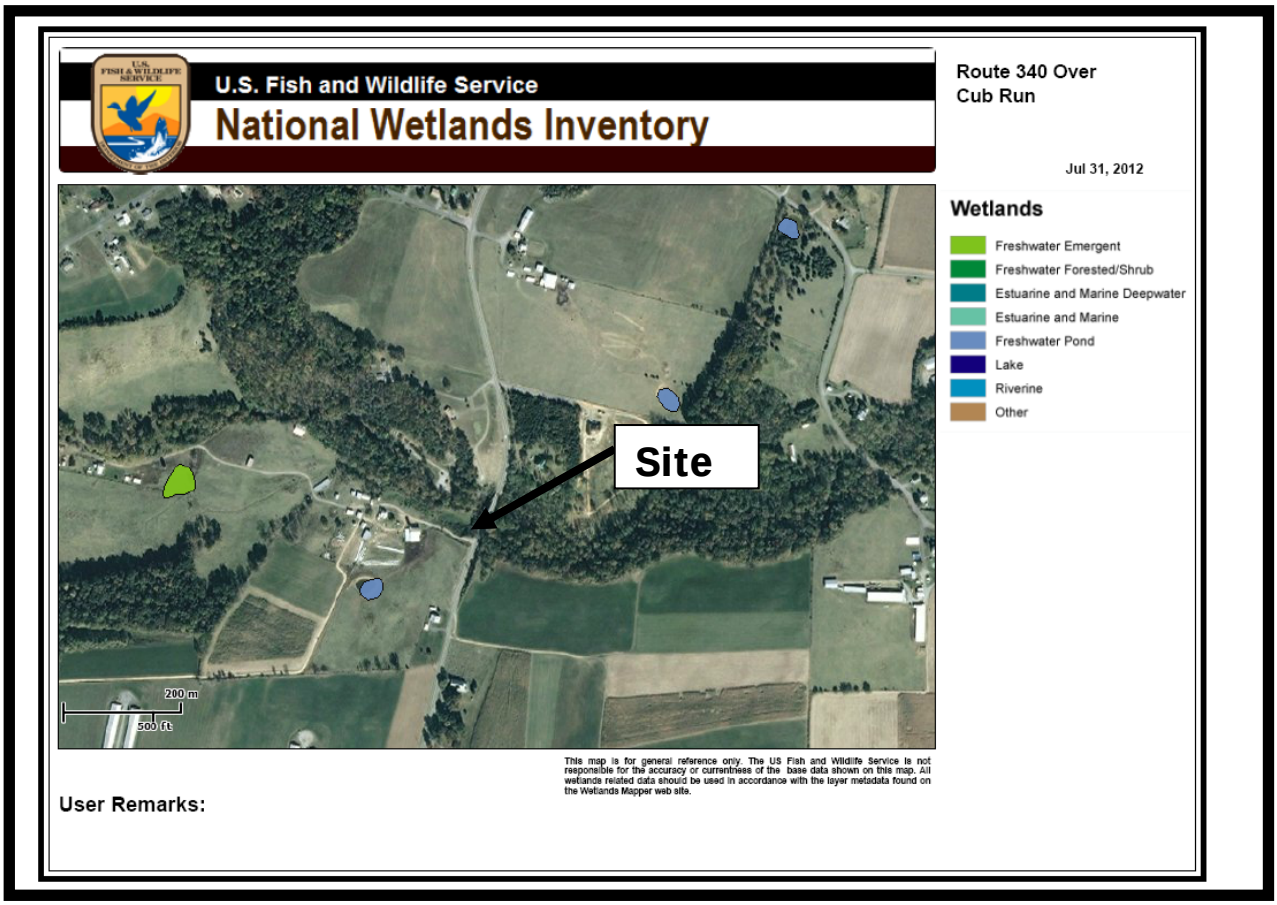
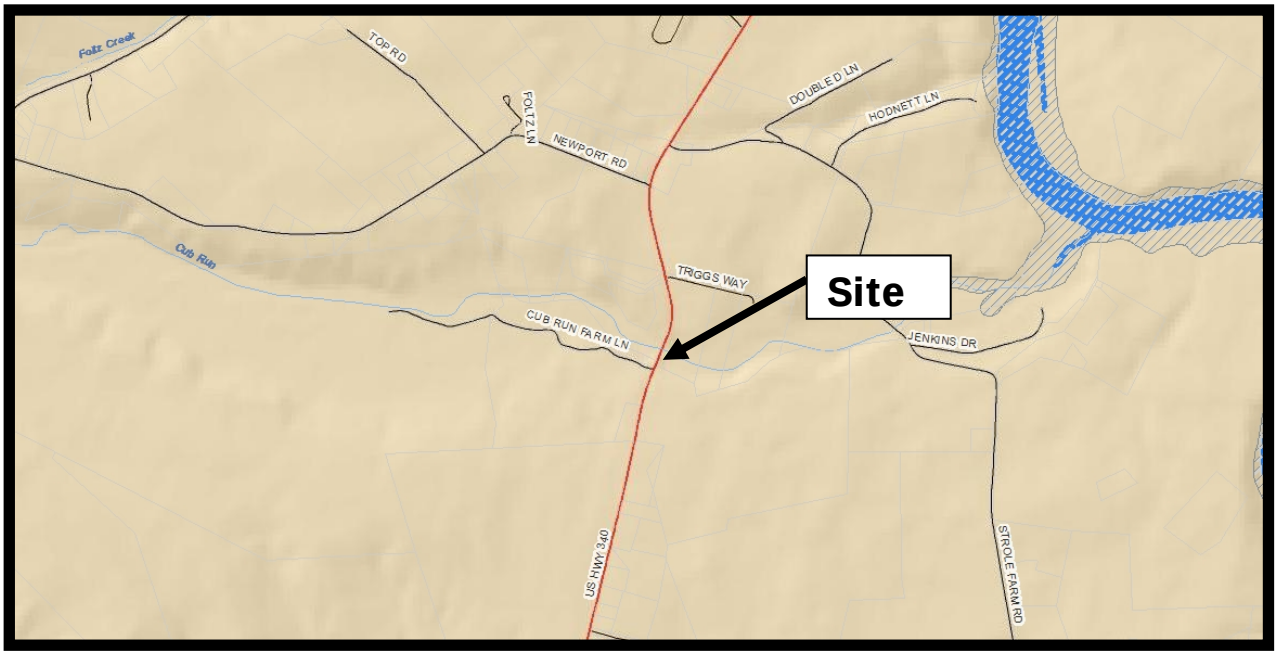


Figure 8: National Wetlands Inventory
(Source: Selected National Wetlands Inventory, Branch of Resources and Mapping Support http://www.fWs.gov/wetlands/Data/mapper.html accessed on 07/30/2012.)



FEMA Flood
- 0.2 PCT ANNUAL CHANCE FLOOD HAZARD
- A
- AE

Shenandoah River

Water Bodies

Figure 9: Floodplain Map
(Source: Federal Emergency Management Agency (FEMA), Flood Insurance Rate Maps (FIRMs) http://www.fema.gov/hazard/map/firm.shtm accessed on 07/30/2012)

Figure 10: Existing Northern Approach Pavement

Figure 11: Existing Southern Approach Pavement

Appendix A
Websoil Survey Data

Custom Soil Resource Report for Page County, Virginia (45 pages)

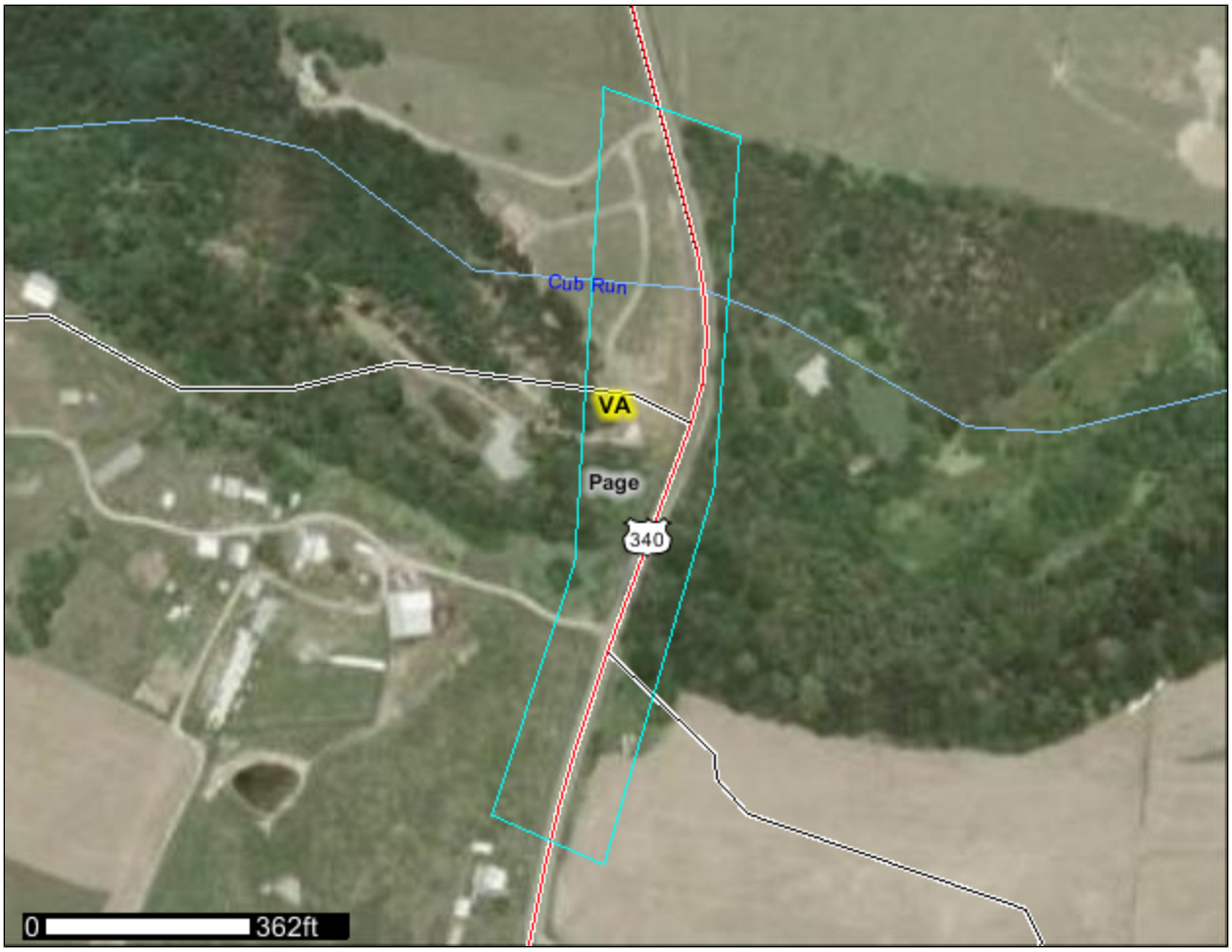
United States Department of Agriculture

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Page County, Virginia



July 31, 2012

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://soils.usda.gov/sqi/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

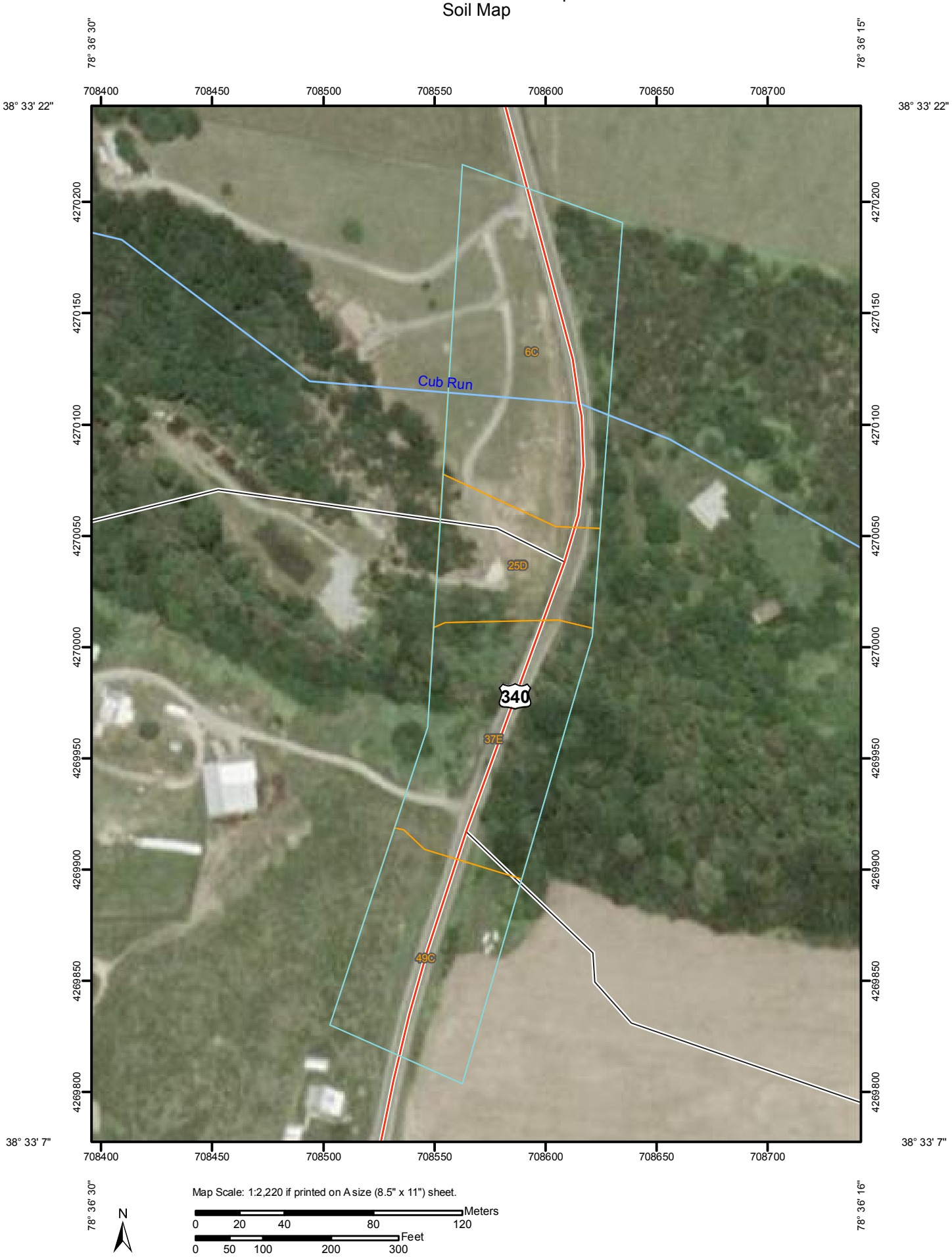
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:2,220 if printed on A size (8.5" x 11") sheet.

N

Meters
0 20 40 80 120

Feet
0 50 100 200 300

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features

- Gully
- Short Steep Slope
- Other

Political Features

- Cities

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:2,220 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 17N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Page County, Virginia
Survey Area Data: Version 7, Jan 26, 2010

Date(s) aerial images were photographed: 6/6/2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Page County, Virginia (VA139)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
6C	Carbo-Rock outcrop complex, 2 to 15 percent slopes	2.6	38.6%
25D	Jefferson fine sandy loam, 15 to 35 percent slopes	0.9	13.8%
37E	Oaklet-Carbo complex, 15 to 35 percent slopes, very rocky	1.7	25.8%
49C	Unison fine sandy loam, 7 to 15 percent slopes	1.4	21.9%
Totals for Area of Interest		**6.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic

classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Page County, Virginia

6C—Carbo-Rock outcrop complex, 2 to 15 percent slopes

Map Unit Setting

Elevation: 900 to 2,600 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 52 to 55 degrees F
Frost-free period: 170 to 217 days

Map Unit Composition

Carbo and similar soils: 55 percent
Rock outcrop: 35 percent

Description of Carbo

Setting

Landform: Hills
Landform position (two-dimensional): Summit, backslope, shoulder
Landform position (three-dimensional): Nose slope, side slope, interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from limestone

Properties and qualities

Slope: 2 to 15 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.0 inches)

Interpretive groups

Land capability (nonirrigated): 3e

Typical profile

0 to 7 inches: Silt loam
7 to 38 inches: Clay
38 to 48 inches: Bedrock

Description of Rock Outcrop

Setting

Landform: Hills
Landform position (two-dimensional): Summit, backslope, shoulder
Landform position (three-dimensional): Interfluve, nose slope, side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from limestone

Properties and qualities

Slope: 2 to 15 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability (nonirrigated): 8s

Typical profile

0 to 60 inches: Bedrock

25D—Jefferson fine sandy loam, 15 to 35 percent slopes

Map Unit Setting

Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 52 to 55 degrees F
Frost-free period: 170 to 217 days

Map Unit Composition

Jefferson and similar soils: 75 percent

Description of Jefferson

Setting

Landform: Fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Lower third of mountainflank
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Acid sandstone, shale, and siltstone colluvium

Properties and qualities

Slope: 15 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.6 inches)

Interpretive groups

Land capability (nonirrigated): 6e

Typical profile

0 to 12 inches: Fine sandy loam
12 to 44 inches: Gravelly sandy clay loam
44 to 65 inches: Very gravelly sandy clay loam

37E—Oaklet-Carbo complex, 15 to 35 percent slopes, very rocky

Map Unit Setting

Elevation: 500 to 2,600 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 52 to 55 degrees F
Frost-free period: 170 to 217 days

Map Unit Composition

Oaklet and similar soils: 55 percent
Carbo and similar soils: 40 percent

Description of Oaklet

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountaintop
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Residuum weathered from limestone and shale

Properties and qualities

Slope: 15 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.4 inches)

Interpretive groups

Land capability (nonirrigated): 7e

Typical profile

0 to 7 inches: Silt loam
7 to 73 inches: Clay

Description of Carbo

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope, nose slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from limestone

Properties and qualities

Slope: 15 to 35 percent

Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.0 inches)

Interpretive groups
Land capability (nonirrigated): 7e

Typical profile
0 to 7 inches: Silt loam
7 to 38 inches: Clay
38 to 48 inches: Bedrock

49C—Unison fine sandy loam, 7 to 15 percent slopes

Map Unit Setting
Elevation: 500 to 2,000 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 52 to 55 degrees F
Frost-free period: 170 to 217 days

Map Unit Composition
Unison and similar soils: 85 percent

Description of Unison

Setting
Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Old alluvium derived from sandstone and shale

Properties and qualities
Slope: 7 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 9.2 inches)

Interpretive groups
Land capability (nonirrigated): 3e

Typical profile

0 to 10 inches: Fine sandy loam

10 to 72 inches: Clay

Soil Information for All Uses

Suitabilities and Limitations for Use

The Suitabilities and Limitations for Use section includes various soil interpretations displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each interpretation.

Building Site Development

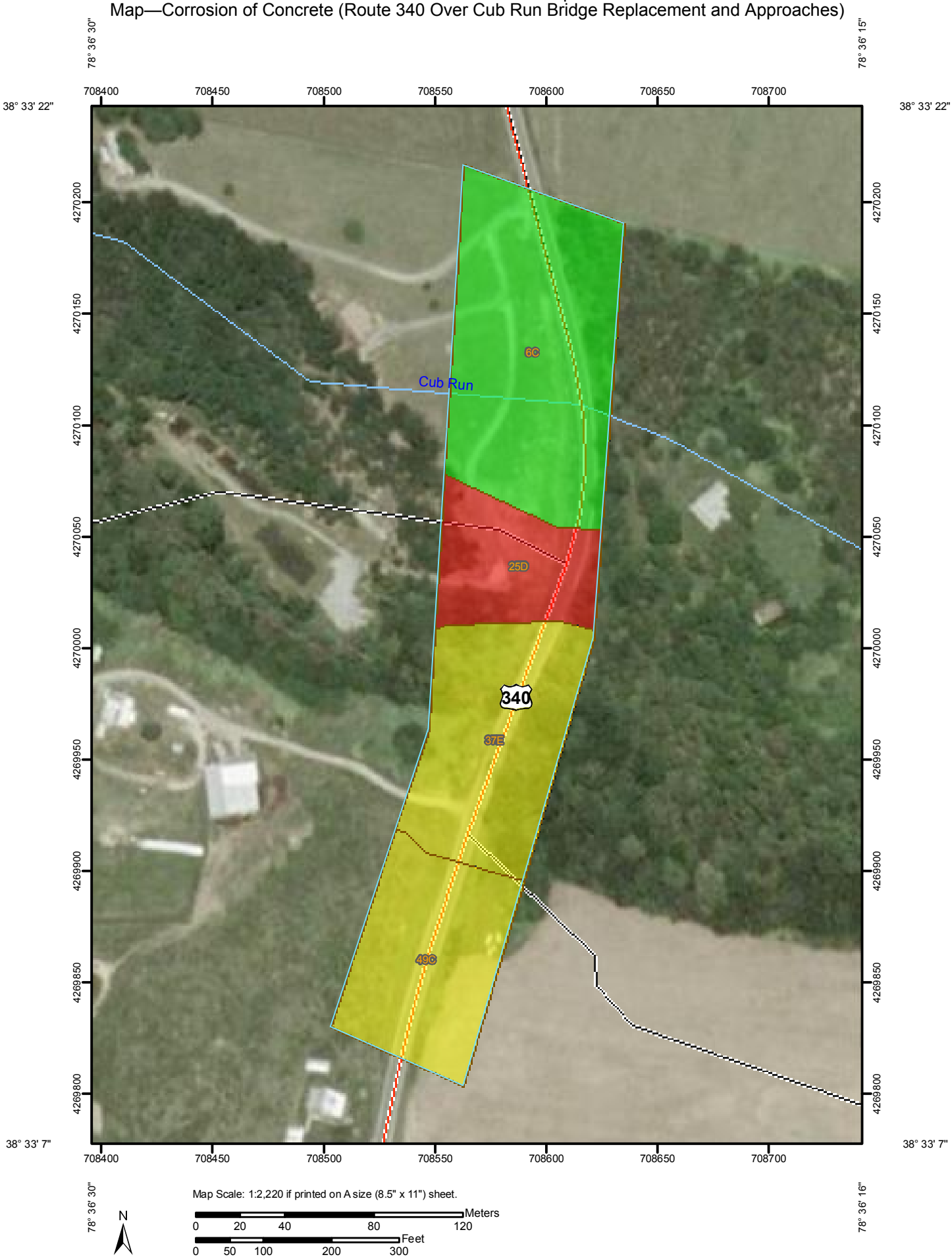
Building site development interpretations are designed to be used as tools for evaluating soil suitability and identifying soil limitations for various construction purposes. As part of the interpretation process, the rating applies to each soil in its described condition and does not consider present land use. Example interpretations can include corrosion of concrete and steel, shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping.

Corrosion of Concrete (Route 340 Over Cub Run Bridge Replacement and Approaches)

"Risk of corrosion" pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens concrete. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the concrete in installations that are entirely within one kind of soil or within one soil layer.

The risk of corrosion is expressed as "low," "moderate," or "high."

Custom Soil Resource Report
Map—Corrosion of Concrete (Route 340 Over Cub Run Bridge Replacement and Approaches)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

High

Moderate

Low

Not rated or not available

Political Features

Cities

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

MAP INFORMATION

Map Scale: 1:2,220 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 17N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Page County, Virginia
Survey Area Data: Version 7, Jan 26, 2010

Date(s) aerial images were photographed: 6/6/2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Corrosion of Concrete (Route 340 Over Cub Run Bridge Replacement and Approaches)

Corrosion of Concrete— Summary by Map Unit — Page County, Virginia (VA139)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
6C	Carbo-Rock outcrop complex, 2 to 15 percent slopes	Low	2.6	38.6%
25D	Jefferson fine sandy loam, 15 to 35 percent slopes	High	0.9	13.8%
37E	Oaklet-Carbo complex, 15 to 35 percent slopes, very rocky	Moderate	1.7	25.8%
49C	Unison fine sandy loam, 7 to 15 percent slopes	Moderate	1.4	21.9%
Totals for Area of Interest			**6.6**	**100.0%**

Rating Options—Corrosion of Concrete (Route 340 Over Cub Run Bridge Replacement and Approaches)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie.

The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

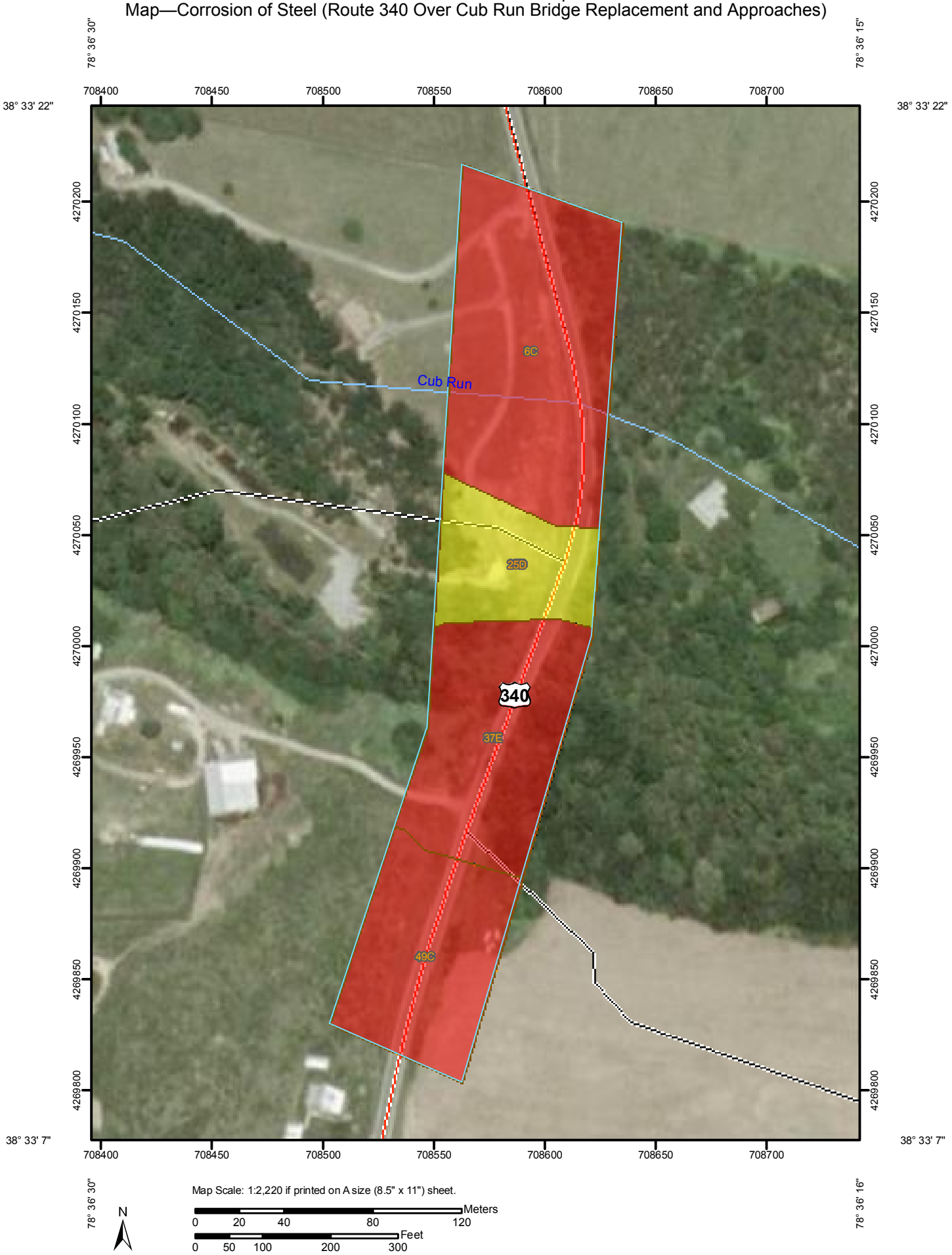
The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Corrosion of Steel (Route 340 Over Cub Run Bridge Replacement and Approaches)

"Risk of corrosion" pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel in installations that are entirely within one kind of soil or within one soil layer.

The risk of corrosion is expressed as "low," "moderate," or "high."

Custom Soil Resource Report
Map—Corrosion of Steel (Route 340 Over Cub Run Bridge Replacement and Approaches)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

High

Moderate

Low

Not rated or not available

Political Features

Cities

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

MAP INFORMATION

Map Scale: 1:2,220 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 17N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Page County, Virginia
Survey Area Data: Version 7, Jan 26, 2010

Date(s) aerial images were photographed: 6/6/2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Corrosion of Steel (Route 340 Over Cub Run Bridge Replacement and Approaches)

Corrosion of Steel— Summary by Map Unit — Page County, Virginia (VA139)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
6C	Carbo-Rock outcrop complex, 2 to 15 percent slopes	High	2.6	38.6%
25D	Jefferson fine sandy loam, 15 to 35 percent slopes	Moderate	0.9	13.8%
37E	Oaklet-Carbo complex, 15 to 35 percent slopes, very rocky	High	1.7	25.8%
49C	Unison fine sandy loam, 7 to 15 percent slopes	High	1.4	21.9%
Totals for Area of Interest			**6.6**	**100.0%**

Rating Options—Corrosion of Steel (Route 340 Over Cub Run Bridge Replacement and Approaches)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie.

The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Land Management

Land management interpretations are tools designed to guide the user in evaluating existing conditions in planning and predicting the soil response to various land management practices, for a variety of land uses, including cropland, forestland, hayland, pastureland, horticulture, and rangeland. Example interpretations include suitability for a variety of irrigation practices, log landings, haul roads and major skid trails, equipment operability, site preparation, suitability for hand and mechanical planting, potential erosion hazard associated with various practices, and ratings for fencing and waterline installation.

Erosion Hazard (Off-Road, Off-Trail) (Route 340 Over Cub Run Bridge Replacement and Approaches)

The ratings in this interpretation indicate the hazard of soil loss from off-road and off-trail areas after disturbance activities that expose the soil surface. The ratings are based on slope and soil erosion factor K. The soil loss is caused by sheet or rill erosion in off-road or off-trail areas where 50 to 75 percent of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance.

The ratings are both verbal and numerical. The hazard is described as "slight," "moderate," "severe," or "very severe." A rating of "slight" indicates that erosion is unlikely under ordinary climatic conditions; "moderate" indicates that some erosion is likely and that erosion-control measures may be needed; "severe" indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised; and "very severe" indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical.

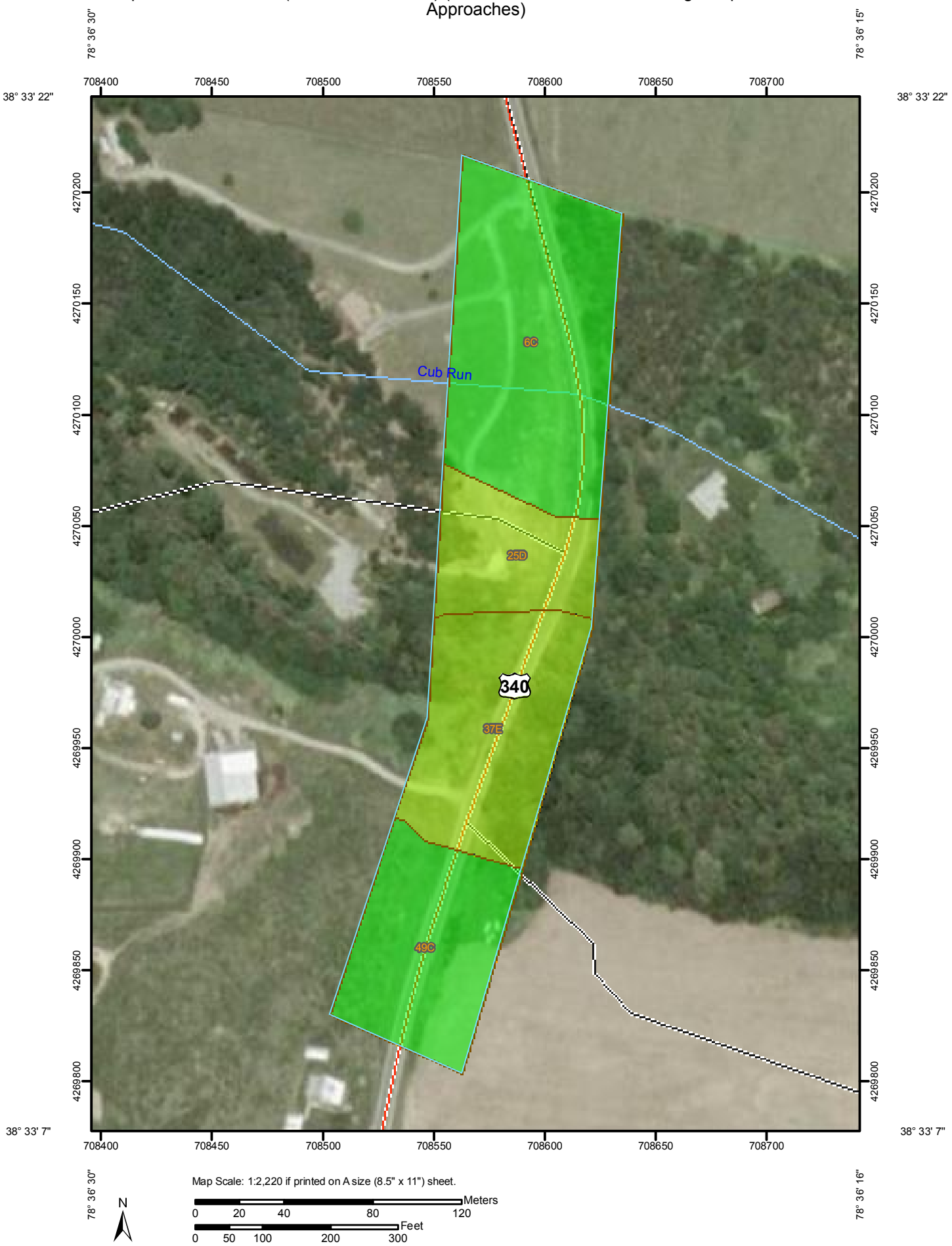
Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the specified aspect of forestland management (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are

determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Custom Soil Resource Report
Map—Erosion Hazard (Off-Road, Off-Trail) (Route 340 Over Cub Run Bridge Replacement and Approaches)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

Very severe

Severe

Moderate

Slight

Not rated or not available

Political Features

Cities

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

MAP INFORMATION

Map Scale: 1:2,220 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 17N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Page County, Virginia
Survey Area Data: Version 7, Jan 26, 2010

Date(s) aerial images were photographed: 6/6/2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Erosion Hazard (Off-Road, Off-Trail) (Route 340 Over Cub Run Bridge Replacement and Approaches)

Erosion Hazard (Off-Road, Off-Trail)— Summary by Map Unit — Page County, Virginia (VA139)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
6C	Carbo-Rock outcrop complex, 2 to 15 percent slopes	Slight	Carbo (55%)		2.6	38.6%
25D	Jefferson fine sandy loam, 15 to 35 percent slopes	Moderate	Jefferson (75%)	Slope/erodibility (0.50)	0.9	13.8%
37E	Oaklet-Carbo complex, 15 to 35 percent slopes, very rocky	Moderate	Oaklet (55%)	Slope/erodibility (0.50)	1.7	25.8%
			Carbo (40%)	Slope/erodibility (0.50)		
49C	Unison fine sandy loam, 7 to 15 percent slopes	Slight	Unison (85%)		1.4	21.9%
Totals for Area of Interest					**6.6**	**100.0%**

Erosion Hazard (Off-Road, Off-Trail)— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Slight	4.0	60.4%
Moderate	2.6	39.6%
Totals for Area of Interest	**6.6**	**100.0%**

Rating Options—Erosion Hazard (Off-Road, Off-Trail) (Route 340 Over Cub Run Bridge Replacement and Approaches)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component

typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie.

The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Erosion Hazard (Road, Trail) (Route 340 Over Cub Run Bridge Replacement and Approaches)

The ratings in this interpretation indicate the hazard of soil loss from unsurfaced roads and trails. The ratings are based on soil erosion factor K, slope, and content of rock fragments.

The ratings are both verbal and numerical. The hazard is described as "slight," "moderate," or "severe." A rating of "slight" indicates that little or no erosion is likely; "moderate" indicates that some erosion is likely, that the roads or trails may require occasional maintenance, and that simple erosion-control measures are needed; and "severe" indicates that significant erosion is expected, that the roads or trails require frequent maintenance, and that costly erosion-control measures are needed.

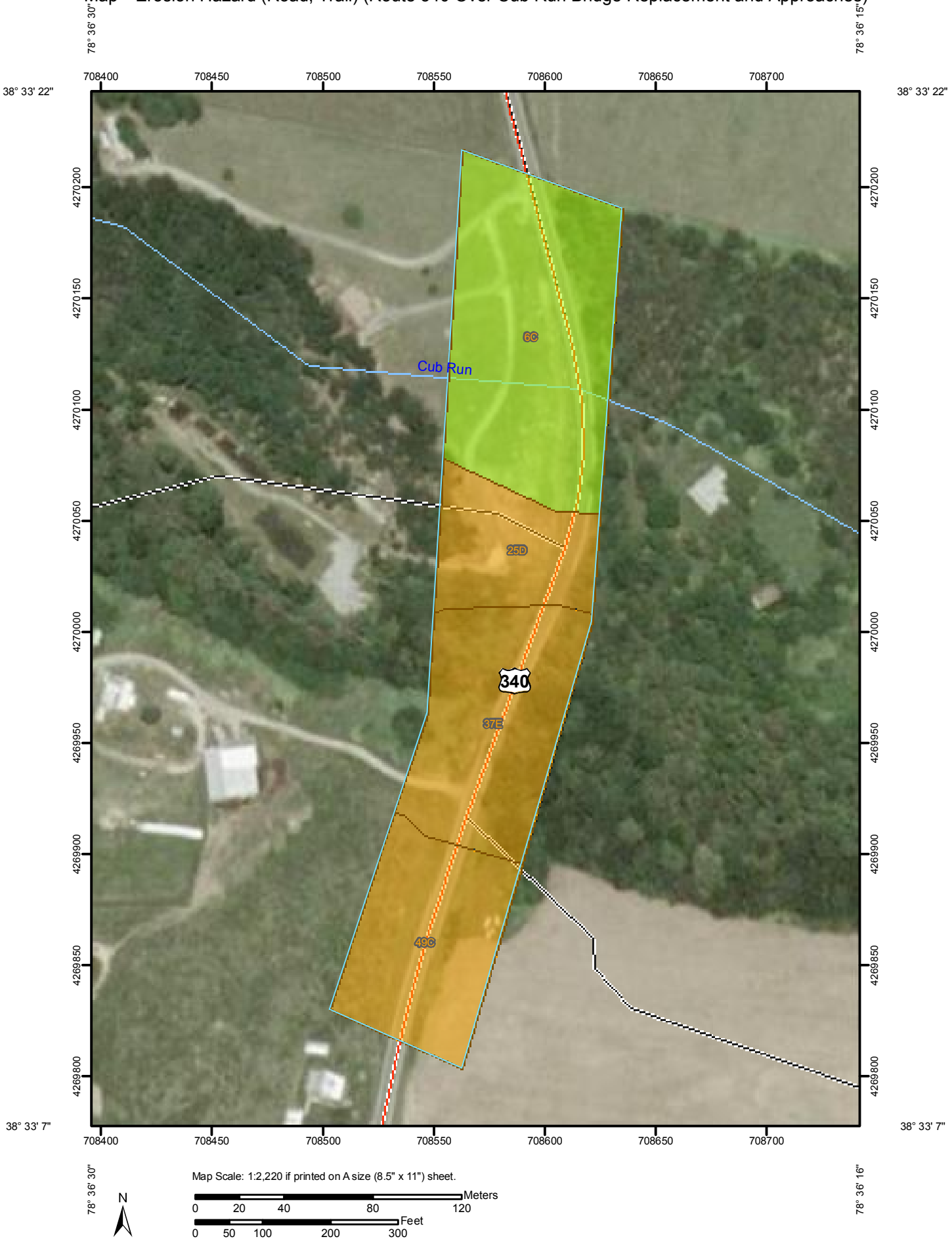
Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the specified aspect of forestland management (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have

the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Custom Soil Resource Report
Map—Erosion Hazard (Road, Trail) (Route 340 Over Cub Run Bridge Replacement and Approaches)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

Very severe

Severe

Moderate

Slight

Not rated or not available

Political Features

Cities

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

MAP INFORMATION

Map Scale: 1:2,220 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 17N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Page County, Virginia
Survey Area Data: Version 7, Jan 26, 2010

Date(s) aerial images were photographed: 6/6/2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Tables—Erosion Hazard (Road, Trail) (Route 340 Over Cub Run Bridge Replacement and Approaches)

Erosion Hazard (Road, Trail)— Summary by Map Unit — Page County, Virginia (VA139)						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
6C	Carbo-Rock outcrop complex, 2 to 15 percent slopes	Moderate	Carbo (55%)	Slope/erodibility (0.50)	2.6	38.6%
25D	Jefferson fine sandy loam, 15 to 35 percent slopes	Severe	Jefferson (75%)	Slope/erodibility (0.95)	0.9	13.8%
37E	Oaklet-Carbo complex, 15 to 35 percent slopes, very rocky	Severe	Oaklet (55%)	Slope/erodibility (0.95)	1.7	25.8%
			Carbo (40%)	Slope/erodibility (0.95)		
49C	Unison fine sandy loam, 7 to 15 percent slopes	Severe	Unison (85%)	Slope/erodibility (0.95)	1.4	21.9%
Totals for Area of Interest					**6.6**	**100.0%**

Erosion Hazard (Road, Trail)— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Severe	4.1	61.4%
Moderate	2.6	38.6%
Totals for Area of Interest	**6.6**	**100.0%**

Rating Options—Erosion Hazard (Road, Trail) (Route 340 Over Cub Run Bridge Replacement and Approaches)

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component

typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie.

The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Chemical Properties

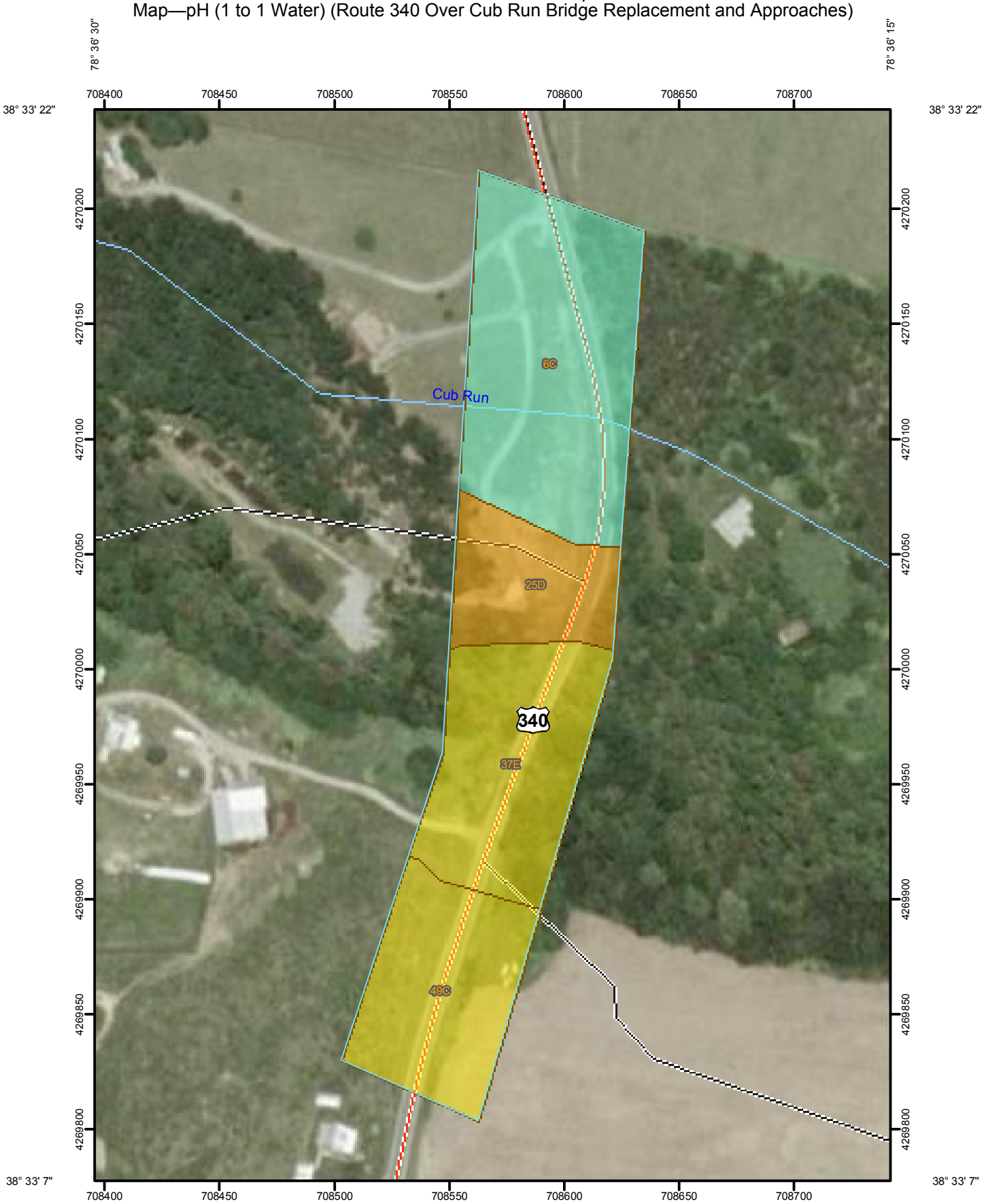
Soil Chemical Properties are measured or inferred from direct observations in the field or laboratory. Examples of soil chemical properties include pH, cation exchange capacity, calcium carbonate, gypsum, and electrical conductivity.

pH (1 to 1 Water) (Route 340 Over Cub Run Bridge Replacement and Approaches)

Soil reaction is a measure of acidity or alkalinity. It is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion. In general, soils that are either highly alkaline or highly acid are likely to be very corrosive to steel. The most common soil laboratory measurement of pH is the 1:1 water method. A crushed soil sample is mixed with an equal amount of water, and a measurement is made of the suspension.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Custom Soil Resource Report
Map—pH (1 to 1 Water) (Route 340 Over Cub Run Bridge Replacement and Approaches)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

Ultra acid (ph < 3.5)

Extremely acid (pH 3.5 - 4.4)

Very strongly acid (pH 4.5 - 5.0)

Strongly acid (pH 5.1 - 5.5)

Moderately acid (pH 5.6 - 6.0)

Slightly acid (pH 6.1 - 6.5)

Neutral (pH 6.6 - 7.3)

Slightly alkaline (pH 7.4 - 7.8)

Moderately alkaline (pH 7.9 - 8.4)

Strongly alkaline (pH 8.5 - 9.0)

Very strongly alkaline (pH > 9.0)

Not rated or not available

Political Features

Cities

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

MAP INFORMATION

Map Scale: 1:2,220 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 17N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Page County, Virginia
Survey Area Data: Version 7, Jan 26, 2010

Date(s) aerial images were photographed: 6/6/2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—pH (1 to 1 Water) (Route 340 Over Cub Run Bridge Replacement and Approaches)

pH (1 to 1 Water)— Summary by Map Unit — Page County, Virginia (VA139)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
6C	Carbo-Rock outcrop complex, 2 to 15 percent slopes	6.6	2.6	38.6%
25D	Jefferson fine sandy loam, 15 to 35 percent slopes	5.0	0.9	13.8%
37E	Oaklet-Carbo complex, 15 to 35 percent slopes, very rocky	5.5	1.7	25.8%
49C	Unison fine sandy loam, 7 to 15 percent slopes	5.3	1.4	21.9%
Totals for Area of Interest			**6.6**	**100.0%**

Rating Options—pH (1 to 1 Water) (Route 340 Over Cub Run Bridge Replacement and Approaches)

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options: All Layers

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Soil Physical Properties

This folder contains a collection of tabular reports that present soil physical properties. The reports (tables) include all selected map units and components for each map unit. Soil physical properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

Engineering Properties (Route 340 Over Cub Run Bridge Replacement and Approaches)

This table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme,

soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

References:

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Absence of an entry indicates that the data were not estimated. The asterisk '*' denotes the representative texture; other possible textures follow the dash.

Engineering Properties– Page County, Virginia												
Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
6C—Carbo-Rock outcrop complex, 2 to 15 percent slopes												
Carbo	0-7	*Silt loam	CL	A-7, A-6	0	0-2	95-100	90-100	85-95	75-85	30-50	10-25
	7-38	*Clay	CH	A-7	0	0-5	95-100	85-100	80-95	70-90	60-80	35-55
	38-48	*Bedrock	—	—	—	—	—	—	—	—	—	—
Rock outcrop	0-60	*Bedrock	—	—	—	—	—	—	—	—	—	—
25D—Jefferson fine sandy loam, 15 to 35 percent slopes												
Jefferson	0-12	*Fine sandy loam	SC, CL, CL-ML	A-2, A-4	0	0-5	90-100	85-95	60-81	34-52	21-30	4-11
	12-44	*Gravelly sandy clay loam, Gravelly loam, gravelly clay loam	CL, SC	A-6, A-2	0	0-5	75-90	50-90	42-90	30-72	28-43	10-21
	44-65	*Very gravelly sandy clay loam, Very gravelly loam, very gravelly clay loam	SC, CL, GC-GM	A-4, A-2	0	0-5	55-75	25-75	21-75	15-60	26-39	8-18

Engineering Properties– Page County, Virginia												
Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
37E—Oaklet-Carbo complex, 15 to 35 percent slopes, very rocky												
Oaklet	0-7	*Silt loam	CH, CL	A-6, A-7	0	0-5	80-100	80-100	76-100	60-90	31-52	13-28
	7-73	*Clay	CH	A-7	0	0-10	80-100	80-100	70-100	60-95	68-87	44-59
Carbo	0-7	*Silt loam	CL	A-6, A-7	0	0-2	95-100	90-100	85-95	75-85	30-50	10-25
	7-38	*Clay	CH	A-7	0	0-5	95-100	85-100	80-95	70-90	60-80	35-55
	38-48	*Bedrock	—	—	—	—	—	—	—	—	—	—
49C—Unison fine sandy loam, 7 to 15 percent slopes												
Unison	0-10	*Fine sandy loam	CL, CL-ML, SC	A-6, A-4	0	0-10	90-100	85-100	60-85	35-55	22-41	6-17
	10-72	*Clay, Clay loam, gravelly silty clay	CH, CL	A-6, A-7	0	0-10	65-100	50-100	45-100	35-95	39-76	21-51

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

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United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://soils.usda.gov/

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.glti.nrcs.usda.gov/

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://soils.usda.gov/

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://soils.usda.gov/

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210.

Appendix B
Subsurface Investigation

Subsurface Investigation Procedures (1 page)
Identification of Soil (1 page)
Test Boring Notes (1 page)
Soil Test Boring Logs (3 pages)
Rock Core and Pavement Cores Photos (3 pages)
Boring Location Plan, Figure B-1 (1 page)

Subsurface Investigation Procedures

1. Test Borings – Hollow Stem Augers

The borings are advanced by turning an auger with a center opening of 3-¼ inches. A plug device blocks off the center opening while augers are advanced. Cuttings are brought to the surface by the auger flights. Sampling is performed through the center opening in the hollow stem auger, by standard methods, after removal of the plug. Usually, no water is introduced into the boring using this procedure.

2. Standard Penetration Tests

Standard penetration tests are performed by driving a 2 inch O.D., 1-⅜ inch I.D. sampling spoon with a 140-pound hammer falling 30 inches, according to ASTM D-1586. After an initial 6 inches penetration to assure the sampling spoon is in undisturbed material, the number of blows required to drive the sampler an additional 12 inches is generally taken as the N value. In the event 30 or more blows are required to drive the sampling spoon the initial 6 inch interval, the sampling spoon is driven to a total penetration resistance of 100 blows or 18 inches, whichever occurs first. The sampling operation is terminated after a total of 100 hammer blows and the depth of penetration is recorded.

3. Rock Core Drilling

Rock is core drilled using NQ size core bits set with carbide steel or diamond, depending upon the rock texture. The bit is fitted onto a double tube swivel-type core barrel in which an exterior tube and bit rotate, and an interior barrel remains stationary to receive the rock core. Water is circulated between the barrels and across the bit face to cool the core bit and to flush away cuttings.

4. Test Boring and Stakeout

The test boring stakeout was provided by Dewberry.

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Identification of Soil

I. DEFINITION OF SOIL GROUP NAMES

		ASTM D-2487	Symbol	Group Name
Coarse-Grained Soils More than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines	*GW*	WELL GRADED GRAVEL
			GP	POORLY GRADED GRAVEL
		Gravels with Fines More than 12% fines	*GM*	silty GRAVEL
			GC	clayey GRAVEL
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines	*SW*	WELL GRADED SAND
			SP	POORLY GRADED SAND
		Sands with fines More than 12% fines	*SM*	silty SAND
			SC	clayey SAND
Fine-Grained Soils 50% or more passes the No. 200 sieve	**Silts and Clays** Liquid Limit less than 50	Inorganic	*CL*	LEAN CLAY
			ML	SILT
		Organic	*OL*	ORGANIC CLAY
				ORGANIC SILT
	Silts and Clays Liquid Limit 50 or more	Inorganic	*CH*	FAT CLAY
			MH	ELASTIC SILT
		Organic	*OH*	ORGANIC CLAY
				ORGANIC SILT
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor		*PT*	PEAT

II. DEFINITION OF MINOR COMPONENT PROPORTIONS

Minor Component	Approximate Percentage of Fraction by Weight
Gravelly. Sandy (adjective)	30% or more coarse grained
Sand, Gravel (with)	15% to 29% coarse grained
Silt, Clay (with)	5% to 12% fine grained

III. GLOSSARY OF MISCELLANEOUS TERMS

SYMBOLS	Unified Soil Classification Symbols are shown above as group symbols. Use "A" Line Chart for laboratory identification. Dual symbols are used for borderline classification.
BOULDERS & COBBLES	Boulders are considered pieces of rock larger than 12 inches, while cobbles range from 3 to 12 inches.
DISINTEGRATED ROCK	Residual rock material with a standard penetration test (SPT) resistance between 60 blows per foot and refusal.
ROCK	Rock material with a standard penetration test (SPT) resistance of 100 blows for 2 inches or 50 blows for 0 inches, or less penetration
DECOMPOSED ROCK	Residual rock material exhibiting rock-like properties that can be excavated by backhoe equipment. Similar to Disintegrated Rock, but cannot be classified as such because SPT N-Values were not obtained.
ROCK FRAGMENTS	Angular pieces of rock, distinguished from rounded transported gravel, which have separated from original vein or strata and are present in a soil matrix.
QUARTZ	A hard silicate mineral often found in residual soils. Only used when describing residual soils.
CEMENTED SAND	Usually localized rock-like deposits within a soil stratum composed of sand grains cemented by calcium carbonate, iron oxide, or other minerals. Commonly encountered in Coastal Plain sediments, primarily in the Potomac Group sands (Kps).
MICA	A plate-like phyllosilicate mineral found in many rocks, and in residual or transported soil derived therefrom.
ORGANIC MATERIALS (Excluding Peat)	Topsoil - Surface soils that support plant life and contain organic matter. Lignite - Hard, brittle decomposed organic matter with low fixed carbon content (a low grade of coal).
FILL	Man made deposit containing soil, rock, and other foreign matter.
PROBABLE FILL	Soils which contain no visually detected foreign matter but which are suspect with regard to origin.
LAYERS	½ to 12 inch seam of minor soil component.
COLOR	Two most predominant colors present should be described.
MOISTURE CONDITIONS	Wet, moist, or dry to indicate visual appearance of specimen.

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Test Boring Notes

1. Classification of soil is by visual inspection and is in accordance with the Unified Soil Classification System.

2. Estimated groundwater levels are indicated on the logs. These are only estimates from available data and may vary with precipitation, porosity of soil, site topography, etc.

3. Sampling data presents standard penetrations for 6-inch intervals or as indicated with graphic representations adjacent to the sampling data.

4. The logs and related information depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at the test locations. Also, the passage of time may result in a change in the subsurface conditions at the test locations.

5. The stratification lines represent the approximate boundary between soil types as determined in the sampling operation. Some variation may be expected vertically between samples taken. The soil profile, groundwater level observations and penetration resistances presented on the logs have been made with reasonable care and accuracy and must be considered only an approximate representation of subsurface conditions to be encountered at the particular location.

Virginia Department of Transportation

PROJECT #: 11066.01
LOCATION: Route 340 Bridge over Cub Run
STRUCTURE: ROADWAY

B-1
PAGE 1 OF 1

STATION: 15+50 OFFSET: 4.0 ft. Left
LATITUDE: 38.552758° N LONGITUDE: 78.606806° W
SURFACE ELEVATION: 958.85 ft COORD. DATUM: NAD 83

Date(s) Drilled: 9/26/2012 - 9/26/2012
Drilling Method(s): 3.25" I.D. HSA, 3" Core Barrel (NQ2)
SPT Method: Automatic Hammer
Other Test(s):
Driller: Connelly and Associates, Inc. (Roberts)
Logger: W. Richards

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NOT ENCOUNTERED DURING DRILLING

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
	958										0.0 / 958.85 Asphalt = 22 inches **ASPH**			
											1.8 / 957.05 Gravel Base = 8 inches			
	956	7 7 21 50/3 100/2	59 85		2.5 4.5 4.7						2.5 / 956.35 Brown and gray, silty gravel FILL, with sand, medium dense, moist **GM**	NP	NP	3.2
5	954										4.5 / 954.35 Gray, decomposed DOLOSTONE Sample as: poorly graded GRAVEL, very dense, moist **GP**			1.0
											4.7 / 954.15 Auger and spoon refusal at 4.7 ft.			
	952					74	18				4.7 / 954.15 Highly weathered, hard, thinly bedded, moderately fractured: DOLOSTONE, gray **DLS**			
	950				9.7						9.7 / 949.15 BOTTOM OF BORING AT 9.7 FT.			

REMARKS: Cave-in depth: 3.0 ft
Bulk sample collected from 0.0 to 5.0 ft. from offset location.
Offset is from center of existing pavement.
Backfilled upon completion.

PAGE 1 OF 1
B-1

SPT_LOG:LOGS.GPJ:8.30.002:021011:11/13/12

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Virginia Department of Transportation

PROJECT #: 11066.01
LOCATION: Route 340 Bridge over Cub Run
STRUCTURE: ROADWAY

B-2
PAGE 1 OF 1

STATION: 17+00 OFFSET: 10.0 ft. Left
LATITUDE: 38.553150° N LONGITUDE: 78.606642° W
SURFACE ELEVATION: 947.9 ft COORD. DATUM: NAD 83

Date(s) Drilled: 9/26/2012 - 9/26/2012
Drilling Method(s): 3.25" I.D. HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: Connelly and Associates, Inc. (Roberts)
Logger: W. Richards

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NOT ENCOUNTERED DURING DRILLING

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		5									0.0 / 947.9 Topsoil = 2 inches **TOPS**			
	947	6	70								0.17 / 947.73 Brown, clayey sand FILL, with gravel, medium dense, moist **SC**			2.8
		18												
		30												
	946	100/2	100		2 2.2						2.2 / 945.7 AUGER AND SPOON REFUSAL AT 2.2 FT.			0.5

REMARKS: Cave-in depth: 1.0 ft
An additional offset boring was drilled 5.0 ft. south of B-2. Auger and spoon refusal at 2.2 ft.
Offset is from center of existing pavement.
Backfilled upon completion.

PAGE 1 OF 1
B-2

SPT_LOG:LOGS.GPJ:8.30.002:021011:11/13/12

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Virginia Department of Transportation

PROJECT #: 11066.01
LOCATION: Route 340 Bridge over Cub Run
STRUCTURE: ROADWAY

B-3
PAGE 1 OF 1

STATION: 18+50 OFFSET: 5.0 ft. Left
LATITUDE: 38.553531° N LONGITUDE: 78.606406° W
SURFACE ELEVATION: 941.26 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 9/26/2012 - 9/26/2012
Drilling Method(s): 3.25" I.D. HSA, 3" Core Barrel (NQ2)
SPT Method: Automatic Hammer
Other Test(s):
Driller: Connelly and Associates, Inc. (Roberts)
Logger: W. Richards

GROUND WATER
FIRST ENCOUNTERED AT 28.5 ft DEPTH
STABILIZED AT 26.0 ft

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
	940										0.0 / 941.26 Asphalt = 18 inches **ASPH**			
		11 8 7 15	20		2.5						1.5 / 939.76 Gravel Base = 12 inches			1.1
5		3 3 14 8	55		4.5						2.5 / 938.76 Brown, lean clay FILL, with gravel and sand, stiff, moist **CL**			21.1
	935	8 2 2 4	85		6.5						4.5 / 936.76 SAME: very stiff below 4.5 ft.	45	23	30.9
		9 7 7 8	45		8.5						6.5 / 934.76 SAME: without gravel, soft below 6.5 ft.			1.6
10	930				10.5						8.5 / 932.76 Brown, clayey gravel FILL, with sand, medium dense, moist **GC**			
		3 3 5	107		13.5							29	16	12.7
15	925				15						13.5 / 927.76 Brown, clayey sand FILL, loose, moist **SC**			
		4 3 2	60		18.5									29.9
20	920				20									
		3 3 2	87		23.5						23.5 / 917.76 SAME: with gravel below 23.5 ft.	55	37	13.2
25	915				25									
		6 5 7	40		28.5						28.5 / 912.76 SAME: medium dense below 28.5 ft.			19.6
30	910				30									
		39 7 12	33		33.5						33.5 / 907.76 Brown, clayey SAND, with gravel, medium dense, moist **SC**	25	10	12.9
35	905				35									
		28 100/4 100/0	63		38.5 39.3						38.5 / 902.76 Dark brown, decomposed DOLOSTONE Sampled as: clayey SAND, very dense, wet **SC**			14.9
40	900				40									
						86	68				40.0 / 901.26 Auger and spoon refusal at 40.0 ft			
45	895				45						40.0 / 901.26 Moderately weathered, hard, thinly bedded, slightly fractured: DOLOSTONE, gray **DLS**			
						100	100				41.0 / 900.26 SAME: white from 40.0 to 41.0 ft.			
50					50						50.0 / 891.26 BOTTOM OF BORING AT 50.0 FT.			

REMARKS: Cave-in depth: 34.0 ft
Offset is from center of existing pavement.
Backfilled upon completion.

PAGE 1 OF 1
B-3

SPT_LOG:LOGS.GPJ:8.30.002:021011:11/13/12

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11066.01
Route 340 Bridge Replacement and Approaches over Cub Run

Photo B-1: Pavement Core C-1

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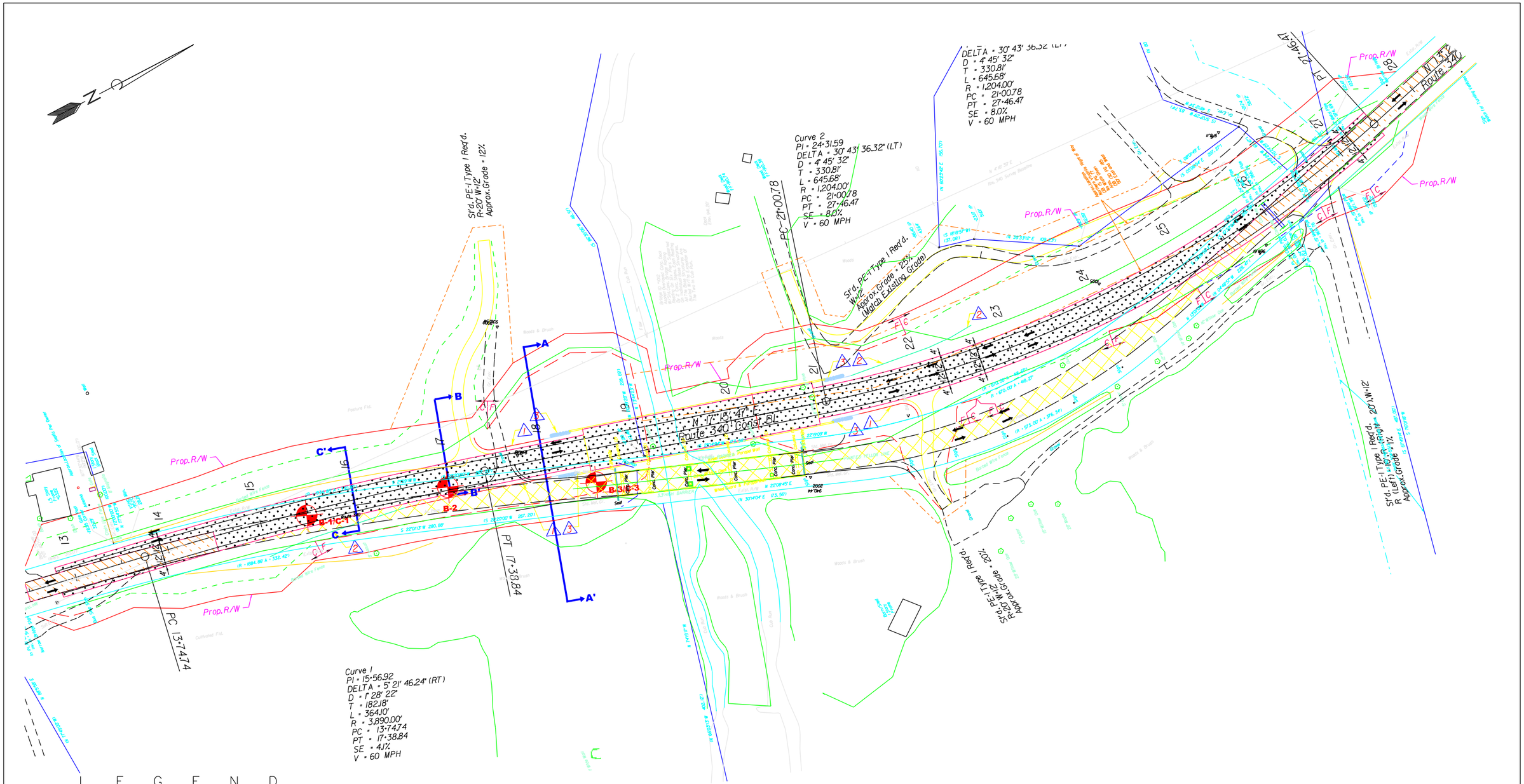
11066.01
Route 340 Bridge Replacement and Approaches over Cub Run

Photo B-2: Pavement Core C-3

GeoConcepts Engineering, Inc.

11066.01
Route 340 Bridge Replacement and Approaches over Cub Run

Photo B-3: Test Boring B-1 (Run 1)
Test Boring B-3 (Run 1 and Run 2)



L E G E N D

- TEST BORING LOCATION
- FULL-DEPTH PAVEMENT
- TEMPORARY PAVEMENT
- OVERLAY AND BUILD UP
- DEMOLITION
- TRAFFIC PATTERN DURING CONSTRUCTION

A A' SLOPE STABILITY SECTION

C-1 INDICATES PAVEMENT CORE

GRAPHICAL SCALE

100' 0 100' 200'

NOTE: BASE PLAN PROVIDED BY DEWBERRY DATED SEPTEMBER 2012

GeoConcepts Engineering, Inc.
19955 Highland Vista Dr., Suite 170 (703) 726-8030
Ashburn, Virginia 20147 (703) 726-8032 fax

ROUTE 340 BRIDGE REPLACEMENT AND APPROACHES OVER CUB RUN, PAGE COUNTY, VIRGINIA

BORING LOCATION PLAN		Scale: AS SHOWN	Fig.
Date: NOVEMBER 2012	Checked By: T.H.	Project No.: 11066.01	B-1

N:\PROJECTS\Active 11 Projects\11066.01, Rt 340\DGN FILES\Figure 1.dgn

Appendix C
Laboratory Test Results

Summary of Soil Laboratory Test Results (1 page)
Unconfined Rock Compressive Strength Test Report (1 page)
Corrosion Series Test Reports (1 page)
Moisture Density Relationship Test Data (1 page)
CBR Test Data (1 page)

Summary of Soil Laboratory Test Results

Project: **Route 340 Bridge Replacement and Approaches Over Cub Run** **Contract No.: 11066.01**

Boring	Depth (ft.)	Sample Type	Stratum	Description of Soil Specimen	Sieve Results		Atterberg Limits			Natural Moisture Content (%)	Remarks
					Percent Retained # 4 Sieve	Percent Passing # 200 Sieve	LL	PL	PI		
B-1	2.5-4.5	Jar	A	silty GRAVEL with sand (GM)	60.3	14.7	NP	NP	NP	3.2	---
B-3	6.5-8.5	Jar	A	lean CLAY with sand (CL)	2.9	84.3	45	22	23	30.9	---
B-3	13.5-15.0	Jar	A	clayey SAND (SC)	10.5	38.3	29	13	16	12.7	---
B-3	23.5-25.0	Jar	A	clayey SAND with gravel (SC)	34.8	30.5	55	18	37	13.2	---
B-3	33.5-35.0	Jar	B1	clayey SAND with gravel (SC)	22.8	25.3	25	15	10	12.9	---
B-1	0.0-5.0	Bulk	A	sandy lean CLAY with gravel (CL)	22.2	52.2	38	24	14	12.6	CBR = 4.2%

Notes:

1. Soil tests are in accordance with applicable ASTM standards.
2. Soil classification symbols are in accordance with Unified Soil Classification System.
3. Visual identification of samples is in accordance with ASTM D-2488.
4. Key to abbreviations: LL= Liquid Limit; PL= Plastic Limit; PI= Plasticity Index; NP= Nonplastic; N/T = Not Tested

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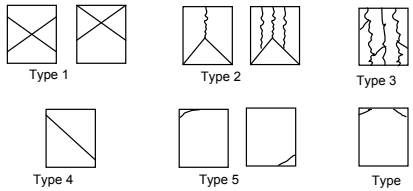
UNCONFINED ROCK COMPRESSIVE STRENGTH TEST REPORT

Project Number:	11066.01
Project:	Route 340 Bridge Replacement and Approaches Over Cub Run
Client:	Dewberry

Sample No.	Sample Depth (feet)	Rock Type	Test Date	Length Uncapped (in.)	Diameter (in.)	Area (in^2)	Load (lbs.)	Compressive Strength (psi)	L/D	Corrected Compressive Strength (psi)	Failure Type
B-1	6.5-6.83	Dolostone	10/24/2012	3.98	1.99	3.11	14280	4591	2.00	4591	3
B-3	42.0-42.33	Dolostone	10/24/2012	3.98	1.99	3.11	10780	3466	2.00	3466	3
B-3	46.0-46.33	Dolostone	10/24/2012	3.98	1.99	3.11	13240	4257	2.00	4257	3

Method: ASTM D7012

TYPES OF FRACTURES



Reported by: Shawn Harris

Report Number: **124560**

HP ENVIRONMENTAL
INCORPORATED

Certificate of Laboratory Analysis

GeoConcepts Engineering, Inc.
Attn: Bill Richards
19955 Highland Vista Dr.
Suite 170
Ashburn, VA 20147

Date Received: 10/02/12
Date Reported: 10/05/12
Project Location: **Rt 340 Bridge over Cub Run**

1. Client Sample No: **B-3**
Sample Matrix: Soil
Sample Location:

HPE Sample No.: 124560-01
Date Collected: 10/02/12

Test(s) Requested: **Soil Corrosion Potential Profile**
Analysis Method(s): Various

Date Analyzed: 10/05/12

Analyte	Result	Units	Reporting Limit	Qualifier
Resistivity - ASTM G187	**900**	ohm-cm	N/A	
Redox Potential - Electrode	+ **154**	mV	N/A	
pH - CA643	**7.5**	pH	N/A	
Chloride (Water Soluble) - CA422	**130**	mg/Kg	2.5	D
Sulfate (Water Soluble) - CA417	**48**	mg/Kg	10	
Sulfide (Water Soluble) EPA 376.2	< 1.2	mg/Kg	1.2	U

JP 10/05/12
Approved by Date

Analyte Qualifier Codes
U = Analyte was not detected
J = Analyte detected below reporting limit (estimated value)
D = Analyte reported from a sample dilution
B = Analyte was detected in the corresponding method blank

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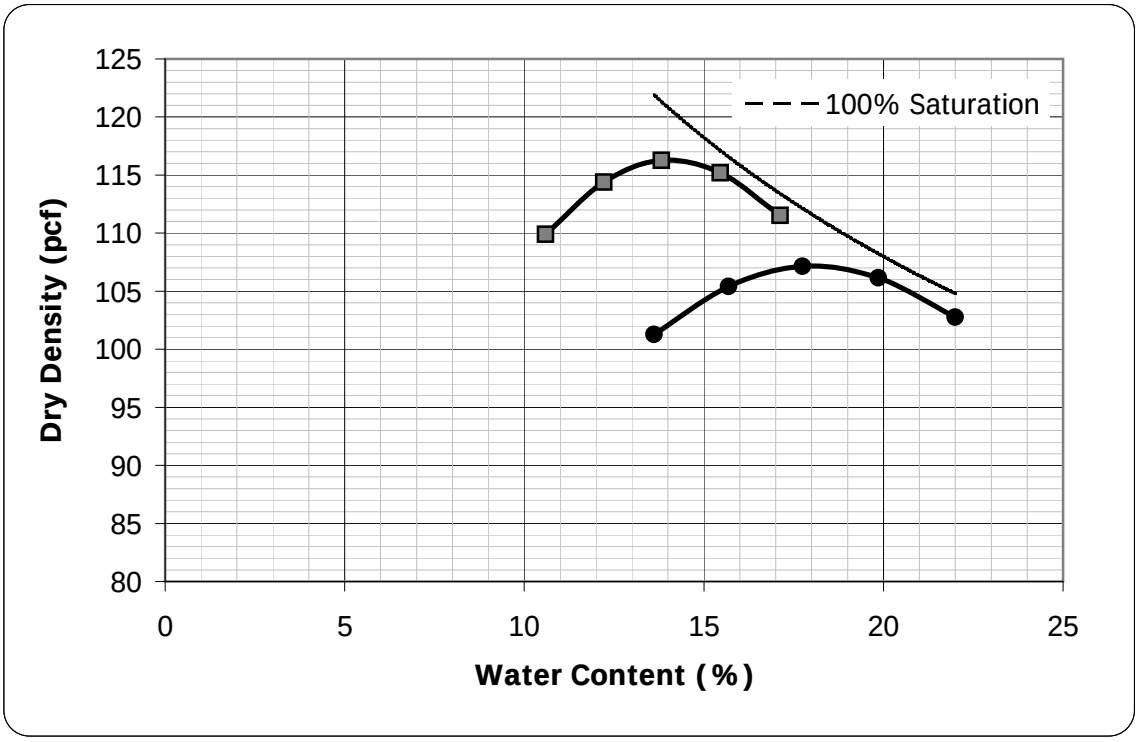
MOISTURE DENSITY RELATIONSHIP - VTM-001			
Project No.	11066.01	**Project Name**	Route 340 Bridge Over Club Run
Test Boring No.	B-1	**Depth (Feet)**	0.0-5.0
Lab Order No.	2823	**Date**	10/24/2012



TEST RESULTS	Before Correc.		After Correc.					
Maximum Dry Density (pcf)	107		116		Color			
Optimum Moisture Content (%)	18		14		Brown			
Material	**Classification**		**Nat. Moist. (%)**	**Sp. G. (Assumed)**	**LL**	**PI**	**% > # 4**	**% < #200**
sandy Lean Clay with gravel	USCS	AASHTO	12.6	2.65	38	14	22.2	52.2
	CL	A-6						

Tested by _____

Reviewed by _____

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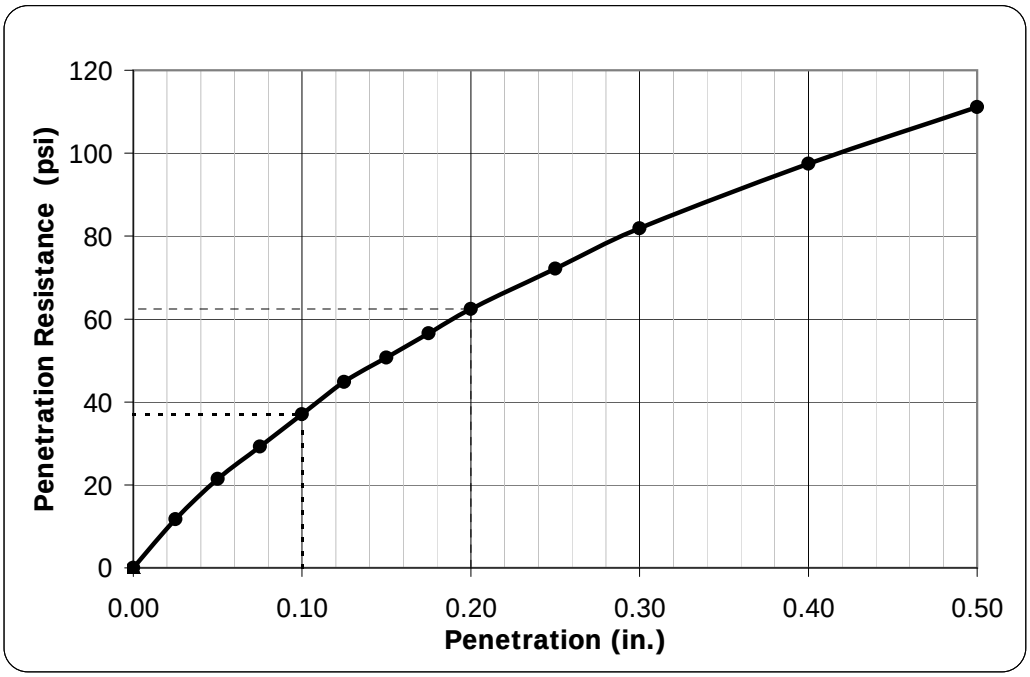
CALIFORNIA BEARING RATIO (CBR) TEST - VTM-008			
Project No.	11066.01	**Project Name**	Route 340 Bridge Over Club Run
Test Boring No.	B-1	**Depth (Feet)**	0.0-5.0
Lab Order No.	2823	**Date**	10/24/2012



Molded	
Dry Density (pcf)	115.0
Moisture (%)	14.4
Percent of Max. Density (%)	99.2

Soaked	
Dry Density (pcf)	112.7
Moisture (%)	19.2
Percentage of Max. Density (%)	97.2

CBR (%)	
0.1 in.	3.7
0.2 in.	4.2

Linearity Correction	0.000
Surcharge (lbs)	10
Max Swell (%)	2.0

Material Description	sandy Lean Clay with gravel
USCS	CL
Max Density	116
Optimum Moisture (%)	14
LL	38
PI	14
Color	Brown

Tested by: _____

Reviewed by: _____

Appendix D
Pavement Design Calculation

Pavement Design Calculation (2 pages)

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Flexible Structural Design Module

Mainline and Shoulder - Route 340 Bridge Replacement and Approaches over Cub Run

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,218,368
Initial Serviceability	4.2
Terminal Serviceability	2.8
Reliability Level	85 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	7,500 psi
Stage Construction	1
Calculated Design Structural Number	3.64 in

Simple ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	5,838
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	4.8 %
Average Initial Truck Factor (ESALs/truck)	1.05
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	1.3 %
Growth	Compound
Total Calculated Cumulative ESALs	1,218,368

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	IM-19.0A	0.44	1	2.0	-	0.66
2	BM-25.0A	0.44	1	5	-	2.20
3	VDOT No.21-B	0.12	1	8	-	0.96
Total	-	-	-	14.50	-	3.82

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Flexible Structural Design Module

Temporary Pavement Section - Route 340 Bridge Replacement and Approaches over Cub Run

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	108,168
Initial Serviceability	4.2
Terminal Serviceability	2.8
Reliability Level	85 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	7,500 psi
Stage Construction	1
Calculated Design Structural Number	2.37 in

Simple ESAL Calculation

Performance Period (years)	2
Two-Way Traffic (ADT)	5,838
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	4.8 %
Average Initial Truck Factor (ESALs/truck)	1.05
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	1.3 %
Growth	Compound
Total Calculated Cumulative ESALs	108,168

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	IM-19.0A	0.44	1	2.0	-	0.66
2	BM-25.0A	0.44	1	2.5	-	1.10
3	VDOT No.21-B	0.12	1	6	-	0.72
Total	-	-	-	10.00	-	2.48

Appendix E
Engineering Calculations

Concrete Gravity Retaining Wall Bearing Resistance (2 pages)

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AASHTO LRFD Bridge Specifications 2007

Bearing Resistance of Soil - RW-3 Retaining Wall

Project Number: 11066.01	**Project Engineer: TH**
Project Name: Route 340 Bridge Over Cub Run	**Principal Engineer: PB**
Project Location: Page County	**Date: 11-01-2012**
Test Boring No.: B-3	**Temporary Support RW-3**

Based on Bearing Capacity Equation 10.6.3.1.3-1 of AASHTO LRFD bridge Design Specifications 2007

g (pcf), total or moist	120
Df (ft)	2
Dw, Depth of groundwater (feet)	25
φ_b	0.45

B (ft)	2.0	3.0	4.0	5.0	6.0	7.0	8.0
L (ft)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
$N1_{60}$	10.00						
Cwq	1.00	1.00	1.00	1.00	1.00	1.00	1.00
$Cw\gamma$	1.00	1.00	1.00	1.00	1.00	1.00	1.00
qn (ksf), nominal bearing resistance	8.0	10.0	12.0	14.0	16.0	18.0	20.0
q_R (ksf), factored resistance	3.6	4.5	5.4	6.3	7.2	8.1	9.0

q_R (ksf), extreme event limit	8.0	10.0	12.0	14.0	16.0	18.0	20.0

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AASHTO LRFD Bridge Specifications 2007

Bearing Resistance of Soil - RW-3 Retaining Wall

Project Number: 11066.01	**Project Engineer: TH**
Project Name: Route 340 Bridge Over Cub Run	**Principal Engineer: PB**
Project Location: Page County	**Date: 11-01-2012**
Test Boring No.: B-3	

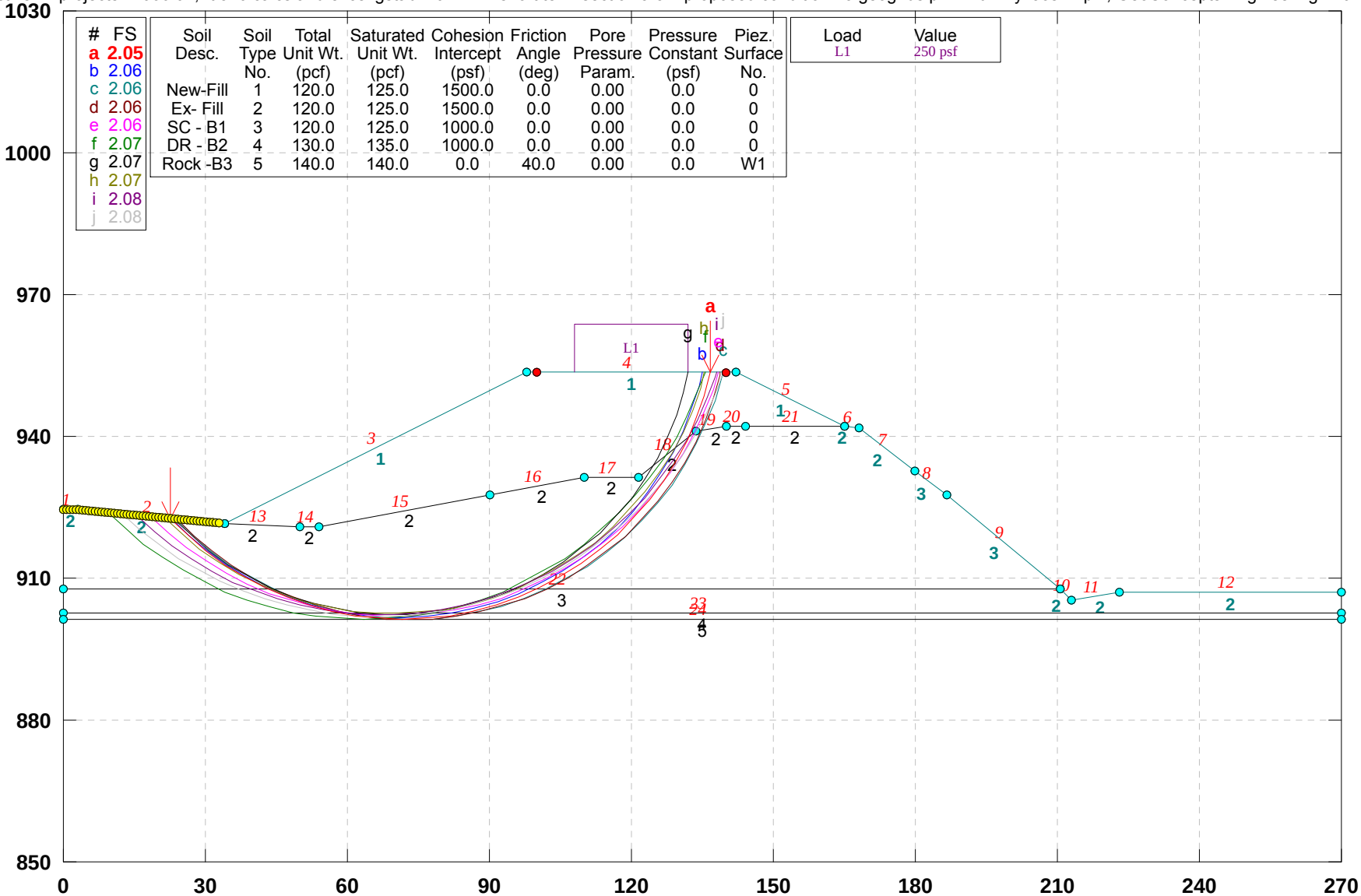
Elastic Half Space Method; Equation 10.6.2.4.2-1								
q0	Applied vertical stress (ksf)	1.0	2.0	3.0	3.0	3.0	3.0	3.0
B	Footing width (ft)	2	3	4	5	6	7	8
Length	Footing length (ft)	100	100	100	100	100	100	100
Es	Young's modulus of soil (ksi)	5	5	5	5	5	5	5
βz	Shape factor (from Table 10.6.2.4.2-1AASHTO LRFD 2007 manual)	1.41	1.41	1.41	1.41	1.41	1.41	1.41
ν	Poisson's Ratio	0.25	0.25	0.25	0.25	0.25	0.25	0.25
L/B	L/B	50.00	33.33	25.00	20.00	16.67	14.29	12.50
A'	Effective area of footing (sq. ft)	200	300	400	500	600	700	800
Se	Elastic settlement (ft)	0.013	0.032	0.055	0.062	0.068	0.073	0.078
Se	Elastic settlement (inch)	0.16	0.38	0.66	0.74	0.81	0.88	0.94

Appendix F
Global and Slope Stability Analyses

GSTABL Output (70 pages)

Section A-A'- West Slope Proposed 2H:1V- Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - proposed condition no geogrids.pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 12:5



GSTABL7 v.2 FSmin=2.05

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
          ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                SLOPE STABILITY ANALYSIS SYSTEM
       Modified Bishop, Simplified Janbu, or GLE Method of Slices.
       (Includes Spencer & Morgenstern-Price Type Analysis)
       Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
       Nonlinear Undrained Shear Strength, Curved Phi Envelope,
       Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
       Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/23/2014
Time of Run:              12:50PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed condition no geogrids.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed condition no geogrids.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed condition no geogrids.PLT
PROBLEM DESCRIPTION:  Section  A-A'- West Slope Proposed 2H:1V
                       - Short Term
BOUNDARY COORDINATES
   12 Top   Boundaries
   24 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1         0.00     924.50       3.00     924.50        2
    2         3.00     924.50      34.00     921.58        2
    3        34.00     921.58      98.00     953.58        1
    4        98.00     953.58     142.00     953.47        1
    5       142.00     953.47     165.00     941.97        1
    6       165.00     941.97     168.00     941.96        2
    7       168.00     941.96     180.00     932.76        2
    8       180.00     932.76     186.50     927.76        3
    9       186.50     927.76     210.50     907.60        3
   10       210.50     907.60     213.00     905.50        2
   11       213.00     905.50     223.00     907.00        2
   12       223.00     907.00     270.00     907.00        2
   13        34.00     921.58      50.00     921.00        2
   14        50.00     921.00      54.00     921.00        2
   15        54.00     921.00      90.00     927.76        2
   16        90.00     927.76     110.00     931.50        2
   17       110.00     931.50     121.50     931.50        2
   18       121.50     931.50     133.50     941.00        2
   19       133.50     941.00     140.00     942.00        2
   20       140.00     942.00     144.00     942.00        2
   21       144.00     942.00     165.00     941.97        2
   22         0.00     907.60     210.50     907.60        3
   23         0.00     902.76     270.00     902.76        4
   24         0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0    1500.0      0.0    0.00       0.0      0
  2   120.0    125.0    1500.0      0.0    0.00       0.0      0
  3   120.0    125.0    1000.0      0.0    0.00       0.0      0
  4   130.0    135.0    1000.0      0.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      1
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
```

```
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      915.26
     2        192.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1        192.00      901.83
     2        270.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         108.00       132.00       250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     3 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        34.00    921.58   2625.00     1.000
        2        69.00    921.58   2625.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        38.00    923.58   2625.00     1.000
        2        73.00    923.58   2625.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        42.00    925.58   2625.00     1.000
        2        77.00    925.58   2625.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  33.50(ft)
 Each Surface Terminates Between   X = 100.00(ft)
                               and   X = 140.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   5.987   FS Min =   2.051   FS Ave =   2.771
          Standard Deviation =    0.649   Coefficient of Variation =   23.43 %
       Failure Surface Specified By 30 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         22.624      922.652
           2         26.164      919.120
           3         29.958      915.863
           4         33.984      912.899
           5         38.222      910.245
           6         42.646      907.915
           7         47.231      905.922
```

8	51.954	904.279
9	56.785	902.993
10	61.700	902.072
11	66.669	901.521
12	71.666	901.344
13	76.662	901.541
14	81.630	902.111
15	86.541	903.051
16	91.367	904.356
17	96.083	906.019
18	100.661	908.029
19	105.075	910.377
20	109.302	913.048
21	113.317	916.028
22	117.098	919.299
23	120.624	922.845
24	123.874	926.644
25	126.831	930.676
26	129.479	934.918
27	131.801	939.346
28	133.786	943.935
29	135.422	948.660
30	136.697	953.483

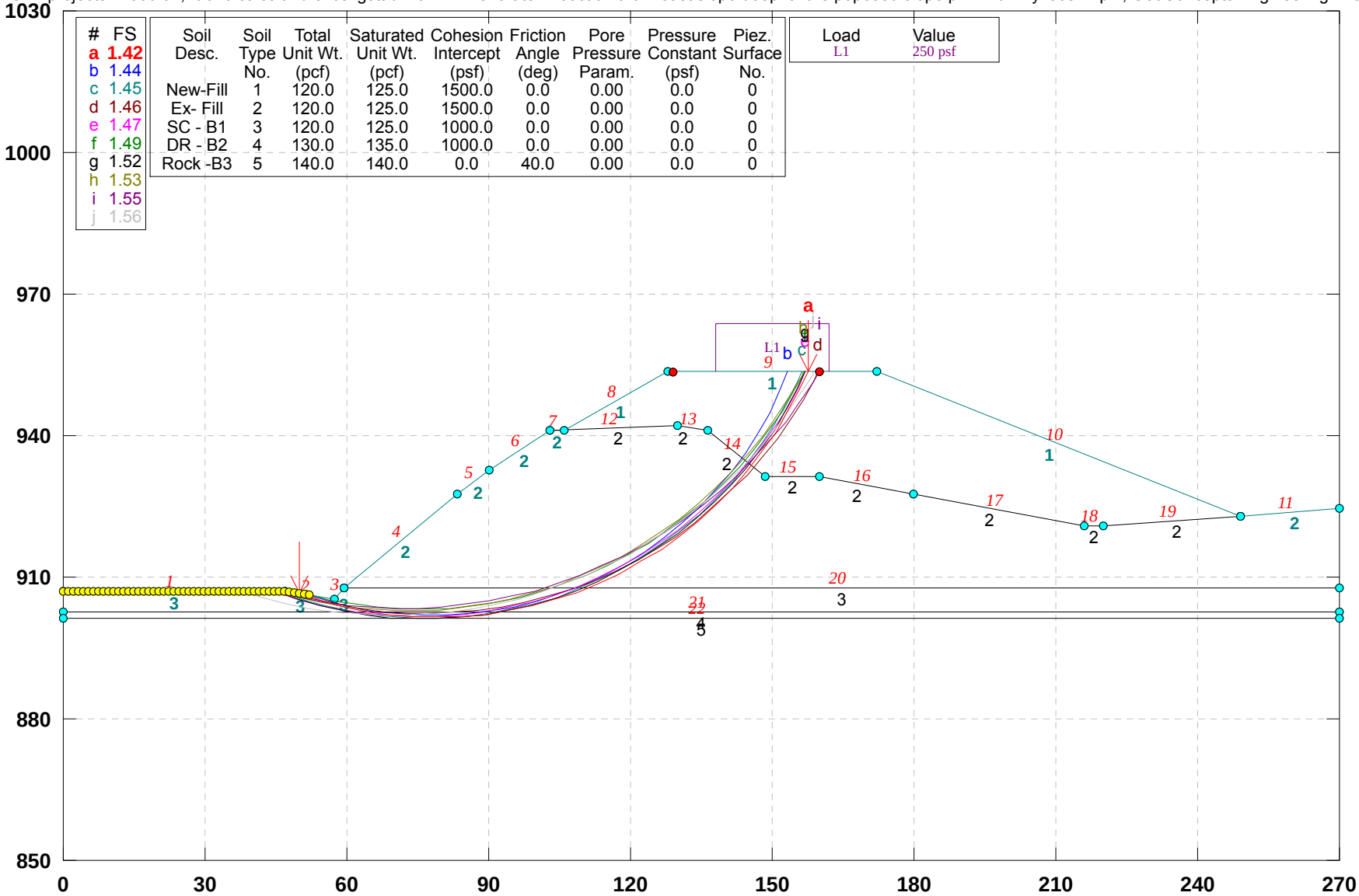
Circle Center At X = 71.534 ; Y = 968.132 ; and Radius = 66.788

Factor of Safety

*** 2.051 ***

Section A-A'- Proposed East Slope 2H:1V - Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - east slope deep failure poposed slope.pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 01:0



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock -B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=1.42

Safety Factors Are Calculated By The Modified Bishop Method

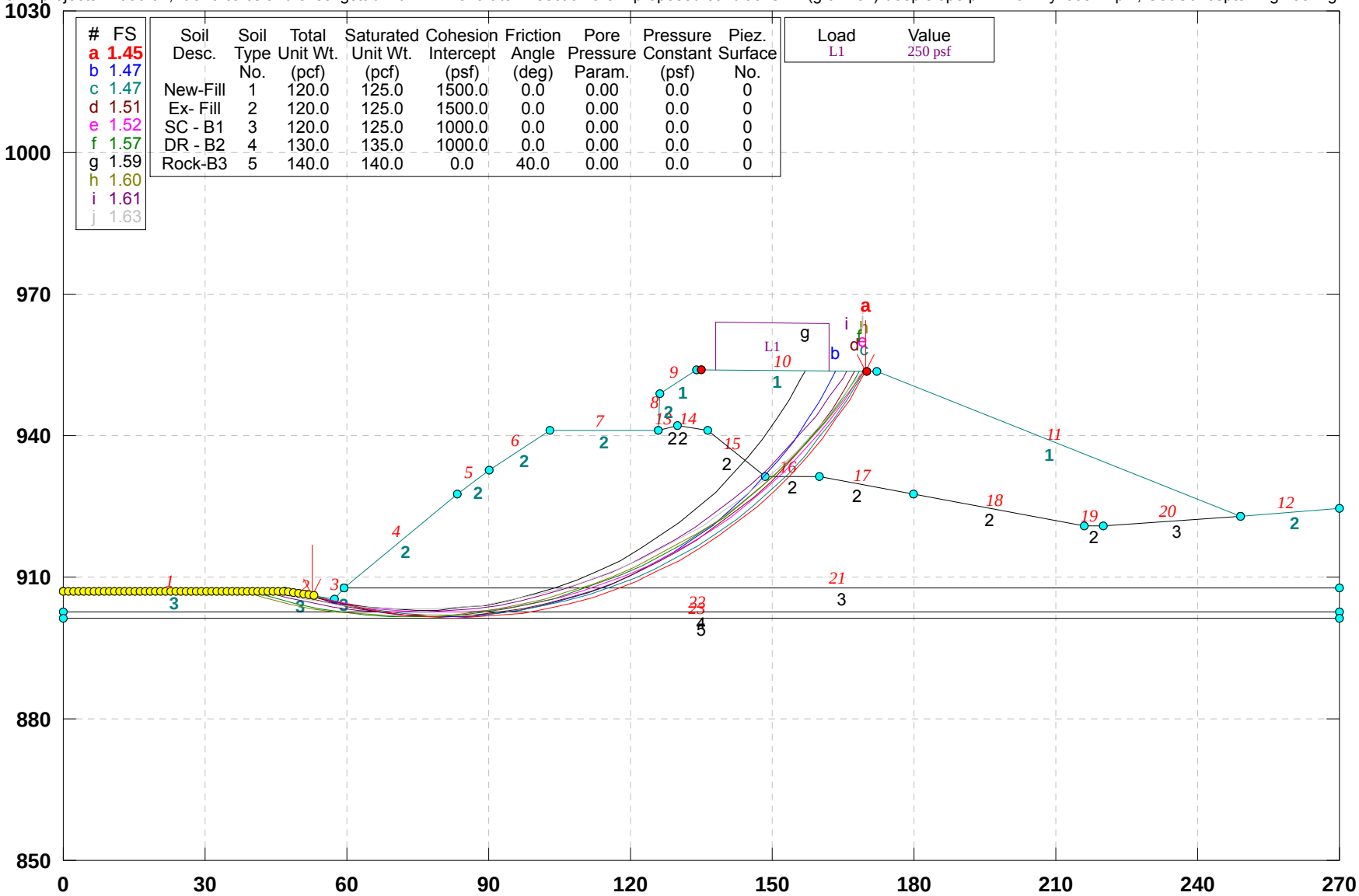
```
                    ***  GSTABL7  ***
             ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
           (All Rights Reserved-Unauthorized Use Prohibited)
*****************************************************************************
                  SLOPE STABILITY ANALYSIS SYSTEM
       Modified Bishop, Simplified Janbu, or GLE Method of Slices.
       (Includes Spencer & Morgenstern-Price Type Analysis)
       Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
       Nonlinear Undrained Shear Strength, Curved Phi Envelope,
       Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
       Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*****************************************************************************
Analysis Run Date:        10/23/2014
Time of Run:              01:08PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope.PLT
PROBLEM DESCRIPTION:  Section A-A'- Proposed East Slope 2H:1V
                      - Short Term
BOUNDARY COORDINATES
   11 Top   Boundaries
   22 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1          0.00     907.00      47.00     907.00        3
    2         47.00     907.00      57.50     905.50        3
    3         57.50     905.50      59.50     907.60        3
    4         59.50     907.60      83.50     927.76        2
    5         83.50     927.76      90.00     932.76        2
    6         90.00     932.76     103.00     941.26        2
    7        103.00     941.26     106.00     941.26        2
    8        106.00     941.26     128.00     953.47        1
    9        128.00     953.47     172.00     953.59        1
   10        172.00     953.59     249.00     923.00        1
   11        249.00     923.00     270.00     924.50        2
   12        103.00     941.26     130.00     942.00        2
   13        130.00     942.00     136.50     941.00        2
   14        136.50     941.00     148.50     931.50        2
   15        148.50     931.50     160.00     931.50        2
   16        160.00     931.50     180.00     927.76        2
   17        180.00     927.76     216.00     921.00        2
   18        216.00     921.00     220.00     921.00        2
   19        220.00     921.00     249.00     923.00        2
   20         59.50     907.60     270.00     907.60        3
   21          0.00     902.76     270.00     902.76        4
   22          0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0    1500.0      0.0    0.00       0.0      0
  2   120.0    125.0    1500.0      0.0    0.00       0.0      0
  3   120.0    125.0    1000.0      0.0    0.00       0.0      0
  4   130.0    135.0    1000.0      0.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
  Point      X-Water     Y-Water
```

```
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        105.00     941.26     105.10     906.26
 SEARCH LIMIT BOUNDARY DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  53.00(ft)
 Each Surface Terminates Between   X = 129.00(ft)
                               and   X = 160.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   3.281   FS Min =   1.419   FS Ave =   2.431
          Standard Deviation =    0.476   Coefficient of Variation =   19.58 %
       Failure Surface Specified By 27 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         49.920      906.583
           2         54.670      905.021
           3         59.503      903.740
           4         64.403      902.744
           5         69.352      902.037
           6         74.335      901.622
           7         79.334      901.499
           8         84.331      901.669
           9         89.309      902.132
          10         94.252      902.885
          11         99.142      903.927
          12        103.963      905.254
          13        108.698      906.861
          14        113.330      908.742
          15        117.844      910.892
          16        122.225      913.303
          17        126.457      915.966
          18        130.525      918.873
          19        134.416      922.013
          20        138.117      925.375
          21        141.614      928.949
          22        144.895      932.721
          23        147.950      936.680
          24        150.768      940.810
```

```
   25        153.339      945.098
   26        155.654      949.530
   27        157.463      953.550
Circle Center At X =    78.930 ; Y =   986.791 ; and Radius =    85.293
       Factor of Safety
      ***    1.419   ***
```

Section A-A' - East Slope - Temporary Shoring- Deep Failure - Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - proposed conditions - 2 (gra. wall)-deep slope.pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 02:



GSTABL7 v.2 FSmin=1.45

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
          ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
       Modified Bishop, Simplified Janbu, or GLE Method of Slices.
       (Includes Spencer & Morgenstern-Price Type Analysis)
       Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
       Nonlinear Undrained Shear Strength, Curved Phi Envelope,
       Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
       Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/23/2014
Time of Run:              02:42PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed conditions - 2 (gra. wall)-deep slope.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed conditions - 2 (gra. wall)-deep slope.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed conditions - 2 (gra. wall)-deep slope.PLT
PROBLEM DESCRIPTION:  Section A-A' - East Slope - Temporary Sh
                      oring- Deep Failure - Short Term
BOUNDARY COORDINATES
   12 Top   Boundaries
   23 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1          0.00     907.00      47.00     907.00        3
    2         47.00     907.00      57.50     905.50        3
    3         57.50     905.50      59.50     907.60        3
    4         59.50     907.60      83.50     927.76        2
    5         83.50     927.76      90.00     932.76        2
    6         90.00     932.76     103.00     941.26        2
    7        103.00     941.26     126.00     941.26        2
    8        126.00     941.26     126.10     948.96        2
    9        126.10     948.96     134.00     953.97        1
   10        134.00     953.97     172.00     953.59        1
   11        172.00     953.59     249.00     923.00        1
   12        249.00     923.00     270.00     924.50        2
   13        126.00     941.26     130.00     942.00        2
   14        130.00     942.00     136.50     941.00        2
   15        136.50     941.00     148.50     931.50        2
   16        148.50     931.50     160.00     931.50        2
   17        160.00     931.50     180.00     927.76        2
   18        180.00     927.76     216.00     921.00        2
   19        216.00     921.00     220.00     921.00        2
   20        220.00     921.00     249.00     923.00        3
   21         59.50     907.60     270.00     907.60        3
   22          0.00     902.76     270.00     902.76        4
   23          0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0    1500.0      0.0    0.00       0.0      0
  2   120.0    125.0    1500.0      0.0    0.00       0.0      0
  3   120.0    125.0    1000.0      0.0    0.00       0.0      0
  4   130.0    135.0    1000.0      0.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
```

```
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00       250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  5 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        126.00     939.26     126.10     948.96
     2        126.10     948.96     127.00     948.96
     3        127.00     948.96     129.00     939.26
     4        126.00     939.26     129.00     939.26
     5        105.00     941.26     105.10     906.26
 SEARCH LIMIT BOUNDARY DATA HAS BEEN SUPPRESSED
REINFORCING LAYER(S)
     4 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.00    941.26   1877.00     1.000
        2       136.00    941.26   1877.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.02    943.26   1877.00     1.000
        2       136.02    943.26   1877.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.05    945.26   1877.00     1.000
        2       136.05    945.26   1877.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.08    947.26   1877.00     1.000
        2       136.08    947.26   1877.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  54.00(ft)
 Each Surface Terminates Between   X = 135.00(ft)
                               and   X = 170.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
```

Total Number of Trial Surfaces Attempted = 500
Number of Trial Surfaces With Valid FS = 500
Statistical Data On All Valid FS Values:
FS Max = 3.765 FS Min = 1.452 FS Ave = 2.614
Standard Deviation = 0.539 Coefficient of Variation = 20.63 %
Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	52.810	906.170
2	57.606	904.757
3	62.467	903.589
4	67.382	902.671
5	72.338	902.003
6	77.320	901.588
7	82.318	901.428
8	87.317	901.521
9	92.305	901.869
10	97.269	902.469
11	102.195	903.322
12	107.072	904.423
13	111.887	905.772
14	116.627	907.363
15	121.280	909.194
16	125.834	911.258
17	130.277	913.552
18	134.598	916.068
19	138.785	918.801
20	142.827	921.743
21	146.715	924.887
22	150.438	928.225
23	153.986	931.748
24	157.351	935.446
25	160.523	939.311
26	163.495	943.332
27	166.258	947.499
28	168.806	951.801
29	169.758	953.612

Circle Center At X = 82.980 ; Y = 999.724 ; and Radius = 98.299
Factor of Safety
*** 1.452 ***

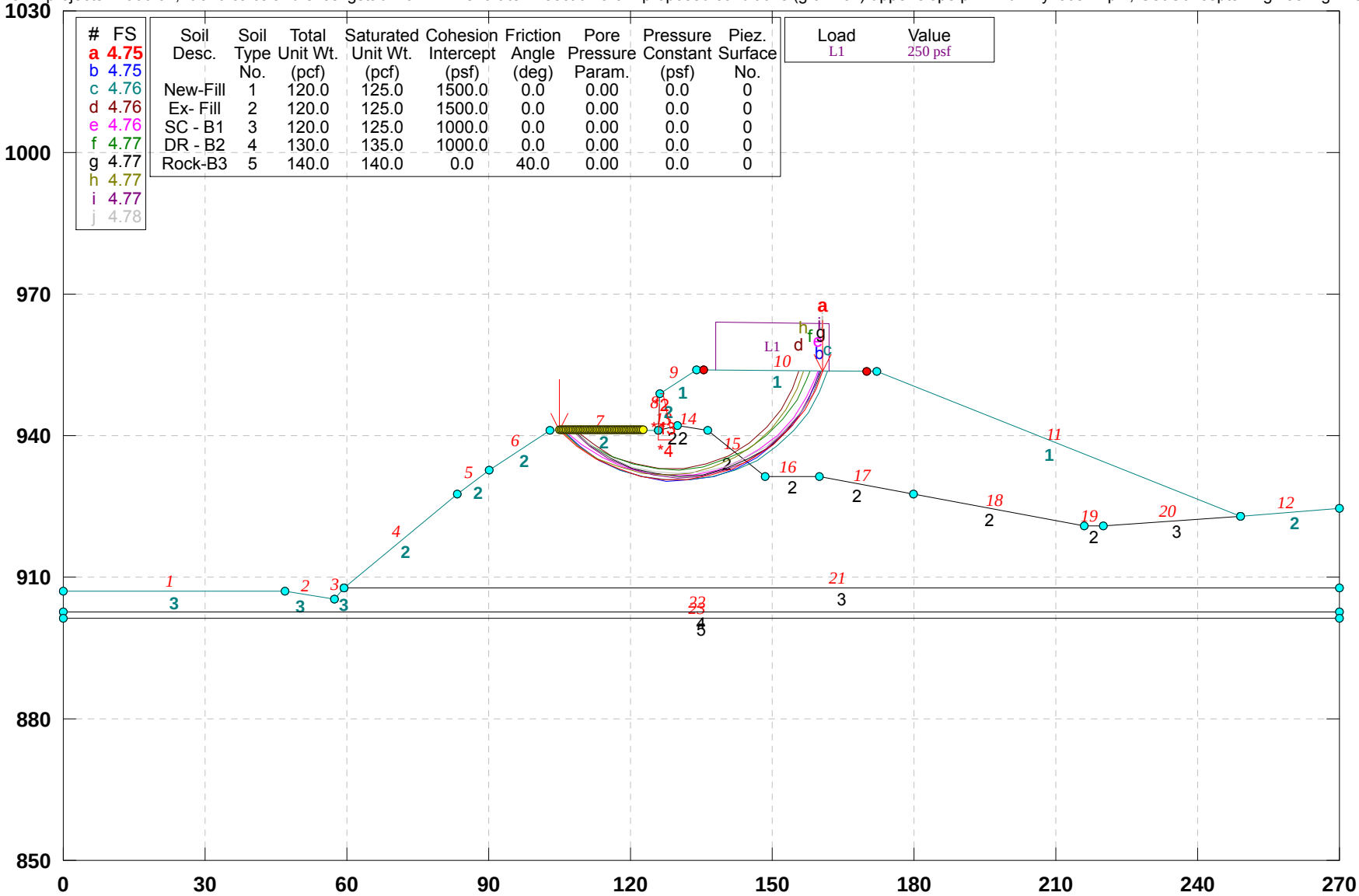
Section A-A'- East Slope - Temporary Shoring - Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - proposed conditions (gra. wall)-upper slope.pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 01:0

#	FS
a	4.75
b	4.75
c	4.76
d	4.76
e	4.76
f	4.77
g	4.77
h	4.77
i	4.77
j	4.78

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock-B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

Load	Value
L1	250 psf



GSTABL7 v.2 FSmin=4.75

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
              ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
           (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
       Modified Bishop, Simplified Janbu, or GLE Method of Slices.
       (Includes Spencer & Morgenstern-Price Type Analysis)
       Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
       Nonlinear Undrained Shear Strength, Curved Phi Envelope,
       Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
       Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/23/2014
Time of Run:              01:06PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed conditions (gra. wall)-upper slope.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed conditions (gra. wall)-upper slope.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed conditions (gra. wall)-upper slope.PLT
PROBLEM DESCRIPTION:  Section A-A'- East Slope - Temporary Sho
                      ring - Short Term
BOUNDARY COORDINATES
   12 Top   Boundaries
   23 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1          0.00     907.00      47.00     907.00        3
    2         47.00     907.00      57.50     905.50        3
    3         57.50     905.50      59.50     907.60        3
    4         59.50     907.60      83.50     927.76        2
    5         83.50     927.76      90.00     932.76        2
    6         90.00     932.76     103.00     941.26        2
    7        103.00     941.26     126.00     941.26        2
    8        126.00     941.26     126.10     948.96        2
    9        126.10     948.96     134.00     953.97        1
   10        134.00     953.97     172.00     953.59        1
   11        172.00     953.59     249.00     923.00        1
   12        249.00     923.00     270.00     924.50        2
   13        126.00     941.26     130.00     942.00        2
   14        130.00     942.00     136.50     941.00        2
   15        136.50     941.00     148.50     931.50        2
   16        148.50     931.50     160.00     931.50        2
   17        160.00     931.50     180.00     927.76        2
   18        180.00     927.76     216.00     921.00        2
   19        216.00     921.00     220.00     921.00        2
   20        220.00     921.00     249.00     923.00        3
   21         59.50     907.60     270.00     907.60        3
   22          0.00     902.76     270.00     902.76        4
   23          0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0    1500.0      0.0    0.00       0.0      0
  2   120.0    125.0    1500.0      0.0    0.00       0.0      0
  3   120.0    125.0    1000.0      0.0    0.00       0.0      0
  4   130.0    135.0    1000.0      0.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
```

```
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00       250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  4 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        126.00     939.26     126.10     948.96
     2        126.10     948.96     127.00     948.96
     3        127.00     948.96     129.00     939.26
     4        126.00     939.26     129.00     939.26
REINFORCING LAYER(S)
     4 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.00    941.26   1877.00     1.000
        2       136.00    941.26   1877.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.02    943.26   1877.00     1.000
        2       136.02    943.26   1877.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.05    945.26   1877.00     1.000
        2       136.05    945.26   1877.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.08    947.26   1877.00     1.000
        2       136.08    947.26   1877.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X = 105.00(ft)
                                and  X = 123.00(ft)
 Each Surface Terminates Between   X = 135.50(ft)
                               and   X = 170.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
```

Statistical Data On All Valid FS Values:
FS Max = 8.519 FS Min = 4.749 FS Ave = 5.629
Standard Deviation = 0.724 Coefficient of Variation = 12.86 %

Failure Surface Specified By 15 Coordinate Points

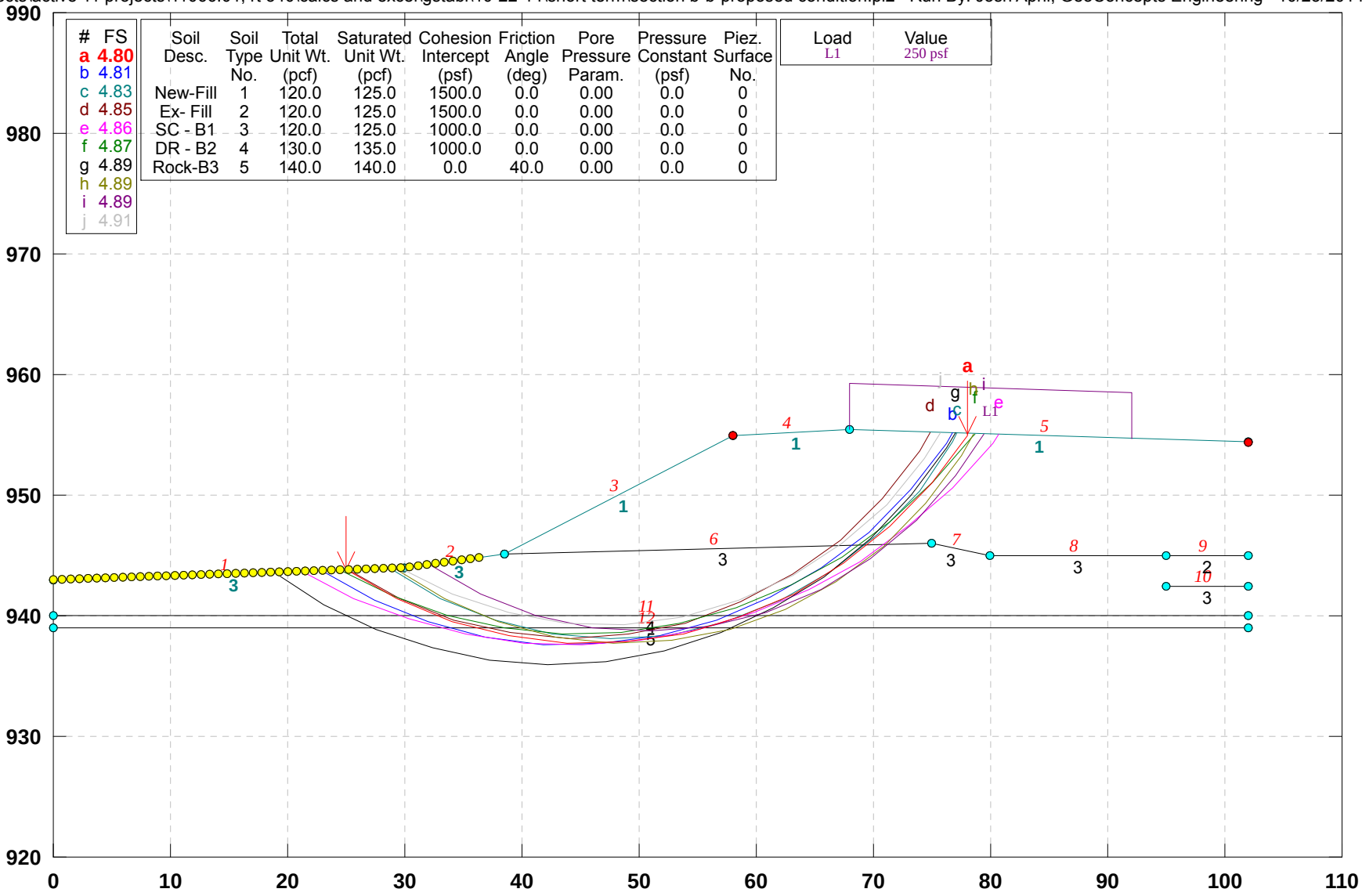
Point No.	X-Surf (ft)	Y-Surf (ft)
1	105.000	941.260
2	108.663	937.857
3	112.798	935.045
4	117.309	932.888
5	122.093	931.436
6	127.042	930.722
7	132.042	930.762
8	136.978	931.555
9	141.739	933.083
10	146.215	935.311
11	150.305	938.188
12	153.913	941.649
13	156.959	945.614
14	159.373	949.993
15	160.737	953.703

Circle Center At X = 129.280 ; Y = 963.724 ; and Radius = 33.077

Factor of Safety
*** 4.749 ***

Section B-B' Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section b-b-proposed condition.pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 12:53PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock-B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=4.80

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
       ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
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    ******************************************************************************
                        SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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    Unit System:              English
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cel\GStabl\10-22-14\Short Term\section b-b-proposed condition.PLT
    PROBLEM DESCRIPTION:  Section B-B' Short Term
    BOUNDARY COORDINATES
        5 Top   Boundaries
       12 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00     943.00      30.00     944.00        3
        2         30.00     944.00      38.50     945.12        3
        3         38.50     945.12      58.00     954.95        1
        4         58.00     954.95      68.00     955.42        1
        5         68.00     955.42     102.00     954.37        1
        6         38.50     945.12      75.00     946.00        3
        7         75.00     946.00      80.00     945.00        3
        8         80.00     945.00      95.00     945.00        3
        9         95.00     945.00     102.00     945.00        2
       10         95.00     942.50     102.00     942.50        3
       11          0.00     940.00     102.00     940.00        4
       12          0.00     939.00     102.00     939.00        5
    User Specified Y-Origin =       920.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0    1500.0      0.0    0.00       0.0      0
      2   120.0    125.0    1500.0      0.0    0.00       0.0      0
      3   120.0    125.0    1000.0      0.0    0.00       0.0      0
      4   130.0    135.0    1000.0      0.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1         78.00      915.26
        2        270.00      915.26
    Piezometric Surface No.  2 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1          0.00      901.83
        2         78.00      901.83
    WATER SURFACE DATA HAS BEEN SUPPRESSED
   BOUNDARY LOAD(S)
```

```
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1          68.00        92.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     4 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.00    941.26   1877.00     1.000
        2       136.00    941.26   1877.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.02    943.26   1877.00     1.000
        2       136.02    943.26   1877.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.05    945.26   1877.00     1.000
        2       136.05    945.26   1877.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.08    947.26   1877.00     1.000
        2       136.08    947.26   1877.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                 and  X =  37.00(ft)
 Each Surface Terminates Between   X =  58.00(ft)
                                 and   X = 102.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =  28.446   FS Min =   4.803   FS Ave =   7.170
          Standard Deviation =    2.583   Coefficient of Variation =   36.02 %
       Failure Surface Specified By 14 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         24.988      943.833
           2         29.356      941.400
           3         34.003      939.554
           4         38.850      938.326
           5         43.815      937.736
           6         48.814      937.795
           7         53.764      938.502
           8         58.581      939.844
           9         63.183      941.799
          10         67.492      944.334
          11         71.437      947.406
          12         74.951      950.964
          13         77.973      954.947
          14         78.066      955.109
```

```
Circle Center At X =    45.858 ; Y =   976.154 ; and Radius =    38.474
       Factor of Safety
      ***    4.803   ***
```

Section C-C' - Short Term

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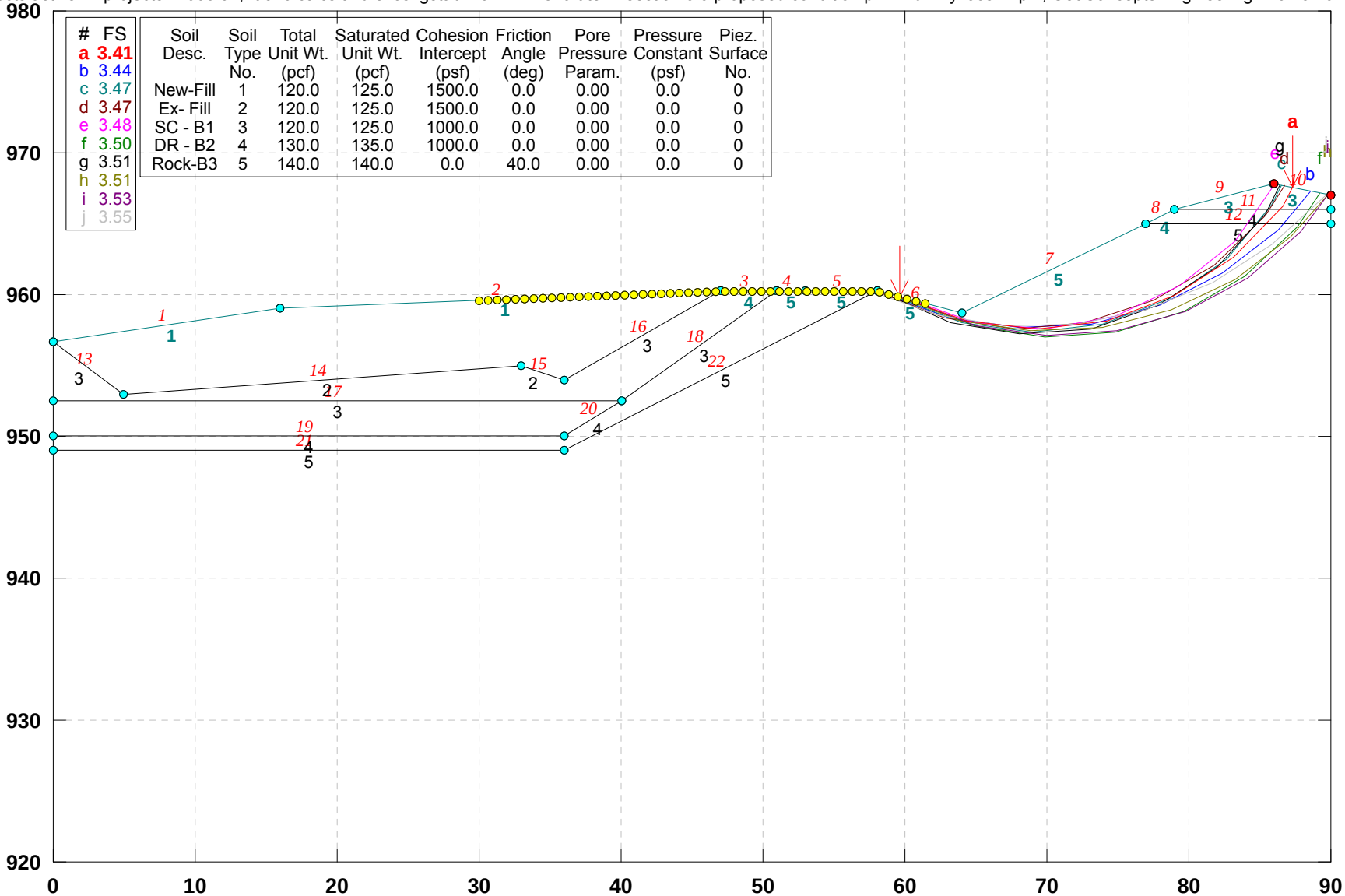

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock-B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=3.41

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
        ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
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    ******************************************************************************
                        SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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cel\GStabl\10-22-14\Short Term\section c-c-proposed condition.PLT
    PROBLEM DESCRIPTION:  Section C-C' - Short Term
    BOUNDARY COORDINATES
       10 Top   Boundaries
       22 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1         0.00     956.63      16.00     959.03        1
        2        16.00     959.03      47.00     960.22        1
        3        47.00     960.22      51.00     960.22        4
        4        51.00     960.22      53.00     960.22        5
        5        53.00     960.22      58.00     960.22        5
        6        58.00     960.22      64.00     958.72        5
        7        64.00     958.72      77.00     965.00        5
        8        77.00     965.00      79.00     966.00        4
        9        79.00     966.00      86.00     967.82        3
       10        86.00     967.82      90.00     967.00        3
       11        79.00     966.00      90.00     966.00        4
       12        77.00     965.00      90.00     965.00        5
       13         0.00     956.63       5.00     953.00        3
       14         5.00     953.00      33.00     955.00        2
       15        33.00     955.00      36.00     954.00        2
       16        36.00     954.00      47.00     960.22        3
       17         0.00     952.50      40.00     952.50        3
       18        40.00     952.50      51.00     960.22        3
       19         0.00     950.00      36.00     950.00        4
       20        36.00     950.00      40.00     952.50        4
       21         0.00     949.00      36.00     949.00        5
       22        36.00     949.00      58.00     960.22        5
    User Specified Y-Origin =       920.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0    1500.0      0.0    0.00       0.0      0
      2   120.0    125.0    1500.0      0.0    0.00       0.0      0
      3   120.0    125.0    1000.0      0.0    0.00       0.0      0
      4   130.0    135.0    1000.0      0.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
```

```
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1          68.00        92.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED
REINFORCING LAYER(S)
     4 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                   FACTOR
        1       126.00    941.26   1877.00     1.000
        2       136.00    941.26   1877.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                   FACTOR
        1       126.02    943.26   1877.00     1.000
        2       136.02    943.26   1877.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                   FACTOR
        1       126.05    945.26   1877.00     1.000
        2       136.05    945.26   1877.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                   FACTOR
        1       126.08    947.26   1877.00     1.000
        2       136.08    947.26   1877.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =  30.00(ft)
                                and  X =  62.00(ft)
 Each Surface Terminates Between   X =  86.00(ft)
                               and   X =  90.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =  16.250   FS Min =   3.407   FS Ave =   6.711
          Standard Deviation =    2.423   Coefficient of Variation =   36.11 %
       Failure Surface Specified By  8 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         59.628      959.813
           2         64.337      958.133
           3         69.306      957.578
```

```
    4         74.270      958.177
    5         78.964      959.898
    6         83.139      962.650
    7         86.571      966.286
    8         87.305      967.552
Circle Center At X =    69.184 ; Y =   978.998 ; and Radius =    21.433
       Factor of Safety
      ***    3.407   ***
```

Section A-A'- West Slope Proposed 2H:1V- Long Term

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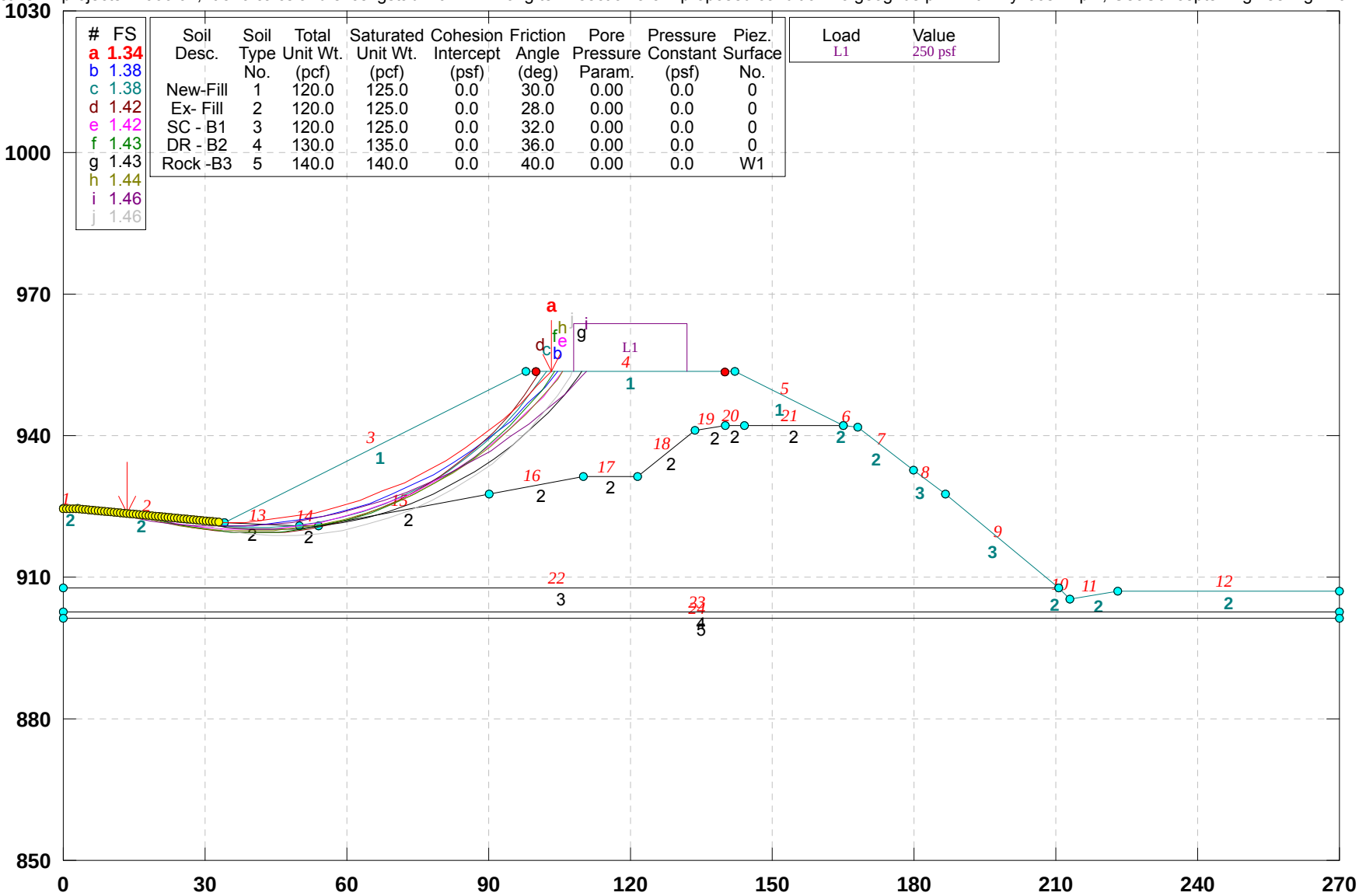

GSTABL7 v.2 FSmin=1.34

Safety Factors Are Calculated By The Modified Bishop Method

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                    ***  GSTABL7  ***
            ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
        Modified Bishop, Simplified Janbu, or GLE Method of Slices.
        (Includes Spencer & Morgenstern-Price Type Analysis)
        Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
        Nonlinear Undrained Shear Strength, Curved Phi Envelope,
        Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
        Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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PROBLEM DESCRIPTION:  Section  A-A'- West Slope Proposed 2H:1V
                      - Long Term
BOUNDARY COORDINATES
   12 Top   Boundaries
   24 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1         0.00     924.50       3.00     924.50        2
    2         3.00     924.50      34.00     921.58        2
    3        34.00     921.58      98.00     953.58        1
    4        98.00     953.58     142.00     953.47        1
    5       142.00     953.47     165.00     941.97        1
    6       165.00     941.97     168.00     941.96        2
    7       168.00     941.96     180.00     932.76        2
    8       180.00     932.76     186.50     927.76        3
    9       186.50     927.76     210.50     907.60        3
   10       210.50     907.60     213.00     905.50        2
   11       213.00     905.50     223.00     907.00        2
   12       223.00     907.00     270.00     907.00        2
   13        34.00     921.58      50.00     921.00        2
   14        50.00     921.00      54.00     921.00        2
   15        54.00     921.00      90.00     927.76        2
   16        90.00     927.76     110.00     931.50        2
   17       110.00     931.50     121.50     931.50        2
   18       121.50     931.50     133.50     941.00        2
   19       133.50     941.00     140.00     942.00        2
   20       140.00     942.00     144.00     942.00        2
   21       144.00     942.00     165.00     941.97        2
   22         0.00     907.60     210.50     907.60        3
   23         0.00     902.76     270.00     902.76        4
   24         0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0       0.0      30.0    0.00       0.0      0
  2   120.0    125.0       0.0      28.0    0.00       0.0      0
  3   120.0    125.0       0.0      32.0    0.00       0.0      0
  4   130.0    135.0       0.0      36.0    0.00       0.0      0
  5   140.0    140.0       0.0      40.0    0.00       0.0      1
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
```

```
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      915.26
     2        192.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1        192.00      901.83
     2        270.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         108.00       132.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     3 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        34.00    921.58   2625.00     1.000
        2        69.00    921.58   2625.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        38.00    923.58   2625.00     1.000
        2        73.00    923.58   2625.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        42.00    925.58   2625.00     1.000
        2        77.00    925.58   2625.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  33.50(ft)
 Each Surface Terminates Between   X = 100.00(ft)
                               and   X = 140.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   3.375   FS Min =   1.338   FS Ave =   2.186
          Standard Deviation =    0.465   Coefficient of Variation =   21.29 %
       Failure Surface Specified By 21 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         13.494      923.512
           2         18.411      922.604
           3         23.370      921.962
           4         28.356      921.587
           5         33.354      921.480
           6         38.352      921.642
           7         43.333      922.071
```

8	48.285	922.767
9	53.192	923.727
10	58.040	924.950
11	62.815	926.431
12	67.505	928.166
13	72.094	930.150
14	76.571	932.377
15	80.921	934.841
16	85.133	937.536
17	89.195	940.452
18	93.094	943.582
19	96.819	946.917
20	100.361	950.446
21	103.172	953.567

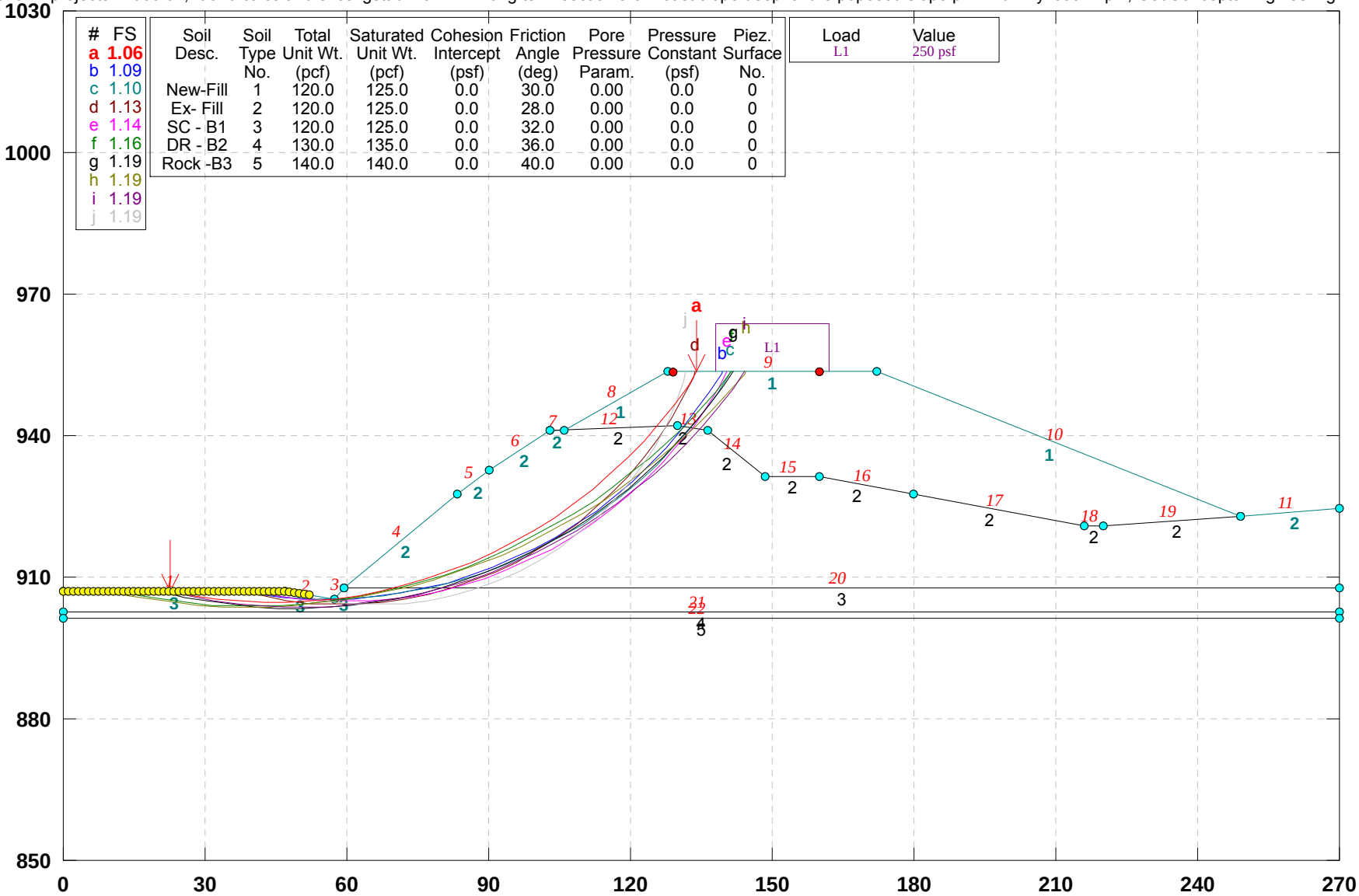
Circle Center At X = 32.848 ; Y = 1014.638 ; and Radius = 93.158

Factor of Safety

*** 1.338 ***

Section A-A'- Proposed East Slope 2H:1V

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section a-a' - east slope deep failure poposed slope.pl2 Run By: Josh April, GeoConcepts Engineering 11/4/2014 01:2



GSTABL7 v.2 FSmin=1.06

Safety Factors Are Calculated By The Modified Bishop Method

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                    ***  GSTABL7  ***
             ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
         Modified Bishop, Simplified Janbu, or GLE Method of Slices.
         (Includes Spencer & Morgenstern-Price Type Analysis)
         Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
         Nonlinear Undrained Shear Strength, Curved Phi Envelope,
         Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
         Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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Analysis Run Date:        11/4/2014
Time of Run:              01:22PM
Run By:                   Josh April, GeoConcepts Engineering
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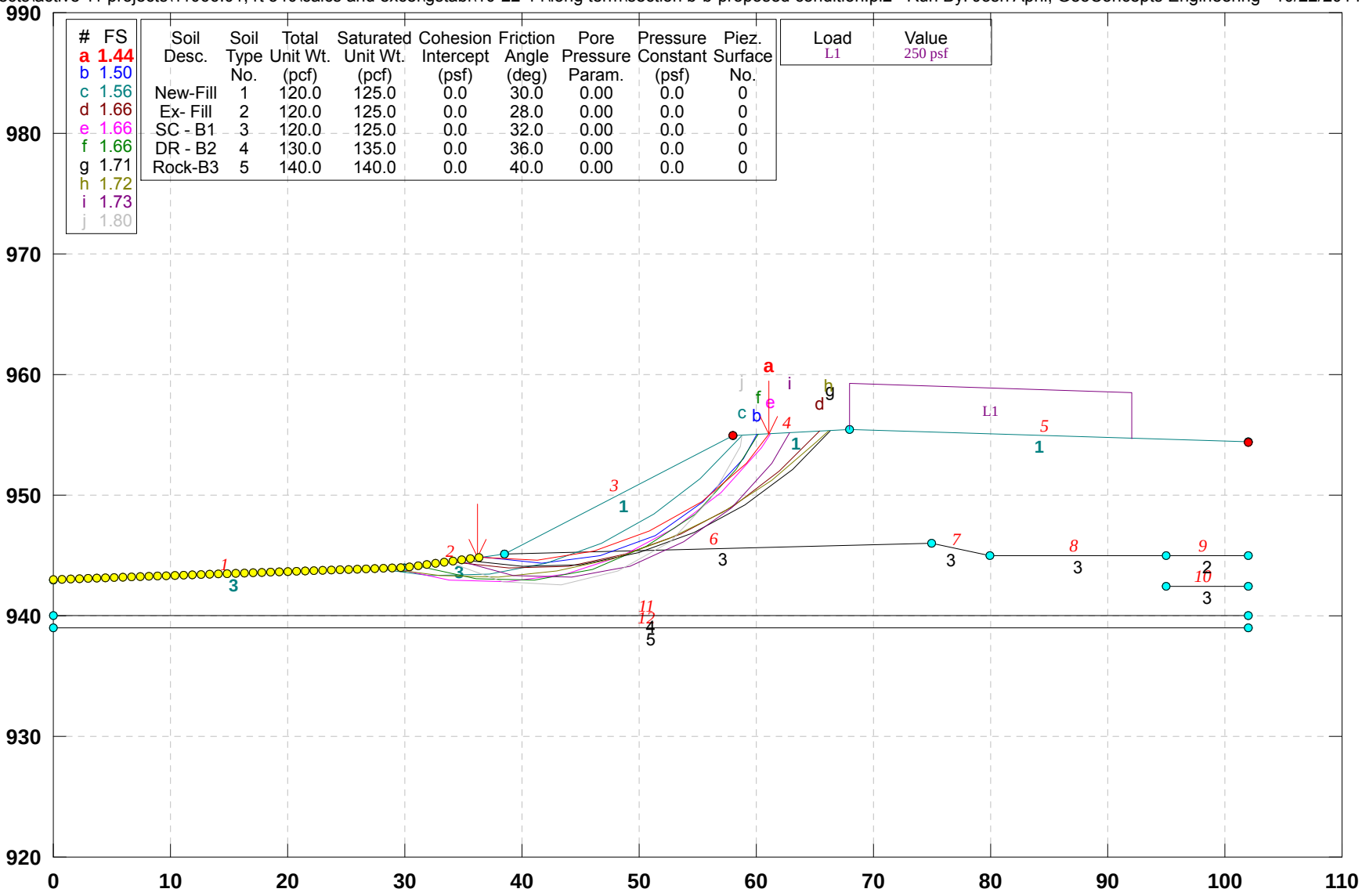
Output Filename:          N:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope.OUT
Unit System:              English
Plotted Output Filename:  N:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope.PLT
PROBLEM DESCRIPTION:  Section A-A'- Proposed East Slope 2H:1V
BOUNDARY COORDINATES
   11 Top   Boundaries
   22 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1          0.00     907.00      47.00     907.00        3
    2         47.00     907.00      57.50     905.50        3
    3         57.50     905.50      59.50     907.60        3
    4         59.50     907.60      83.50     927.76        2
    5         83.50     927.76      90.00     932.76        2
    6         90.00     932.76     103.00     941.26        2
    7        103.00     941.26     106.00     941.26        2
    8        106.00     941.26     128.00     953.47        1
    9        128.00     953.47     172.00     953.59        1
   10        172.00     953.59     249.00     923.00        1
   11        249.00     923.00     270.00     924.50        2
   12        103.00     941.26     130.00     942.00        2
   13        130.00     942.00     136.50     941.00        2
   14        136.50     941.00     148.50     931.50        2
   15        148.50     931.50     160.00     931.50        2
   16        160.00     931.50     180.00     927.76        2
   17        180.00     927.76     216.00     921.00        2
   18        216.00     921.00     220.00     921.00        2
   19        220.00     921.00     249.00     923.00        2
   20         59.50     907.60     270.00     907.60        3
   21          0.00     902.76     270.00     902.76        4
   22          0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0       0.0     30.0    0.00       0.0      0
  2   120.0    125.0       0.0     28.0    0.00       0.0      0
  3   120.0    125.0       0.0     32.0    0.00       0.0      0
  4   130.0    135.0       0.0     36.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
  Point      X-Water     Y-Water
   No.         (ft)        (ft)
```

```
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        105.00     941.26     105.10     906.26
 SEARCH LIMIT BOUNDARY DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  53.00(ft)
 Each Surface Terminates Between   X = 129.00(ft)
                                and   X = 160.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   3.290   FS Min =   1.060   FS Ave =   2.290
          Standard Deviation =    0.614   Coefficient of Variation =   26.80 %
       Failure Surface Specified By 27 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         22.623      907.000
           2         27.536      906.070
           3         32.487      905.372
           4         37.466      904.909
           5         42.460      904.682
           6         47.460      904.690
           7         52.454      904.934
           8         57.431      905.414
           9         62.380      906.127
          10         67.290      907.074
          11         72.149      908.251
          12         76.948      909.656
          13         81.675      911.285
          14         86.320      913.136
          15         90.872      915.204
          16         95.322      917.485
          17         99.659      919.973
          18        103.874      922.662
          19        107.957      925.548
          20        111.900      928.623
          21        115.693      931.880
          22        119.328      935.313
          23        122.797      938.914
          24        126.093      942.674
          25        129.208      946.585
```

```
   26        132.134      950.640
   27        133.991      953.486
Circle Center At X =    44.786 ; Y =  1010.610 ; and Radius =   105.954
       Factor of Safety
      ***    1.060   ***
```

Section B-B' - Long Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section b-b-proposed condition.pl2 Run By: Josh April, GeoConcepts Engineering 10/22/2014 04:55PM



#	FS
a	1.44
b	1.50
c	1.56
d	1.66
e	1.66
f	1.66
g	1.71
h	1.72
i	1.73
j	1.80

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	0.0	30.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	0.0	28.0	0.00	0.0	0
SC - B1	3	120.0	125.0	0.0	32.0	0.00	0.0	0
DR - B2	4	130.0	135.0	0.0	36.0	0.00	0.0	0
Rock-B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

Load	Value
L1	250 psf

GSTABL7 v.2 FSmin=1.44

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
       ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
                   (All Rights Reserved-Unauthorized Use Prohibited)
    ******************************************************************************
                       SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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    Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
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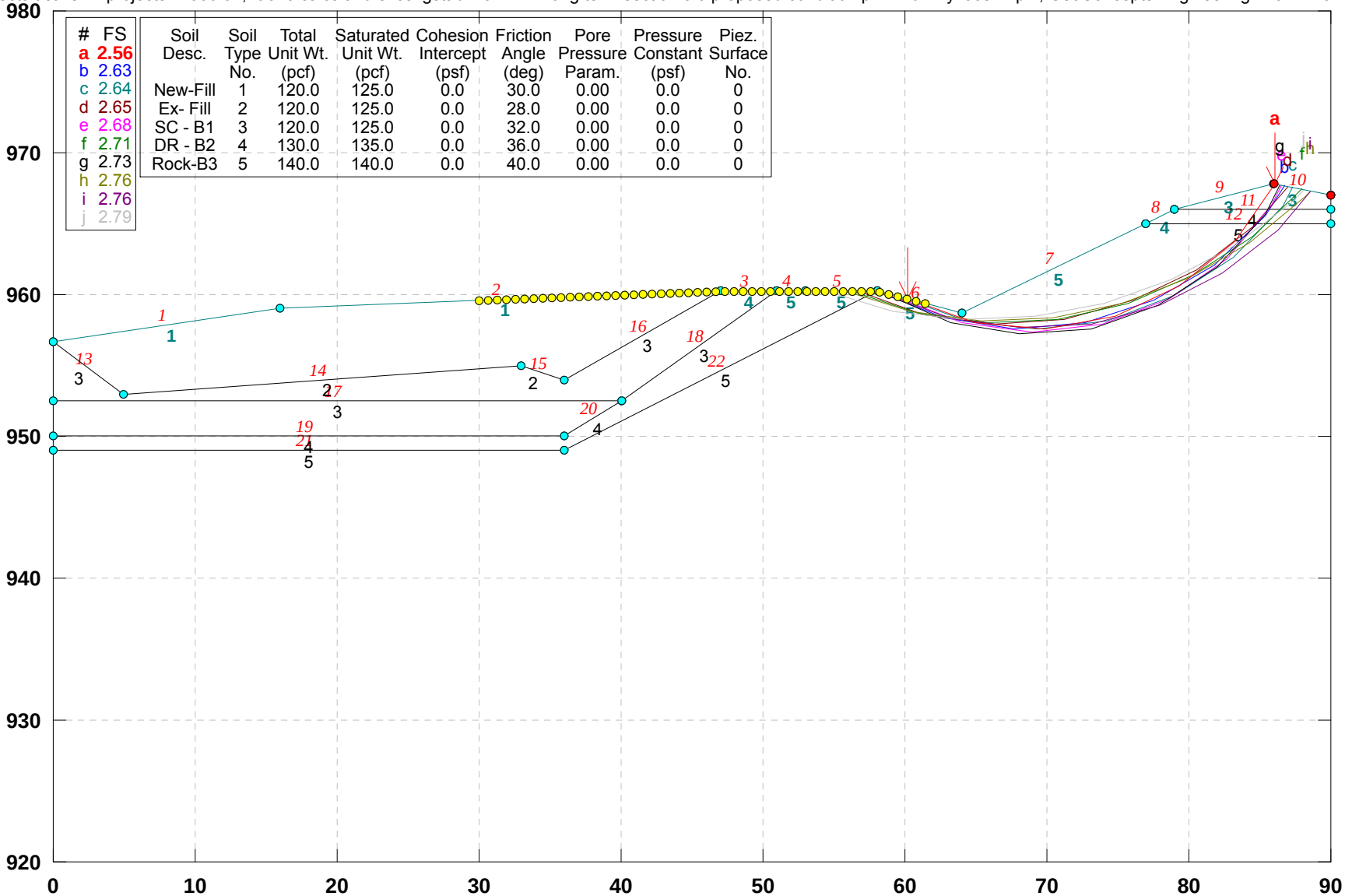
    Unit System:              English
    Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section b-b-proposed condition.PLT
    PROBLEM DESCRIPTION:  Section B-B' - Long Term
    BOUNDARY COORDINATES
        5 Top   Boundaries
       12 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00     943.00      30.00     944.00        3
        2         30.00     944.00      38.50     945.12        3
        3         38.50     945.12      58.00     954.95        1
        4         58.00     954.95      68.00     955.42        1
        5         68.00     955.42     102.00     954.37        1
        6         38.50     945.12      75.00     946.00        3
        7         75.00     946.00      80.00     945.00        3
        8         80.00     945.00      95.00     945.00        3
        9         95.00     945.00     102.00     945.00        2
       10         95.00     942.50     102.00     942.50        3
       11          0.00     940.00     102.00     940.00        4
       12          0.00     939.00     102.00     939.00        5
    User Specified Y-Origin =       920.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0       0.0     30.0    0.00       0.0      0
      2   120.0    125.0       0.0     28.0    0.00       0.0      0
      3   120.0    125.0       0.0     32.0    0.00       0.0      0
      4   130.0    135.0       0.0     36.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1         78.00      915.26
        2        270.00      915.26
    Piezometric Surface No.  2 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1          0.00      901.83
        2         78.00      901.83
    WATER SURFACE DATA HAS BEEN SUPPRESSED
   BOUNDARY LOAD(S)
```

```
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1          68.00        92.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     4 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.00    941.26   1877.00     1.000
        2       136.00    941.26   1877.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.02    943.26   1877.00     1.000
        2       136.02    943.26   1877.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.05    945.26   1877.00     1.000
        2       136.05    945.26   1877.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1       126.08    947.26   1877.00     1.000
        2       136.08    947.26   1877.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                 and  X =  37.00(ft)
 Each Surface Terminates Between   X =  58.00(ft)
                                 and   X = 102.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   9.090   FS Min =   1.436   FS Ave =   4.350
          Standard Deviation =    1.494   Coefficient of Variation =   34.34 %
       Failure Surface Specified By  7 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         36.259      944.825
           2         41.255      944.631
           3         46.202      945.357
           4         50.932      946.978
           5         55.284      949.439
           6         59.110      952.658
           7         61.111      955.096
       Circle Center At X =    39.805 ; Y =   971.728 ; and Radius =    27.136
              Factor of Safety
            ***    1.436   ***
```

Section C-C' - Long Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section c-c-proposed condition.pl2 Run By: Josh April, GeoConcepts Engineering 10/22/2014 04:57PM



#	FS
a	2.56
b	2.63
c	2.64
d	2.65
e	2.68
f	2.71
g	2.73
h	2.76
i	2.76
j	2.79

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	0.0	30.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	0.0	28.0	0.00	0.0	0
SC - B1	3	120.0	125.0	0.0	32.0	0.00	0.0	0
DR - B2	4	130.0	135.0	0.0	36.0	0.00	0.0	0
Rock-B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=2.56

Safety Factors Are Calculated By The Modified Bishop Method

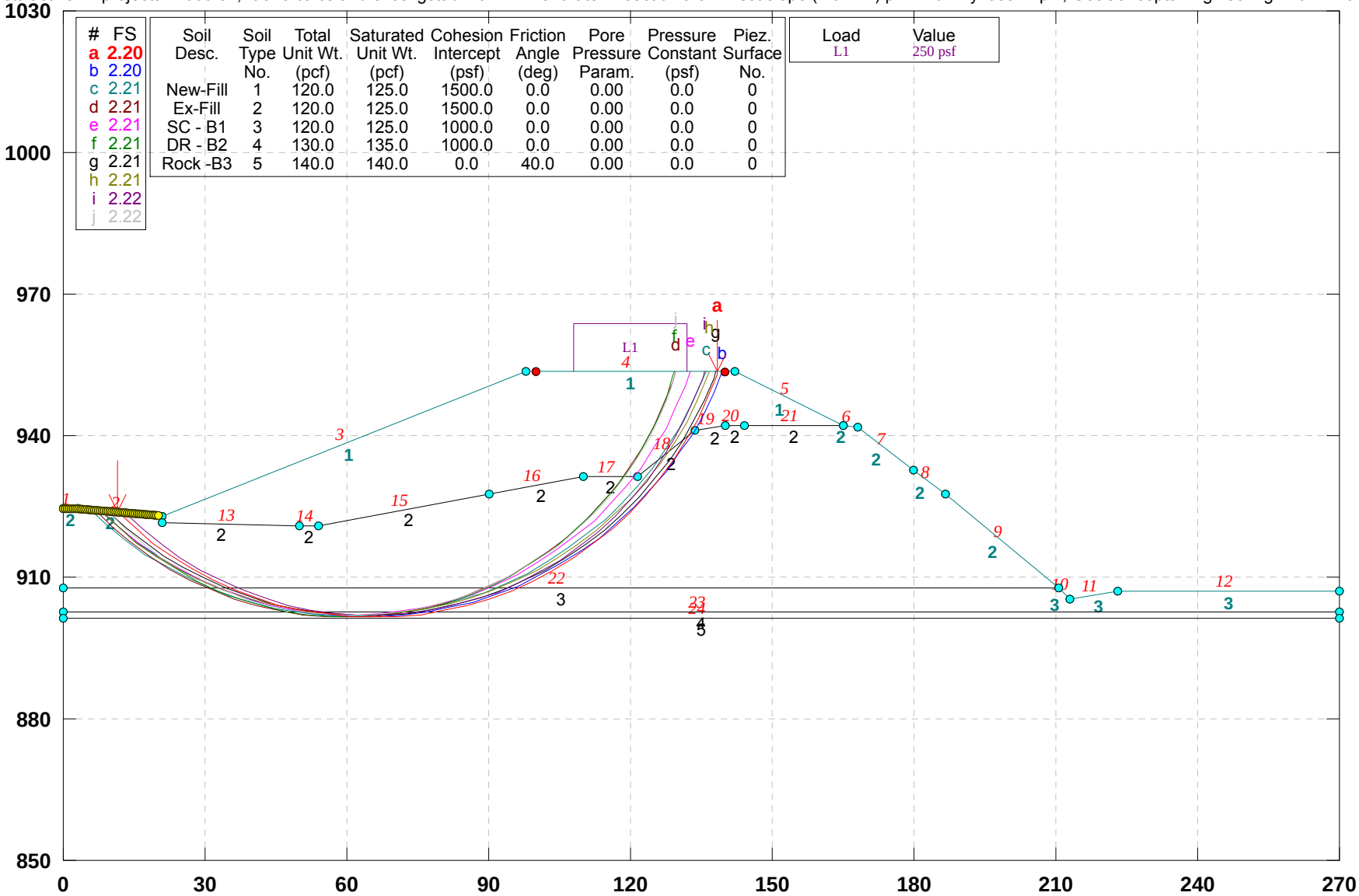
```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
        ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
                    (All Rights Reserved-Unauthorized Use Prohibited)
    ******************************************************************************
                        SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    ******************************************************************************
    Analysis Run Date:        10/22/2014
    Time of Run:              04:57PM
    Run By:                   Josh April, GeoConcepts Engineering
    Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section c-c-proposed condition.in
    Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section c-c-proposed condition.OUT
    Unit System:              English
    Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section c-c-proposed condition.PLT
    PROBLEM DESCRIPTION:  Section C-C' - Long Term
    BOUNDARY COORDINATES
       10 Top   Boundaries
       22 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1         0.00     956.63      16.00     959.03        1
        2        16.00     959.03      47.00     960.22        1
        3        47.00     960.22      51.00     960.22        4
        4        51.00     960.22      53.00     960.22        5
        5        53.00     960.22      58.00     960.22        5
        6        58.00     960.22      64.00     958.72        5
        7        64.00     958.72      77.00     965.00        5
        8        77.00     965.00      79.00     966.00        4
        9        79.00     966.00      86.00     967.82        3
       10        86.00     967.82      90.00     967.00        3
       11        79.00     966.00      90.00     966.00        4
       12        77.00     965.00      90.00     965.00        5
       13         0.00     956.63       5.00     953.00        3
       14         5.00     953.00      33.00     955.00        2
       15        33.00     955.00      36.00     954.00        2
       16        36.00     954.00      47.00     960.22        3
       17         0.00     952.50      40.00     952.50        3
       18        40.00     952.50      51.00     960.22        3
       19         0.00     950.00      36.00     950.00        4
       20        36.00     950.00      40.00     952.50        4
       21         0.00     949.00      36.00     949.00        5
       22        36.00     949.00      58.00     960.22        5
    User Specified Y-Origin =       920.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0       0.0     30.0    0.00       0.0      0
      2   120.0    125.0       0.0     28.0    0.00       0.0      0
      3   120.0    125.0       0.0     32.0    0.00       0.0      0
      4   130.0    135.0       0.0     36.0    0.00       0.0      0
      5   140.0    140.0       0.0     40.0    0.00       0.0      0
    2 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
```

```
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1          68.00        92.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 SURCHARGE BOUNDARY LOAD DATA HAS BEEN SUPPRESSED
REINFORCING LAYER(S)
     4 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                   FACTOR
        1       126.00    941.26   1877.00     1.000
        2       136.00    941.26   1877.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                   FACTOR
        1       126.02    943.26   1877.00     1.000
        2       136.02    943.26   1877.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                   FACTOR
        1       126.05    945.26   1877.00     1.000
        2       136.05    945.26   1877.00     1.000
 REINFORCING LAYER NO.   4
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                   FACTOR
        1       126.08    947.26   1877.00     1.000
        2       136.08    947.26   1877.00     1.000
 REINFORCING LAYER DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =  30.00(ft)
                                and  X =  62.00(ft)
 Each Surface Terminates Between   X =  86.00(ft)
                               and   X =  90.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   8.056   FS Min =   2.558   FS Ave =   4.983
          Standard Deviation =    1.239   Coefficient of Variation =   24.87 %
       Failure Surface Specified By  7 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         60.205      959.669
           2         64.925      958.020
           3         69.909      957.623
```

```
    4         74.831      958.503
    5         79.368      960.604
    6         83.224      963.787
    7         86.112      967.797
Circle Center At X =    68.957 ; Y =   977.144 ; and Radius =    19.544
       Factor of Safety
      ***    2.558   ***
```

Section A-A' - West Slope Proposed 2.5H:1V - Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - west slope (2.5h-1v).pl2 Run By: Josh April, GeoConcepts Engineering 10/22/2014 05:46PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex-Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock -B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=2.20

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
          ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
              (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
         Modified Bishop, Simplified Janbu, or GLE Method of Slices.
         (Includes Spencer & Morgenstern-Price Type Analysis)
         Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
         Nonlinear Undrained Shear Strength, Curved Phi Envelope,
         Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
         Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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Analysis Run Date:        10/22/2014
Time of Run:              05:46PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - west slope (2.5h-1v).in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - west slope (2.5h-1v).OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - west slope (2.5h-1v).PLT
PROBLEM DESCRIPTION:  Section A-A' - West Slope Proposed 2.5H:
                      1V - Short Term
BOUNDARY COORDINATES
   12 Top   Boundaries
   24 Total Boundaries
```

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	924.50	3.00	924.50	2
2	3.00	924.50	21.00	923.00	2
3	21.00	923.00	98.00	953.58	1
4	98.00	953.58	142.00	953.47	1
5	142.00	953.47	165.00	941.97	1
6	165.00	941.97	168.00	941.96	2
7	168.00	941.96	180.00	932.76	2
8	180.00	932.76	186.50	927.76	2
9	186.50	927.76	210.50	907.60	2
10	210.50	907.60	213.00	905.50	3
11	213.00	905.50	223.00	907.00	3
12	223.00	907.00	270.00	907.00	3
13	21.00	921.58	50.00	921.00	2
14	50.00	921.00	54.00	921.00	2
15	54.00	921.00	90.00	927.76	2
16	90.00	927.76	110.00	931.50	2
17	110.00	931.50	121.50	931.50	2
18	121.50	931.50	133.50	941.00	2
19	133.50	941.00	140.00	942.00	2
20	140.00	942.00	144.00	942.00	2
21	144.00	942.00	165.00	941.97	2
22	0.00	907.60	210.50	907.60	3
23	0.00	902.76	270.00	902.76	4
24	0.00	901.26	270.00	901.26	5

```
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
```

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	125.0	1500.0	0.0	0.00	0.0	0
2	120.0	125.0	1500.0	0.0	0.00	0.0	0
3	120.0	125.0	1000.0	0.0	0.00	0.0	0
4	130.0	135.0	1000.0	0.0	0.00	0.0	0
5	140.0	140.0	0.0	40.0	0.00	0.0	0

```
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
```

```
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      915.26
     2        192.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1        192.00      901.83
     2        270.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         108.00       132.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  20.50(ft)
 Each Surface Terminates Between   X = 100.00(ft)
                               and   X = 140.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   5.959   FS Min =   2.204   FS Ave =   2.916
          Standard Deviation =    0.586   Coefficient of Variation =   20.09 %
       Failure Surface Specified By 33 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         11.421      923.798
           2         15.085      920.396
           3         18.962      917.239
           4         23.036      914.340
           5         27.289      911.711
           6         31.703      909.363
           7         36.261      907.306
           8         40.942      905.550
           9         45.727      904.100
          10         50.597      902.964
          11         55.529      902.146
          12         60.504      901.650
          13         65.501      901.477
          14         70.499      901.629
          15         75.477      902.104
          16         80.413      902.901
          17         85.287      904.016
          18         90.078      905.446
          19         94.767      907.182
          20         99.333      909.220
          21        103.757      911.549
          22        108.021      914.160
          23        112.107      917.042
          24        115.998      920.182
          25        119.676      923.569
          26        123.128      927.187
          27        126.337      931.021
          28        129.291      935.055
```

```
   29        131.977      939.272
   30        134.384      943.654
   31        136.502      948.184
   32        138.322      952.841
   33        138.525      953.479
Circle Center At X =    65.665 ; Y =   978.548 ; and Radius =    77.071
       Factor of Safety
      ***    2.204   ***
```

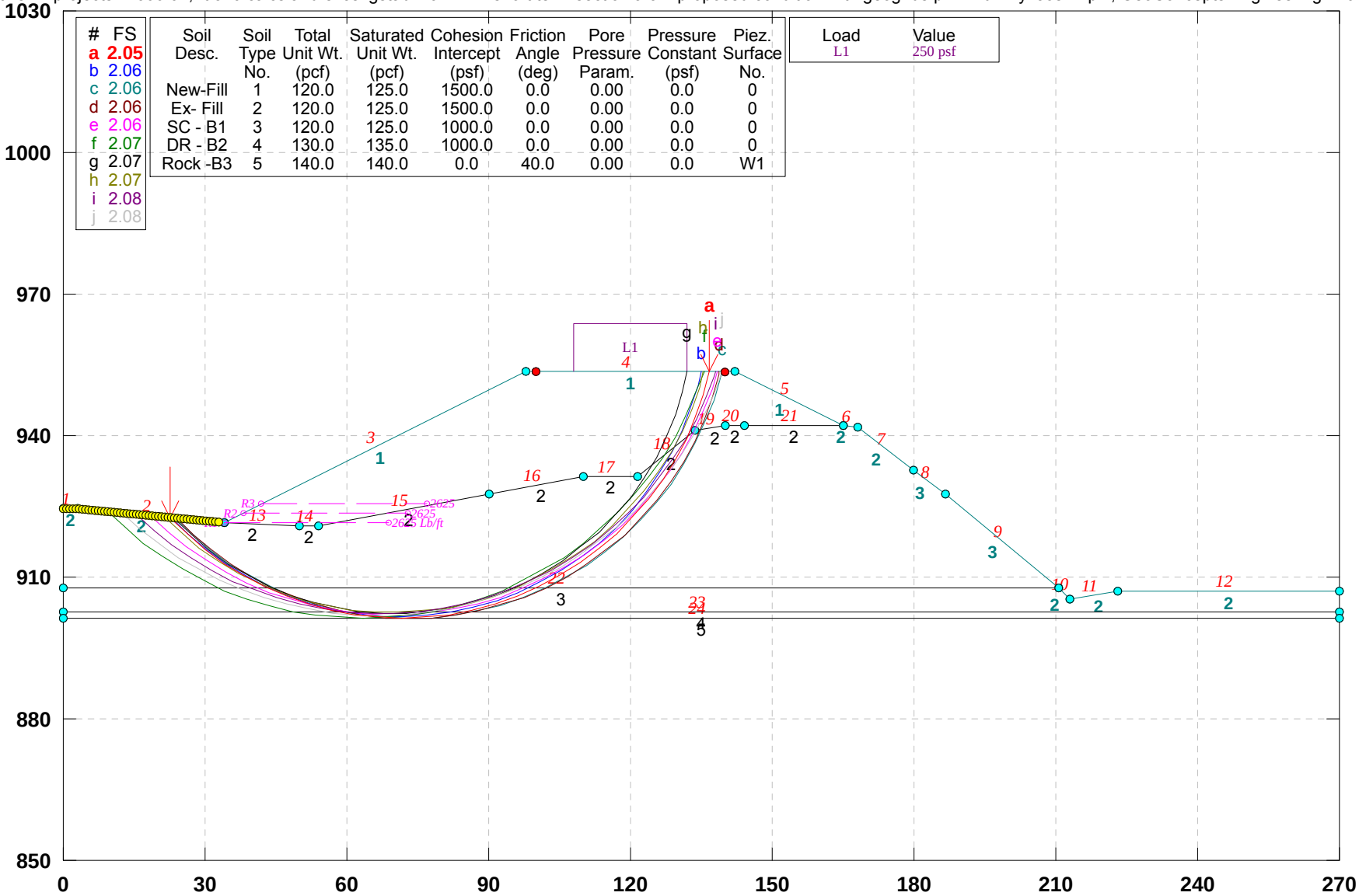
Section A-A'- West Slope Proposed 2H:1V- with Geogrids - Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - proposed condition with geogrids.pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 12:5

#	FS
a	2.05
b	2.06
c	2.06
d	2.06
e	2.06
f	2.07
g	2.07
h	2.07
i	2.08
j	2.08

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock -B3	5	140.0	140.0	0.0	40.0	0.00	0.0	W1

Load	Value
L1	250 psf



GSTABL7 v.2 FSmin=2.05

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
            ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
        Modified Bishop, Simplified Janbu, or GLE Method of Slices.
        (Includes Spencer & Morgenstern-Price Type Analysis)
        Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
        Nonlinear Undrained Shear Strength, Curved Phi Envelope,
        Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
        Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/23/2014
Time of Run:              12:50PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
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Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed condition with geogrids.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - proposed condition with geogrids.PLT
PROBLEM DESCRIPTION:  Section  A-A'- West Slope Proposed 2H:1V
                      - with Geogrids - Short Term
BOUNDARY COORDINATES
   12 Top   Boundaries
   24 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1         0.00     924.50       3.00     924.50        2
    2         3.00     924.50      34.00     921.58        2
    3        34.00     921.58      98.00     953.58        1
    4        98.00     953.58     142.00     953.47        1
    5       142.00     953.47     165.00     941.97        1
    6       165.00     941.97     168.00     941.96        2
    7       168.00     941.96     180.00     932.76        2
    8       180.00     932.76     186.50     927.76        3
    9       186.50     927.76     210.50     907.60        3
   10       210.50     907.60     213.00     905.50        2
   11       213.00     905.50     223.00     907.00        2
   12       223.00     907.00     270.00     907.00        2
   13        34.00     921.58      50.00     921.00        2
   14        50.00     921.00      54.00     921.00        2
   15        54.00     921.00      90.00     927.76        2
   16        90.00     927.76     110.00     931.50        2
   17       110.00     931.50     121.50     931.50        2
   18       121.50     931.50     133.50     941.00        2
   19       133.50     941.00     140.00     942.00        2
   20       140.00     942.00     144.00     942.00        2
   21       144.00     942.00     165.00     941.97        2
   22         0.00     907.60     210.50     907.60        3
   23         0.00     902.76     270.00     902.76        4
   24         0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0    1500.0      0.0    0.00       0.0      0
  2   120.0    125.0    1500.0      0.0    0.00       0.0      0
  3   120.0    125.0    1000.0      0.0    0.00       0.0      0
  4   130.0    135.0    1000.0      0.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      1
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
```

```
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      915.26
     2        192.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1        192.00      901.83
     2        270.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         108.00       132.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     3 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        34.00    921.58   2625.00     1.000
        2        69.00    921.58   2625.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        38.00    923.58   2625.00     1.000
        2        73.00    923.58   2625.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        42.00    925.58   2625.00     1.000
        2        77.00    925.58   2625.00     1.000
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  33.50(ft)
 Each Surface Terminates Between   X = 100.00(ft)
                               and   X = 140.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   6.304   FS Min =   2.051   FS Ave =   2.787
          Standard Deviation =    0.691   Coefficient of Variation =   24.80 %
       Failure Surface Specified By 30 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1        22.624      922.652
           2        26.164      919.120
           3        29.958      915.863
           4        33.984      912.899
           5        38.222      910.245
           6        42.646      907.915
           7        47.231      905.922
           8        51.954      904.279
```

9	56.785	902.993
10	61.700	902.072
11	66.669	901.521
12	71.666	901.344
13	76.662	901.541
14	81.630	902.111
15	86.541	903.051
16	91.367	904.356
17	96.083	906.019
18	100.661	908.029
19	105.075	910.377
20	109.302	913.048
21	113.317	916.028
22	117.098	919.299
23	120.624	922.845
24	123.874	926.644
25	126.831	930.676
26	129.479	934.918
27	131.801	939.346
28	133.786	943.935
29	135.422	948.660
30	136.697	953.483

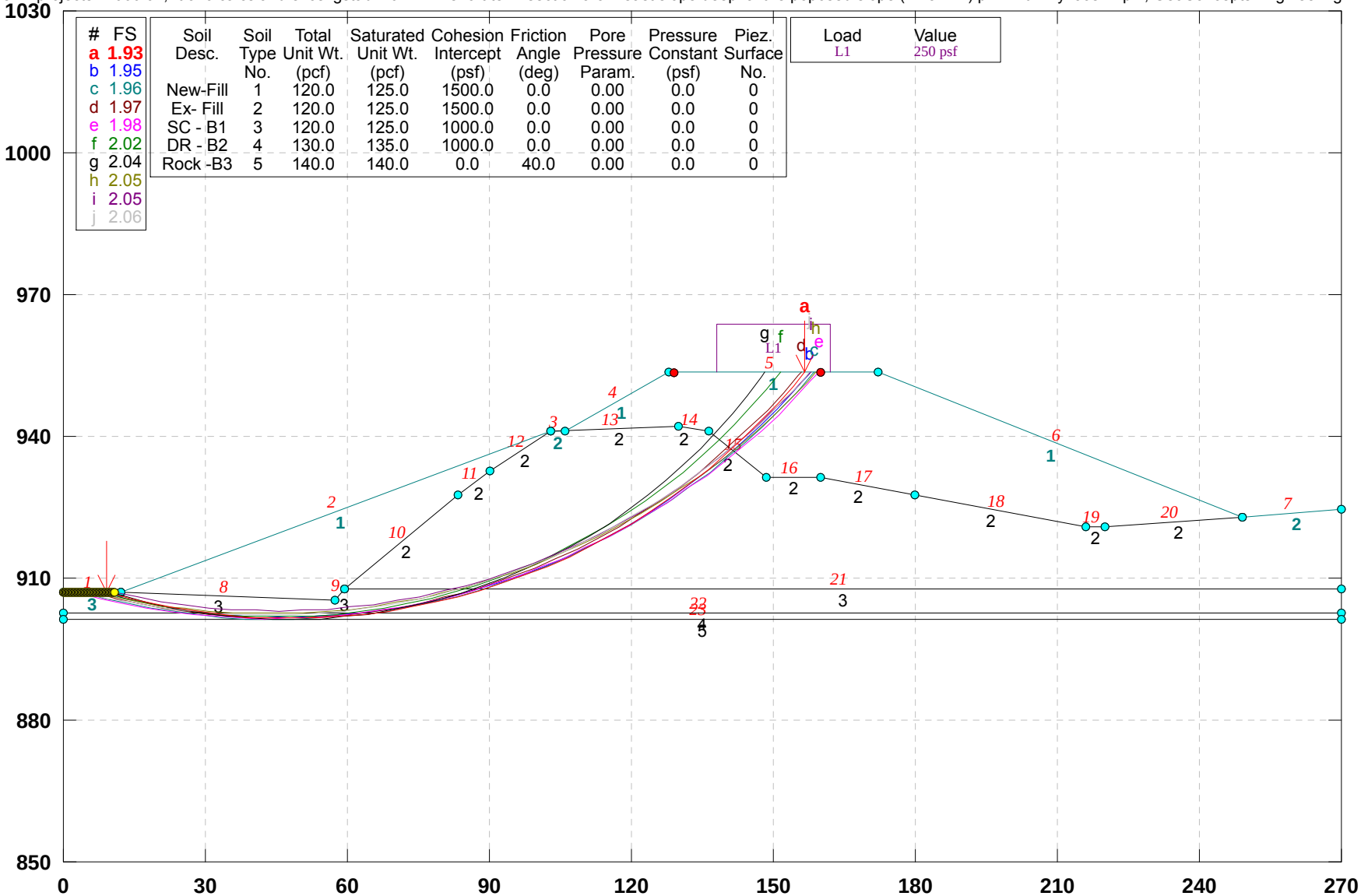
Circle Center At X = 71.534 ; Y = 968.132 ; and Radius = 66.788

Factor of Safety

*** 2.051 ***

Section - A-A'- Proposed East Slope 2.75H:1V - Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - east slope deep failure poposed slope (2.75h-1v).pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 12



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	1500.0	0.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	1500.0	0.0	0.00	0.0	0
SC - B1	3	120.0	125.0	1000.0	0.0	0.00	0.0	0
DR - B2	4	130.0	135.0	1000.0	0.0	0.00	0.0	0
Rock -B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=1.93

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
          ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
        Modified Bishop, Simplified Janbu, or GLE Method of Slices.
        (Includes Spencer & Morgenstern-Price Type Analysis)
        Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
        Nonlinear Undrained Shear Strength, Curved Phi Envelope,
        Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
        Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/23/2014
Time of Run:              12:47PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope (2.75h-1v).in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope (2.75h-1v).OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope (2.75h-1v).PLT
PROBLEM DESCRIPTION:  Section - A-A'- Proposed East Slope 2.75
                      H:1V - Short Term
BOUNDARY COORDINATES
    7 Top   Boundaries
   23 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1         0.00     907.00      12.00     907.00        3
    2        12.00     907.00     103.00     941.26        1
    3       103.00     941.26     106.00     941.26        2
    4       106.00     941.26     128.00     953.47        1
    5       128.00     953.47     172.00     953.59        1
    6       172.00     953.59     249.00     923.00        1
    7       249.00     923.00     270.00     924.50        2
    8        12.00     907.00      57.50     905.50        3
    9        57.50     905.50      59.50     907.60        3
   10        59.50     907.60      83.50     927.76        2
   11        83.50     927.76      90.00     932.76        2
   12        90.00     932.76     103.00     941.26        2
   13       103.00     941.26     130.00     942.00        2
   14       130.00     942.00     136.50     941.00        2
   15       136.50     941.00     148.50     931.50        2
   16       148.50     931.50     160.00     931.50        2
   17       160.00     931.50     180.00     927.76        2
   18       180.00     927.76     216.00     921.00        2
   19       216.00     921.00     220.00     921.00        2
   20       220.00     921.00     249.00     923.00        2
   21        59.50     907.60     270.00     907.60        3
   22         0.00     902.76     270.00     902.76        4
   23         0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0    1500.0      0.0    0.00       0.0      0
  2   120.0    125.0    1500.0      0.0    0.00       0.0      0
  3   120.0    125.0    1000.0      0.0    0.00       0.0      0
  4   130.0    135.0    1000.0      0.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
```

```
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        105.00     941.26     105.10     906.26
 SEARCH LIMIT BOUNDARY DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  11.00(ft)
 Each Surface Terminates Between   X = 129.00(ft)
                               and   X = 160.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   4.116   FS Min =   1.926   FS Ave =   3.204
          Standard Deviation =    0.627   Coefficient of Variation =   19.56 %
       Failure Surface Specified By 34 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1          9.281      907.000
           2         14.107      905.694
           3         18.977      904.562
           4         23.885      903.606
           5         28.824      902.827
           6         33.788      902.227
           7         38.770      901.805
           8         43.764      901.562
           9         48.764      901.499
          10         53.762      901.617
          11         58.753      901.913
          12         63.731      902.389
          13         68.688      903.044
          14         73.618      903.877
          15         78.515      904.886
          16         83.373      906.070
          17         88.184      907.429
          18         92.944      908.960
          19         97.646      910.661
          20        102.284      912.530
          21        106.851      914.564
          22        111.342      916.761
          23        115.752      919.119
```

24	120.074	921.633
25	124.302	924.301
26	128.432	927.120
27	132.458	930.085
28	136.375	933.193
29	140.177	936.440
30	143.860	939.822
31	147.419	943.333
32	150.850	946.971
33	154.147	950.729
34	156.446	953.548

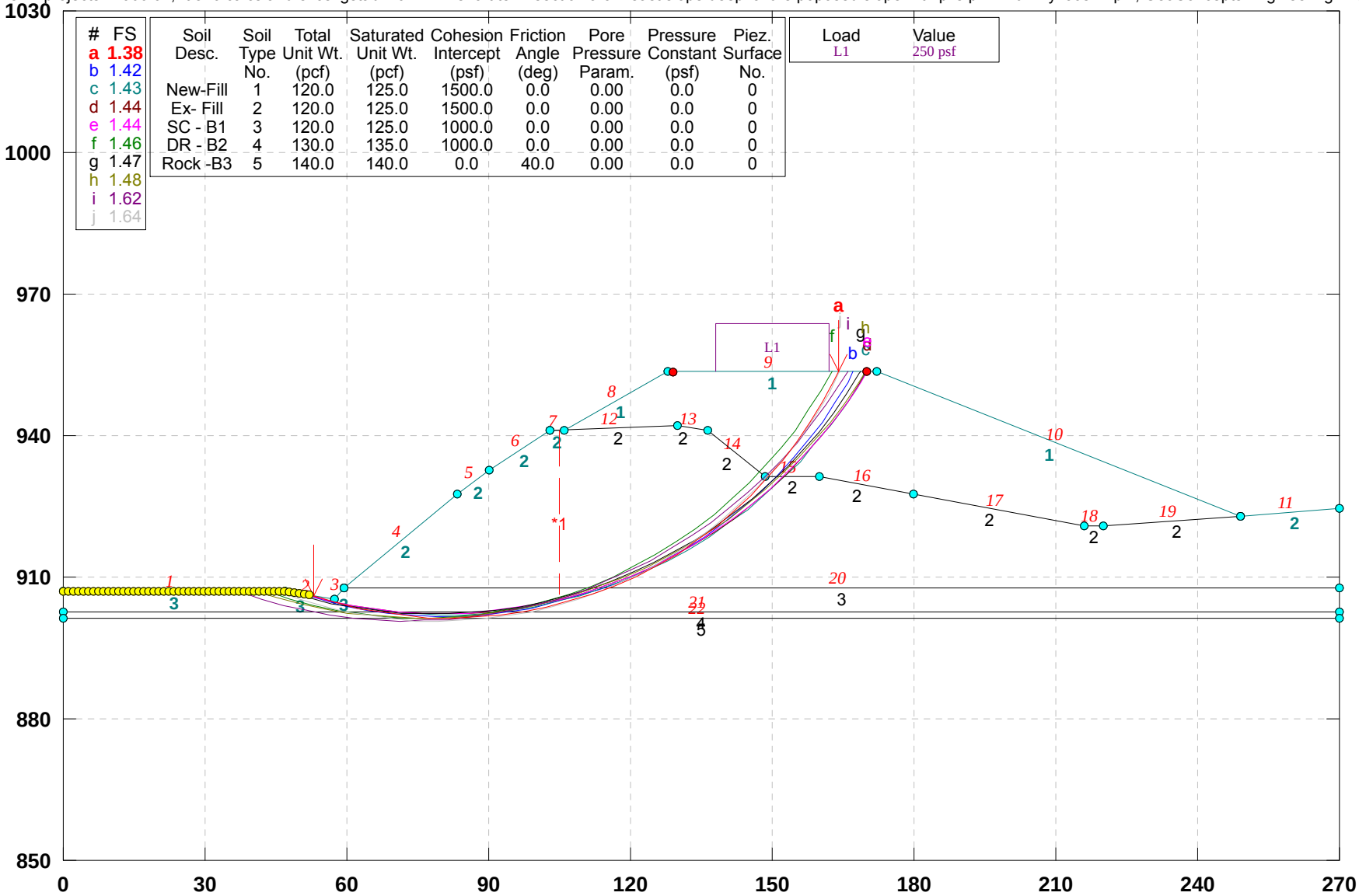
Circle Center At X = 48.008 ; Y = 1040.474 ; and Radius = 138.978

Factor of Safety

*** 1.926 ***

Section A-A'- Proposed East Slope 2H:1V with Pier - Short Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\short term\section a-a' - east slope deep failure poposed slope with pile.pl2 Run By: Josh April, GeoConcepts Engineering 10/23/2014 01:0



GSTABL7 v.2 FSmin=1.38

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
            ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
        Modified Bishop, Simplified Janbu, or GLE Method of Slices.
        (Includes Spencer & Morgenstern-Price Type Analysis)
        Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
        Nonlinear Undrained Shear Strength, Curved Phi Envelope,
        Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
        Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/23/2014
Time of Run:              01:07PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope with pile.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope with pile.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Short Term\section a-a' - east slope deep failure poposed slope with pile.PLT
PROBLEM DESCRIPTION:  Section A-A'- Proposed East Slope 2H:1V
                      with Pier - Short Term
BOUNDARY COORDINATES
   11 Top   Boundaries
   22 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1          0.00     907.00      47.00     907.00        3
    2         47.00     907.00      57.50     905.50        3
    3         57.50     905.50      59.50     907.60        3
    4         59.50     907.60      83.50     927.76        2
    5         83.50     927.76      90.00     932.76        2
    6         90.00     932.76     103.00     941.26        2
    7        103.00     941.26     106.00     941.26        2
    8        106.00     941.26     128.00     953.47        1
    9        128.00     953.47     172.00     953.59        1
   10        172.00     953.59     249.00     923.00        1
   11        249.00     923.00     270.00     924.50        2
   12        103.00     941.26     130.00     942.00        2
   13        130.00     942.00     136.50     941.00        2
   14        136.50     941.00     148.50     931.50        2
   15        148.50     931.50     160.00     931.50        2
   16        160.00     931.50     180.00     927.76        2
   17        180.00     927.76     216.00     921.00        2
   18        216.00     921.00     220.00     921.00        2
   19        220.00     921.00     249.00     923.00        2
   20         59.50     907.60     270.00     907.60        3
   21          0.00     902.76     270.00     902.76        4
   22          0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0    1500.0      0.0    0.00       0.0      0
  2   120.0    125.0    1500.0      0.0    0.00       0.0      0
  3   120.0    125.0    1000.0      0.0    0.00       0.0      0
  4   130.0    135.0    1000.0      0.0    0.00       0.0      0
  5   140.0    140.0       0.0     40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
  Point      X-Water     Y-Water
```

```
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        105.00     941.26     105.10     906.26
PIER/PILE LOAD(S)
     1 Pier/Pile Load(s) Specified
Pier/Pile  X-Pos    Y-Pos     Load    Spacing  Inclination  Length
   No.     (ft)     (ft)      (lbs)     (ft)      (deg)      (ft)
    1     105.00   941.26    30000.0     1.0      90.00       35.0
 NOTE - An Equivalent Line Load Is Calculated For Each Row Of Piers/Piles
        Assuming A Uniform Distribution Of Load Horizontally Between
        Individual Piers/Piles.
 PIER/PILE LOAD DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  53.00(ft)
 Each Surface Terminates Between   X = 129.00(ft)
                              and   X = 170.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   3.674   FS Min =   1.380   FS Ave =   2.648
          Standard Deviation =    0.507   Coefficient of Variation =   19.14 %
       Failure Surface Specified By 28 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         52.894      906.158
           2         57.670      904.679
           3         62.520      903.465
           4         67.431      902.521
           5         72.385      901.850
           6         77.370      901.454
           7         82.368      901.333
           8         87.366      901.489
           9         92.347      901.920
          10         97.297      902.626
          11        102.200      903.604
          12        107.042      904.851
          13        111.808      906.364
          14        116.483      908.138
          15        121.053      910.167
          16        125.503      912.445
```

17	129.821	914.966
18	133.994	917.721
19	138.007	920.703
20	141.850	923.902
21	145.511	927.308
22	148.978	930.911
23	152.240	934.699
24	155.288	938.663
25	158.113	942.788
26	160.706	947.064
27	163.058	951.476
28	164.030	953.568

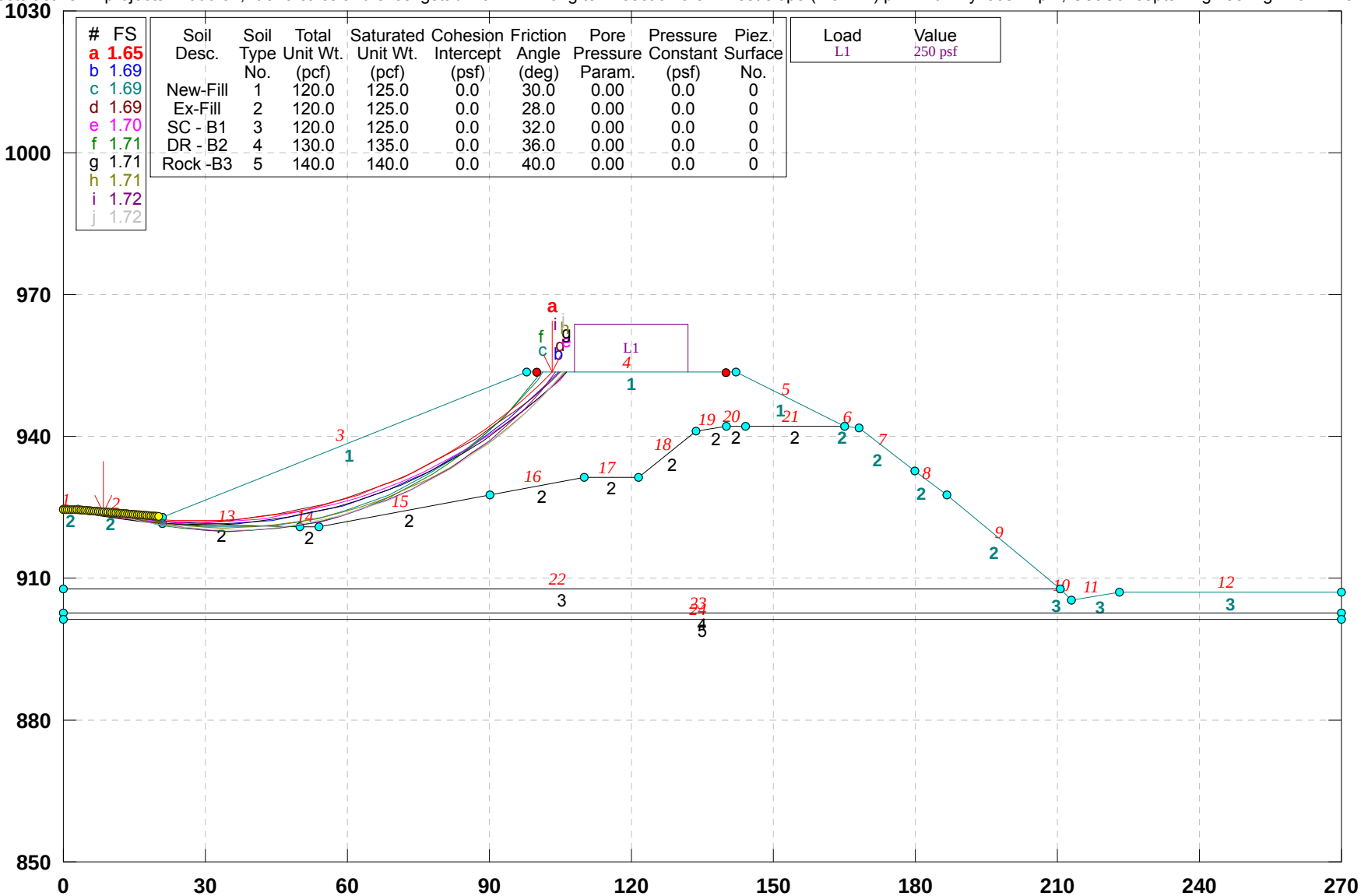
Circle Center At X = 82.054 ; Y = 991.766 ; and Radius = 90.438

Factor of Safety

*** 1.380 ***

Section A-A' - West Slope Proposed 2.5H:1V - Long Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section a-a' - west slope (2.5h-1v).pl2 Run By: Josh April, GeoConcepts Engineering 10/22/2014 05:00PM



GSTABL7 v.2 FSmin=1.65

Safety Factors Are Calculated By The Modified Bishop Method

```
                                   ***  GSTABL7  ***
                         ** GSTABL7 by Garry H. Gregory, P.E. **
      ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
                   (All Rights Reserved-Unauthorized Use Prohibited)
   ***************************************************************************
                         SLOPE STABILITY ANALYSIS SYSTEM
          Modified Bishop, Simplified Janbu, or GLE Method of Slices.
          (Includes Spencer & Morgenstern-Price Type Analysis)
          Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
          Nonlinear Undrained Shear Strength, Curved Phi Envelope,
          Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
          Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
   ***************************************************************************
   Analysis Run Date:        10/22/2014
   Time of Run:              05:00PM
   Run By:                   Josh April, GeoConcepts Engineering
   Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - west slope (2.5h-1v).in
   Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - west slope (2.5h-1v).OUT
   Unit System:              English
   Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - west slope (2.5h-1v).PLT
   PROBLEM DESCRIPTION:  Section A-A' - West Slope Proposed 2.5H:
                          1V - Long Term
   BOUNDARY COORDINATES
      12 Top   Boundaries
      24 Total Boundaries
   Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
      No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
       1         0.00     924.50       3.00     924.50        2
       2         3.00     924.50      21.00     923.00        2
       3        21.00     923.00      98.00     953.58        1
       4        98.00     953.58     142.00     953.47        1
       5       142.00     953.47     165.00     941.97        1
       6       165.00     941.97     168.00     941.96        2
       7       168.00     941.96     180.00     932.76        2
       8       180.00     932.76     186.50     927.76        2
       9       186.50     927.76     210.50     907.60        2
      10       210.50     907.60     213.00     905.50        3
      11       213.00     905.50     223.00     907.00        3
      12       223.00     907.00     270.00     907.00        3
      13        21.00     921.58      50.00     921.00        2
      14        50.00     921.00      54.00     921.00        2
      15        54.00     921.00      90.00     927.76        2
      16        90.00     927.76     110.00     931.50        2
      17       110.00     931.50     121.50     931.50        2
      18       121.50     931.50     133.50     941.00        2
      19       133.50     941.00     140.00     942.00        2
      20       140.00     942.00     144.00     942.00        2
      21       144.00     942.00     165.00     941.97        2
      22         0.00     907.60     210.50     907.60        3
      23         0.00     902.76     270.00     902.76        4
      24         0.00     901.26     270.00     901.26        5
   User Specified Y-Origin =       850.00(ft)
   Default X-Plus Value = 0.00(ft)
   Default Y-Plus Value = 0.00(ft)
  ISOTROPIC SOIL PARAMETERS
    5 Type(s) of Soil
   Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
   Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
    No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
     1   120.0    125.0       0.0      30.0    0.00       0.0      0
     2   120.0    125.0       0.0      28.0    0.00       0.0      0
     3   120.0    125.0       0.0      32.0    0.00       0.0      0
     4   130.0    135.0       0.0      36.0    0.00       0.0      0
     5   140.0    140.0       0.0      40.0    0.00       0.0      0
   2 PIEZOMETRIC SURFACE(S) SPECIFIED
   Unit Weight of Water =  62.40 (pcf)
   Piezometric Surface No.  1 Specified by  2 Coordinate Points
```

```
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      915.26
     2        192.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1        192.00      901.83
     2        270.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         108.00       132.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  20.50(ft)
 Each Surface Terminates Between   X = 100.00(ft)
                               and   X = 140.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   3.708   FS Min =   1.647   FS Ave =   2.462
          Standard Deviation =    0.472   Coefficient of Variation =   19.16 %
       Failure Surface Specified By 22 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1          8.340      924.055
           2         13.266      923.201
           3         18.228      922.584
           4         23.214      922.206
           5         28.212      922.068
           6         33.211      922.169
           7         38.199      922.510
           8         43.165      923.091
           9         48.098      923.908
          10         52.986      924.962
          11         57.817      926.249
          12         62.582      927.766
          13         67.267      929.510
          14         71.864      931.477
          15         76.362      933.662
          16         80.749      936.060
          17         85.016      938.667
          18         89.153      941.474
          19         93.151      944.477
          20         97.000      947.669
          21        100.691      951.041
          22        103.202      953.567
       Circle Center At X =    28.601 ; Y =  1026.146 ; and Radius =   104.082
              Factor of Safety
            ***    1.647   ***
```

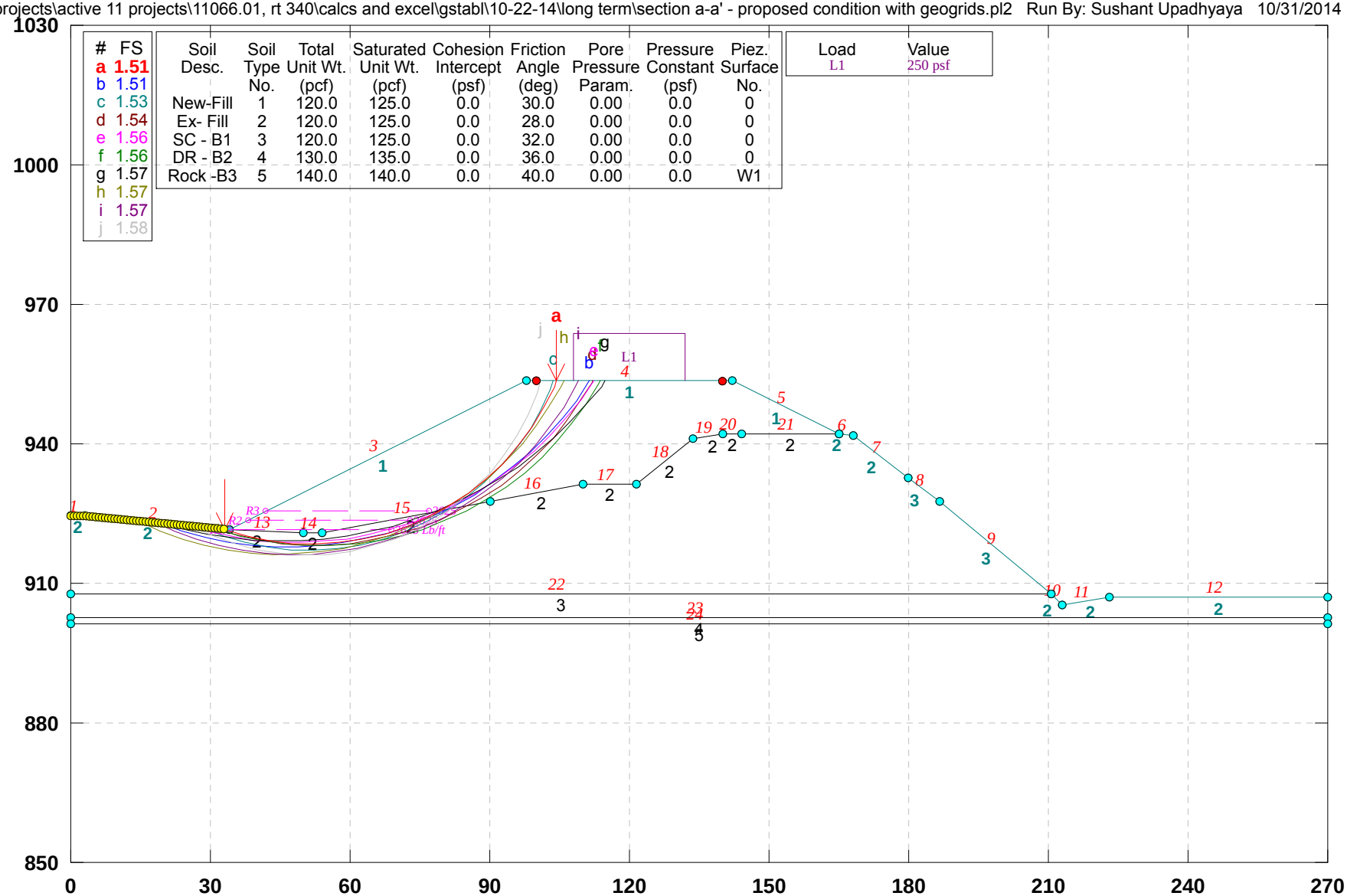
Section A-A'- West Slope Proposed 2H:1V- with Geogrids - Long Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section a-a' - proposed condition with geogrids.pl2 Run By: Sushant Upadhyaya 10/31/2014 09:31AM

#	FS
a	1.51
b	1.51
c	1.53
d	1.54
e	1.56
f	1.56
g	1.57
h	1.57
i	1.57
j	1.58

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	0.0	30.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	0.0	28.0	0.00	0.0	0
SC - B1	3	120.0	125.0	0.0	32.0	0.00	0.0	0
DR - B2	4	130.0	135.0	0.0	36.0	0.00	0.0	0
Rock -B3	5	140.0	140.0	0.0	40.0	0.00	0.0	W1

Load	Value
L1	250 psf



GSTABL7 v.2 FSmin=1.51

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
            ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
        Modified Bishop, Simplified Janbu, or GLE Method of Slices.
        (Includes Spencer & Morgenstern-Price Type Analysis)
        Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
        Nonlinear Undrained Shear Strength, Curved Phi Envelope,
        Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
        Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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Analysis Run Date:        10/31/2014
Time of Run:              09:31AM
Run By:                   Sushant Upadhyaya
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - proposed condition with geogrids.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - proposed condition with geogrids.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - proposed condition with geogrids.PLT
PROBLEM DESCRIPTION:  Section  A-A'- West Slope Proposed 2H:1V
                      - with Geogrids - Long Term
BOUNDARY COORDINATES
   12 Top   Boundaries
   24 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1         0.00     924.50       3.00     924.50        2
    2         3.00     924.50      34.00     921.58        2
    3        34.00     921.58      98.00     953.58        1
    4        98.00     953.58     142.00     953.47        1
    5       142.00     953.47     165.00     941.97        1
    6       165.00     941.97     168.00     941.96        2
    7       168.00     941.96     180.00     932.76        2
    8       180.00     932.76     186.50     927.76        3
    9       186.50     927.76     210.50     907.60        3
   10       210.50     907.60     213.00     905.50        2
   11       213.00     905.50     223.00     907.00        2
   12       223.00     907.00     270.00     907.00        2
   13        34.00     921.58      50.00     921.00        2
   14        50.00     921.00      54.00     921.00        2
   15        54.00     921.00      90.00     927.76        2
   16        90.00     927.76     110.00     931.50        2
   17       110.00     931.50     121.50     931.50        2
   18       121.50     931.50     133.50     941.00        2
   19       133.50     941.00     140.00     942.00        2
   20       140.00     942.00     144.00     942.00        2
   21       144.00     942.00     165.00     941.97        2
   22         0.00     907.60     210.50     907.60        3
   23         0.00     902.76     270.00     902.76        4
   24         0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0       0.0      30.0    0.00       0.0      0
  2   120.0    125.0       0.0      28.0    0.00       0.0      0
  3   120.0    125.0       0.0      32.0    0.00       0.0      0
  4   130.0    135.0       0.0      36.0    0.00       0.0      0
  5   140.0    140.0       0.0      40.0    0.00       0.0      1
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
```

```
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      915.26
     2        192.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1        192.00      901.83
     2        270.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         108.00       132.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
REINFORCING LAYER(S)
     3 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        34.00    921.58   2625.00     1.000
        2        69.00    921.58   2625.00     1.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        38.00    923.58   2625.00     1.000
        2        73.00    923.58   2625.00     1.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        42.00    925.58   2625.00     1.000
        2        77.00    925.58   2625.00     1.000
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                              and  X =  33.50(ft)
 Each Surface Terminates Between   X = 100.00(ft)
                             and   X = 140.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   3.375   FS Min =   1.506   FS Ave =   2.204
          Standard Deviation =    0.443   Coefficient of Variation =   20.12 %
       Failure Surface Specified By 19 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         32.963      921.678
           2         37.750      920.232
           3         42.644      919.212
           4         47.610      918.624
           5         52.607      918.474
           6         57.599      918.762
           7         62.546      919.486
           8         67.411      920.640
```

9	72.156	922.216
10	76.745	924.202
11	81.142	926.582
12	85.314	929.339
13	89.228	932.449
14	92.855	935.891
15	96.166	939.638
16	99.137	943.660
17	101.744	947.926
18	103.967	952.405
19	104.420	953.564

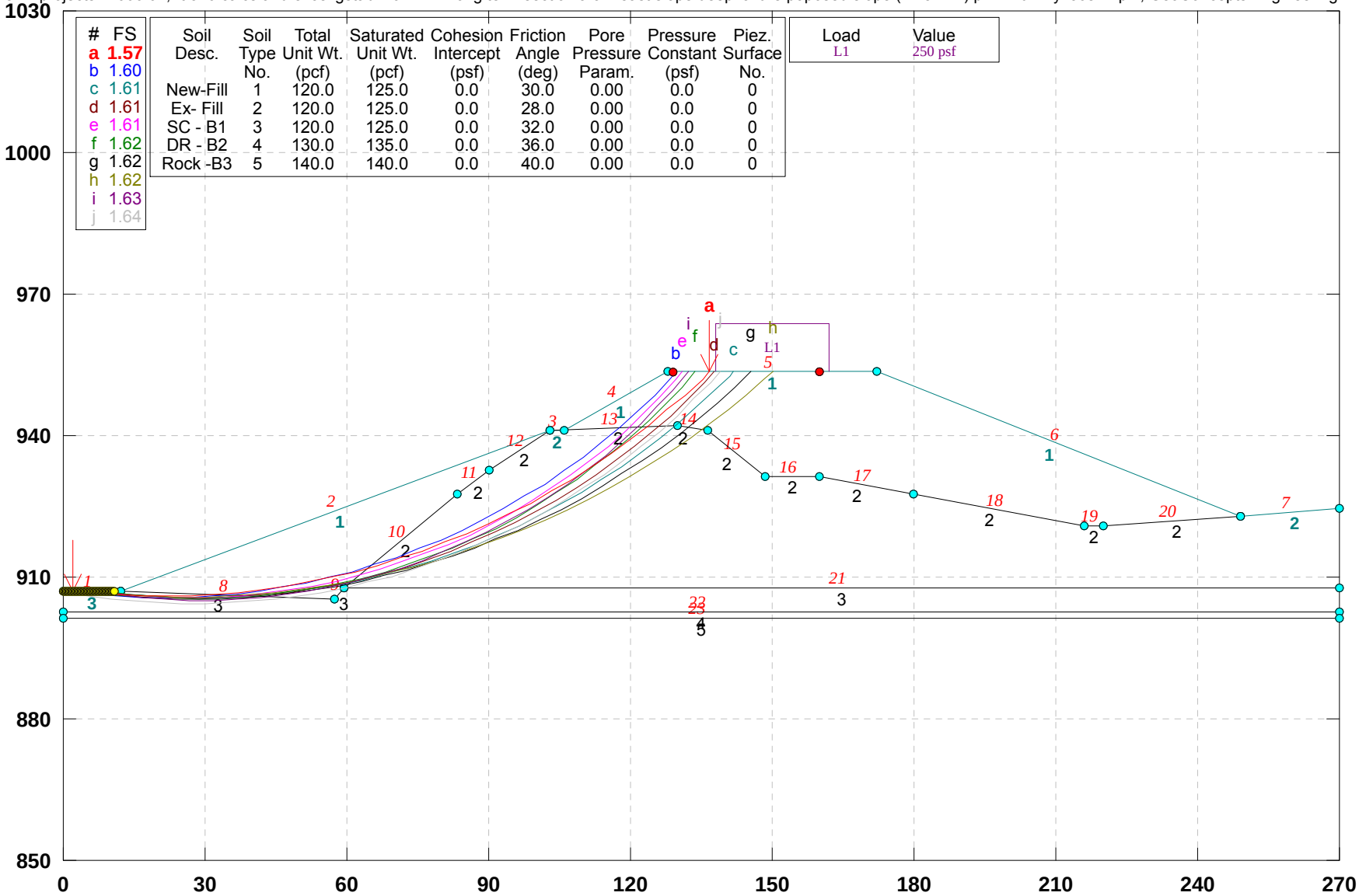
Circle Center At X = 51.824 ; Y = 975.495 ; and Radius = 57.027

Factor of Safety

*** 1.506 ***

Section - A-A'- Proposed East Slope 2.75H:1V - Long Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section a-a' - east slope deep failure poposed slope (2.75h-1v).pl2 Run By: Josh April, GeoConcepts Engineering 10/22/2014 05:



GSTABL7 v.2 FSmin=1.57

Safety Factors Are Calculated By The Modified Bishop Method

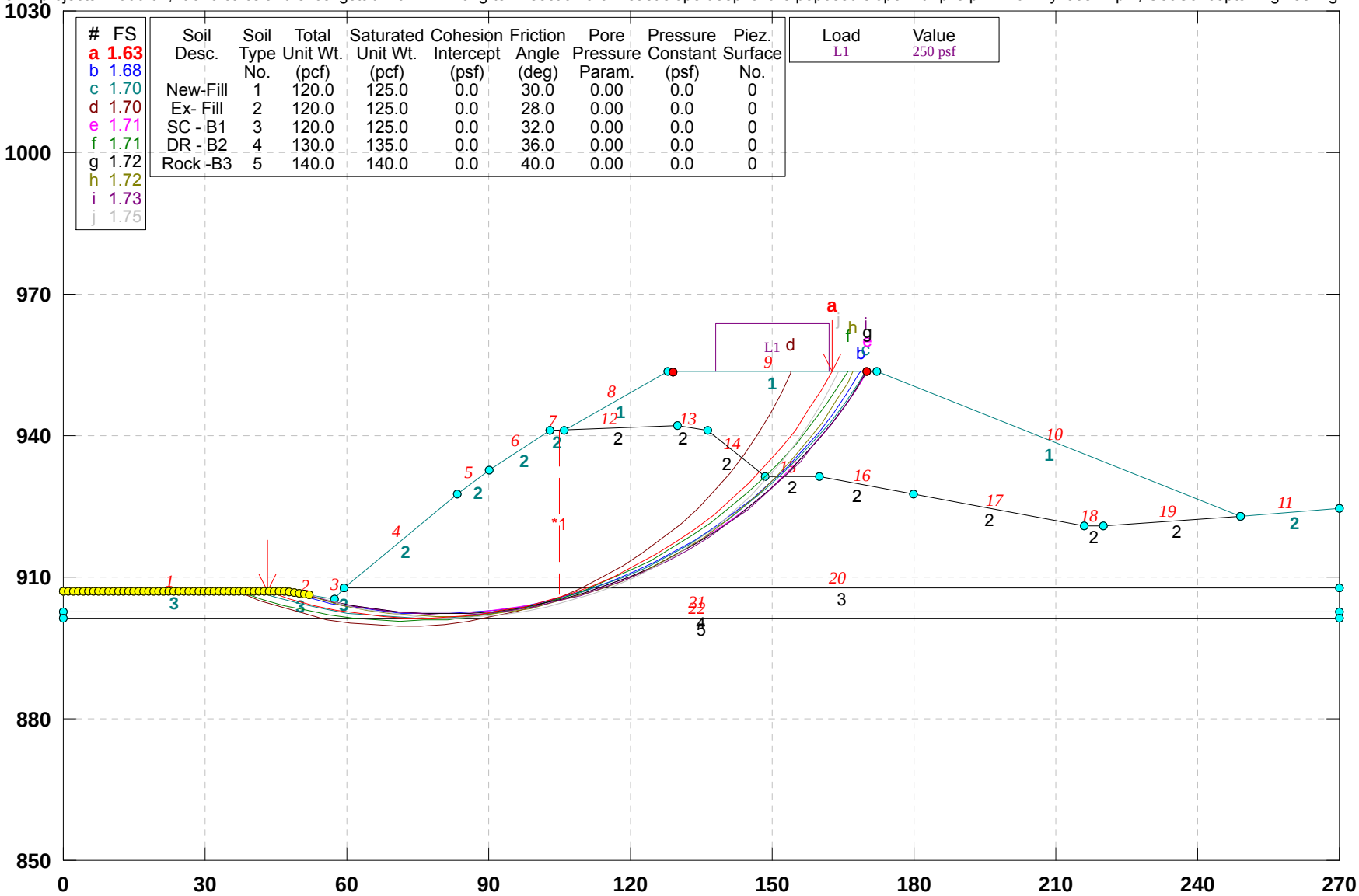
```
                    ***  GSTABL7  ***
          ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
              (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
         Modified Bishop, Simplified Janbu, or GLE Method of Slices.
         (Includes Spencer & Morgenstern-Price Type Analysis)
         Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
         Nonlinear Undrained Shear Strength, Curved Phi Envelope,
         Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
         Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/22/2014
Time of Run:              05:07PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope (2.75h-1v).in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope (2.75h-1v).OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope (2.75h-1v).PLT
PROBLEM DESCRIPTION:  Section - A-A'- Proposed East Slope 2.75
                      H:1V - Long Term
BOUNDARY COORDINATES
    7 Top   Boundaries
   23 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1         0.00     907.00      12.00     907.00        3
    2        12.00     907.00     103.00     941.26        1
    3       103.00     941.26     106.00     941.26        2
    4       106.00     941.26     128.00     953.47        1
    5       128.00     953.47     172.00     953.59        1
    6       172.00     953.59     249.00     923.00        1
    7       249.00     923.00     270.00     924.50        2
    8        12.00     907.00      57.50     905.50        3
    9        57.50     905.50      59.50     907.60        3
   10        59.50     907.60      83.50     927.76        2
   11        83.50     927.76      90.00     932.76        2
   12        90.00     932.76     103.00     941.26        2
   13       103.00     941.26     130.00     942.00        2
   14       130.00     942.00     136.50     941.00        2
   15       136.50     941.00     148.50     931.50        2
   16       148.50     931.50     160.00     931.50        2
   17       160.00     931.50     180.00     927.76        2
   18       180.00     927.76     216.00     921.00        2
   19       216.00     921.00     220.00     921.00        2
   20       220.00     921.00     249.00     923.00        2
   21        59.50     907.60     270.00     907.60        3
   22         0.00     902.76     270.00     902.76        4
   23         0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0       0.0      30.0    0.00       0.0      0
  2   120.0    125.0       0.0      28.0    0.00       0.0      0
  3   120.0    125.0       0.0      32.0    0.00       0.0      0
  4   130.0    135.0       0.0      36.0    0.00       0.0      0
  5   140.0    140.0       0.0      40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
```

```
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        105.00     941.26     105.10     906.26
 SEARCH LIMIT BOUNDARY DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  11.00(ft)
 Each Surface Terminates Between   X = 129.00(ft)
                               and   X = 160.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   4.172   FS Min =   1.573   FS Ave =   3.069
          Standard Deviation =    0.796   Coefficient of Variation =   25.92 %
       Failure Surface Specified By 31 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1          2.116      907.000
           2          7.094      906.532
           3         12.084      906.213
           4         17.081      906.044
           5         22.081      906.025
           6         27.079      906.156
           7         32.072      906.437
           8         37.053      906.868
           9         42.019      907.448
          10         46.966      908.176
          11         51.888      909.053
          12         56.782      910.077
          13         61.643      911.247
          14         66.467      912.563
          15         71.249      914.023
          16         75.986      915.626
          17         80.672      917.370
          18         85.303      919.254
          19         89.876      921.276
          20         94.386      923.434
          21         98.829      925.727
          22        103.202      928.152
          23        107.500      930.707
```

```
   24        111.719      933.390
   25        115.856      936.198
   26        119.907      939.129
   27        123.868      942.180
   28        127.736      945.349
   29        131.506      948.633
   30        135.177      952.028
   31        136.670      953.494
Circle Center At X =    20.212 ; Y =  1072.642 ; and Radius =   166.628
       Factor of Safety
      ***    1.573   ***
```

Section A-A'- Proposed East Slope 2H:1V with Pier - Long Term

n:\projects\active 11 projects\11066.01, rt 340\calcs and excel\gstabl\10-22-14\long term\section a-a' - east slope deep failure poposed slope with pile.pl2 Run By: Josh April, GeoConcepts Engineering 10/22/2014 05:



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
New-Fill	1	120.0	125.0	0.0	30.0	0.00	0.0	0
Ex- Fill	2	120.0	125.0	0.0	28.0	0.00	0.0	0
SC - B1	3	120.0	125.0	0.0	32.0	0.00	0.0	0
DR - B2	4	130.0	135.0	0.0	36.0	0.00	0.0	0
Rock -B3	5	140.0	140.0	0.0	40.0	0.00	0.0	0

GSTABL7 v.2 FSmin=1.63

Safety Factors Are Calculated By The Modified Bishop Method

```
                    ***  GSTABL7  ***
            ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
        Modified Bishop, Simplified Janbu, or GLE Method of Slices.
        (Includes Spencer & Morgenstern-Price Type Analysis)
        Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
        Nonlinear Undrained Shear Strength, Curved Phi Envelope,
        Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
        Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        10/22/2014
Time of Run:              05:12PM
Run By:                   Josh April, GeoConcepts Engineering
Input Data Filename:      n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope with pile.in
Output Filename:          n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope with pile.OUT
Unit System:              English
Plotted Output Filename:  n:\PROJECTS\Active 11 Projects\11066.01, Rt 340\Calcs and Ex
cel\GStabl\10-22-14\Long Term\section a-a' - east slope deep failure poposed slope with pile.PLT
PROBLEM DESCRIPTION:  Section A-A'- Proposed East Slope 2H:1V
                      with Pier - Long Term
BOUNDARY COORDINATES
   11 Top   Boundaries
   22 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1          0.00     907.00      47.00     907.00        3
    2         47.00     907.00      57.50     905.50        3
    3         57.50     905.50      59.50     907.60        3
    4         59.50     907.60      83.50     927.76        2
    5         83.50     927.76      90.00     932.76        2
    6         90.00     932.76     103.00     941.26        2
    7        103.00     941.26     106.00     941.26        2
    8        106.00     941.26     128.00     953.47        1
    9        128.00     953.47     172.00     953.59        1
   10        172.00     953.59     249.00     923.00        1
   11        249.00     923.00     270.00     924.50        2
   12        103.00     941.26     130.00     942.00        2
   13        130.00     942.00     136.50     941.00        2
   14        136.50     941.00     148.50     931.50        2
   15        148.50     931.50     160.00     931.50        2
   16        160.00     931.50     180.00     927.76        2
   17        180.00     927.76     216.00     921.00        2
   18        216.00     921.00     220.00     921.00        2
   19        220.00     921.00     249.00     923.00        2
   20         59.50     907.60     270.00     907.60        3
   21          0.00     902.76     270.00     902.76        4
   22          0.00     901.26     270.00     901.26        5
User Specified Y-Origin =       850.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
  1   120.0    125.0       0.0      30.0    0.00       0.0      0
  2   120.0    125.0       0.0      28.0    0.00       0.0      0
  3   120.0    125.0       0.0      32.0    0.00       0.0      0
  4   130.0    135.0       0.0      36.0    0.00       0.0      0
  5   140.0    140.0       0.0      40.0    0.00       0.0      0
2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  2 Coordinate Points
Pore Pressure Inclination Factor =  0.50
  Point      X-Water     Y-Water
```

```
    No.         (ft)        (ft)
     1         78.00      915.26
     2        270.00      915.26
 Piezometric Surface No.  2 Specified by  2 Coordinate Points
 Pore Pressure Inclination Factor =  0.50
   Point      X-Water     Y-Water
    No.         (ft)        (ft)
     1          0.00      901.83
     2         78.00      901.83
 WATER SURFACE DATA HAS BEEN SUPPRESSED
BOUNDARY LOAD(S)
     1 Load(s) Specified
 Load        X-Left      X-Right     Intensity     Deflection
  No.         (ft)         (ft)        (psf)          (deg)
   1         138.00       162.00        250.0          0.0
 NOTE - Intensity Is Specified As A Uniformly Distributed
        Force Acting On A Horizontally Projected Surface.
Searching Routine Will Be Limited To An Area Defined By  1 Boundaries
 Of Which The First  0 Boundaries Will Deflect Surfaces Upward
 Boundary     X-Left     Y-Left    X-Right    Y-Right
    No.        (ft)       (ft)       (ft)       (ft)
     1        105.00     941.26     105.10     906.26
PIER/PILE LOAD(S)
     1 Pier/Pile Load(s) Specified
Pier/Pile  X-Pos    Y-Pos     Load    Spacing  Inclination  Length
   No.     (ft)     (ft)      (lbs)     (ft)      (deg)      (ft)
    1     105.00   941.26    30000.0     1.0      90.00       35.0
 NOTE - An Equivalent Line Load Is Calculated For Each Row Of Piers/Piles
        Assuming A Uniform Distribution Of Load Horizontally Between
        Individual Piers/Piles.
 PIER/PILE LOAD DATA HAS BEEN SUPPRESSED
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  500 Trial Surfaces Have Been Generated.
    1 Surface(s) Initiate(s) From Each Of   500 Points Equally Spaced
 Along The Ground Surface Between  X =   0.00(ft)
                                and  X =  53.00(ft)
 Each Surface Terminates Between   X = 129.00(ft)
                              and   X = 170.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  5.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   500
       Number of Trial Surfaces With Valid FS =  500
       Statistical Data On All Valid FS Values:
          FS Max =   3.691   FS Min =   1.632   FS Ave =   2.678
          Standard Deviation =    0.487   Coefficient of Variation =   18.18 %
       Failure Surface Specified By 29 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1         43.335      907.000
           2         48.090      905.454
           3         52.918      904.153
           4         57.805      903.100
           5         62.741      902.298
           6         67.710      901.748
           7         72.702      901.453
           8         77.701      901.413
           9         82.697      901.628
          10         87.675      902.098
          11         92.622      902.821
          12         97.526      903.795
          13        102.374      905.019
          14        107.154      906.488
          15        111.852      908.199
          16        116.456      910.148
```

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   17        120.956      912.329
   18        125.338      914.737
   19        129.591      917.365
   20        133.705      920.207
   21        137.669      923.255
   22        141.471      926.501
   23        145.104      929.937
   24        148.556      933.554
   25        151.819      937.342
   26        154.885      941.292
   27        157.745      945.393
   28        160.392      949.635
   29        162.574      953.564
Circle Center At X =    75.987 ; Y =   999.362 ; and Radius =    97.964
       Factor of Safety
      ***    1.632   ***
```