GEOTECHNICAL ENGINEERING SERVICES REPORT

For the proposed

IH-20 Westbound Entrance Ramp Relocation
IH-20 about 0.5 miles west of Campus Dr.
Fort Worth, Texas
CSJ: 0008-13-234

Prepared for

White Hawk Engineering & Design, LLC
309 S. Jupiter Road, Suite 200
Allen, Texas 75002

Prepared by

Professional Service Industries, Inc.
310 Regal Row, Suite 500
Dallas, Texas 75247
Telephone (214) 330-9211

PSI Project No. 03421792

April 8, 2020

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April 8, 2020

White Hawk Engineering & Design, LLC
309 S. Jupiter, Suite 200
Allen, Texas 75002

Attn: Ms. Kimberly Brooks, P.E.
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E: kbrooks@whitehawkmail.com

Re: Geotechnical Engineering Services Report
IH-20 Westbound Entrance Ramp Relocation
IH-20 Westbound about 0.5 miles west of Campus Drive
Fort Worth, Texas
CSJ: 0008-13-234
PSI Project No.: 03421792

Dear Ms. Brooks:

Professional Service Industries, Inc. (PSI) is pleased to provide this Geotechnical Engineering Services Report for the relocation of the westbound entrance ramp on IH-20 west of Campus Drive in Fort Worth, Texas. This report includes the results of field and laboratory testing, and geotechnical engineering recommendations for the embankment slopes.

We appreciate the opportunity to have performed this geotechnical exploration and present our findings and recommendations. If you have any questions pertaining to this report, or if PSI may be of further service, please contact our office at 214-330-9211.

Respectfully submitted,
PROFESSIONAL SERVICE INDUSTRIES, INC.
(Registered Engineering Firm Certification: F-3307)

Tyler Denney, E.I.T.
Project Engineer

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Chief Engineer

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Geotechnical Services

STATE OF TEXAS
RICHARD CHRISTENSEN
120441
LICENSED
PROFESSIONAL ENGINEER
4/8/2020

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1.0 PROJECT INFORMATION

1.1 Project Authorization

Professional Service Industries, Inc. (PSI) has completed the geotechnical exploration and engineering evaluation for the proposed entrance ramp relocation at IH-20 about 0.5 miles west of Campus Drive in Fort Worth, Texas. The work was initiated and performed pursuant to the Agreement between White Hawk Engineering (WHE) and PSI executed on October 22, 2017.

The work was performed in accordance with the project documents, project criteria, and the TxDOT Geotechnical Manual dated December 2016.

1.2 Project Description

Project information was provided to PSI by Mr. Derrick Chiu with WHE. The information provided includes the project site location and the preliminary plan and profile of the embankment cross sections dated September 27, 2019.

This project includes the relocation of the westbound entrance ramp of IH-20 to about 0.5 miles west of Campus Drive in Fort Worth, Texas. The new entrance ramp will be constructed with 4H:1V embankment slopes with a maximum height of about 20 feet.

The geotechnical recommendations presented in this report are based on the available project information, site location, laboratory testing, and the subsurface materials described in this report. If any of the noted information is incorrect, please inform PSI in writing so that the recommendations presented in this report may be amended, if appropriate and desired by the client. PSI shall not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, surface water, groundwater, or air on or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes.

2.0 FIELD EXPLORATION, LABORATORY TESTING AND SUBSURFACE CONDTIONS

The field portion of the subsurface exploration and details relating to the laboratory testing are presented in the following sections of this report.

2.1 Field Exploration

To drill the exploratory borings, several activities were performed both off-site and on-site. The off-site activities include:

1) Notifying and obtaining necessary permits including but not limited to submitting and obtaining necessary Traffic Control Plans from appropriate agencies such as City, County and TXDOT to perform work within the right-of-way (ROW); and
2) Obtaining the public utility clearance by notifying parties such as Texas One Call, Texas Excavation Safety System.

The on-site activities include:

1) Boring location layout or marking the boring locations in the field;
2) Drilling and sampling;
3) Ground water observations;
4) Back-filling the bore holes with soil from auger cuttings;
5) Securing and transporting the samples to the laboratory;
6) Provide boring location information to the survey team for locating after the borings are drilled.

The field coordinator verified site access (ingress/egress) and obtained the utility clearances through notifying parties such as Lone Star Notification Center, Texas One Call, and Texas Excavation Safety System. TXDOT was contacted for public utility clearance prior to the start of drilling activities.

The general site vicinity map is shown in Figure 1 included in Appendix A. Subsurface conditions at the site were explored by drilling two borings at the approximate locations shown on the Boring Location Plan included in Figure 2 of Appendix A.

The boring locations were identified and marked using local landmarks and the engineering judgment of the design team.

Drilling, field testing, and sampling was completed in accordance with TEX-132-E, ASTM D 1587 (Standard 3 inch Shelby Tube Sampling), ASTM D 1586 (1.5 inch Split Barrel Sampler) and ASTM D 2113 (NWD4 Core Barrel) as applicable. The geotechnical borings were drilled utilizing air rotary drilling techniques.

Sampling and testing equipment were checked periodically to confirm compliance with specifications. Performance of the field test methods were reviewed periodically to assure quality of reported test values. Sampling and Texas Cone Penetration Test, Tex-132-E, were performed at 5-foot intervals.

The boring locations were surveyed by others and northing and easting as well as ground elevations for each of the boring locations are provided in Table 2.1.

Table 2.1: Boring Location Surface Coordinates and Elevations

Boring Number	Depth (feet)	Surveyed Coordinates		Ground Elevation (feet)
		Northing	Easting	
B-1	25	6929275	2338017	680.55
B-2	25	6929313	2337772	689.34

2.2 Laboratory Testing

Laboratory testing of soils was performed in general accordance with applicable ASTM procedures or the TxDOT's Materials and Test Division 100-E Series, as required. The laboratory testing program was established so that the engineering design parameters produced from the tests are appropriate for use in the engineering analyses and in support of the conclusions and recommendations. The laboratory results are shown on the boring logs.

The geotechnical laboratory testing included the following tests:

1. Classification (ASTM D 2487 / 2488)
2. Moisture Content (Tex-103-E)
3. Atterberg Limits (Tex-104-E through Tex-106-E)
4. Percent Passing No. 200 Sieve (Tex-111-E)
5. Unconfined compression on rock (ASTM D 2938)

The results of the consolidated undrained Triaxial (CU) test with pore pressure measurements performed on soil samples is presented in Table 2.2.

Table 2.2: Summary of Consolidated Undrained Triaxial Test Results

Boring Number	Depth (feet)	Total Stress		Effective Stress	
		C_T (ksf)	$Ø_T$ (°)	C′ (ksf)	Ø′ (°)
B-2	6.5-8	0.64	13.9	0.46	22

2.3 Site Geology

As shown on the Abilene Sheet of the Geologic Atlas of Texas, the site is located in an area where Quaternary Age Grayson Marl and Main Street Limestone (Kgm) are present at or near the ground surface. The Grayson Marl and Main Street Limestone Formation generally consists of clay soils overlying limestone. The subsurface conditions encountered in the borings are consistent with the mapped site geology.

2.4 Subsurface Conditions

The subsurface conditions identified at the boring locations are shown on the boring logs included in Appendix A. A subsurface profile is also presented in Appendix A.

Based on the subsurface conditions identified by the exploratory borings, the generalized subsurface profile information at the bridge vicinity is shown in Tables 2.3.

Table 2.3: Generalized Subsurface Profile

Stratum	Elevation Range (Feet)	Description
IA	Top of Boring to EL +673.5	Fill: Fat Clay / Lean Clay, firm to hard, brown, with gravel and limestone fragments
I[(1)]	EL +679.8 to EL +673.3	Fat Clay (CH) / Lean Clay (CL), dark brown to tan, with limestone nodules
II	EL +675.3 to +670.3	Weathered Limestone, soft to hard, tan, with interbedded clay seams
III	EL +675.3 to Boring Completion	Limestone, soft to very hard, gray, with interbedded shale and clay seams

Note(s): 1. Stratum only encountered at boring location B-2

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the Appendix should be reviewed for specific information at individual boring locations. These records include soil descriptions, stratification, locations of the samples, and laboratory test data. The stratification shown on the boring logs represent the conditions only at the actual boring locations. Variations may occur and should be expected across the site. The stratification represents the approximate boundary between subsurface materials and the actual transition may be gradual.

2.5 Groundwater Information

The initial water levels were monitored in the open boreholes during drilling and attempts were made to measure final water levels. Groundwater was not encountered at the boring locations during drilling or at the completion of drilling. It is noted that drilling water was introduced to boring B-1 to core the rock by wet rotary drilling methods and groundwater information is not available at this location.

Groundwater levels fluctuate seasonally as a function of rainfall, proximity to creeks, rivers and lakes, the infiltration rate of the soil, seasonal and climatic variations and land usage. Water seepage will largely depend on the permeability of the near surface soils. If more detailed water level information is required, observation wells or piezometers could be installed at the site, and water levels could be monitored.

The groundwater levels presented in this report are the levels that were observed at the time of the field activities. It is recommended that the contractor determine the actual groundwater levels at the site at the time of the construction activities to determine the impact, if any, on the construction procedures.

2.6 Soil Shrink-Swell Potential

Using the Texas Department of Transportation (TXDOT) TEX-124-E method, the estimated PVR value at the borings are provided in Table 2.4.

Table 2.4: PVR at Site

Boring	PVR (inches)
B-1	1.41
B-2	2.66

Based on the borings and the anticipated fill at the site the depth of select fill or low plasticity soil layer thickness to reduce the PVR is presented in the table below.

Table 2.5: Recommended Cover

Select Fill Depth for 1-inch PVR (feet)	Select Fill Depth for 1½-inch PVR (feet)	Select Fill Depth for 2-inch PVR (feet)
5½	4	3

Note: The select fill thickness is rounded up to the nearest half-foot.

2.7 Sulfate Concentration Test Results

The results of laboratory sulfate ion concentration tests (TEX-145-E) performed on soil samples obtained at boring locations are presented in Table 2.6.

Table 2.6: Sulfate Ion Concentration Test Results

Boring Number	Soil Classification	Depth (feet)	Sulfate Concentration (ppm)
B-1	Fill: Fat Clay	0 to 2	<100 (<0.01% by weight)
B-2	Fill: Fat Clay	0 to 2	1380 (0.138% by weight)

Table 2.7: Sulfate Exposure Rating

Water Soluble Sulfate in soil (percent by weight)	Sulfate Exposure
0.00 to 0.10	Negligible or Class 0 Exposure
0.10 to 0.20	Moderate or Class 1 Exposure
0.20 to 2.00	Severe or Class 2 Exposure
Over 2.0	Very Severe or Class 3 Exposure

The concentration of water-soluble sulfates is a good indicator of the potential for chemical attack on concrete. Based on the ACI Manual of Concrete Practice (ACI 201.2R-10) or (ACI 318/318R-33), the amount of water-soluble sulfate in soil can be used to determine the sulfate exposure as shown in Table 2.7.

Based on the test results, the soils at this site could be considered as Negligible or Class 0 sulfate exposure to concrete. It should be realized that limited testing alone might not provide a reliable indication of corrosion potential. Additional sulfate testing should be performed on bulk samples on-site prior to lime application to confirm the sulfate concentration of the soils exposed during mass grading.

In accordance with TxDOT publication, "Guidelines for Treatment of Sulfate-Rich Soils and Base in Pavement Structures", the soils at this site are classified as "Level 1" soils as the sulfate content levels are found to be below 3,000 ppm. This classification is based on the limited sulphate tests performed during the pavement study. Subgrade and fill soils should be tested in bulk for sulfates prior to lime stabilization. However, it is our opinion that traditional lime stabilization can be anticipated for the widening.

3.0 EMBANKMENT RECOMMENDATIONS

3.1 Design Criteria

Based on the available information, project criteria and the details provided in the preceding sections, considerations for approach embankment settlement and the slope stability of the embankment slopes along with earthwork recommendations are developed and presented in the following sections. The recommendations are developed based on the soil conditions observed and information provided to PSI. Reevaluation of the recommendations could be necessary if the subsurface conditions are found to be different during construction or design conditions are modified.

3.2 Slope Stability and Settlement

Based on the embankment cross sections provided, a 4H:1V slope is planned for the entrance ramp. Global stability analyses were performed for short term (undrained –total stress analyses) and long term (drained – effective stress analyses) conditions, using Slide V. 7.010 software.

According to TXDOT Geotechnical Manual December 2018 the minimum required FOS for short-term and long-term conditions for critical structures is 1.5.

Results of the global stability analyses included the embankment section geometry, soil strength parameters, and the lowest computed factor of safety are presented graphically in Appendix C. The summary of the factors of safety values against Global instability are presented in Table 3.1.

Table 3.1 Summary of Global Stability Analyses

Station	Total Slope Height, feet	Slope	Factor of Safety	
			Short Term	Long Term
STA 13+50	20	4H:1V	5.16	2.45

Based on the results of the analyses, the factors of safety obtained in the short-term and long-term condition meet or exceed the TxDOT minimum requirements.

Settlement of the embankment structure will be due to the compression of the newly placed compacted embankment materials and the consolidation of the foundation soils. The amount of self-induced settlement of the new embankment materials will depend on the type of material used for construction. TXDOT Item 132, Type C1 or C2 materials, specified in Table 3.2, placed and compacted in accordance with TXDOT Item 132.3.4.2 “Density Control” could compress on the order of one-percent of the total embankment height. Post construction settlements could be on the order of 1 inch or less.

Additionally, PSI understands that an ITS fiberoptic cable will be placed running parallel to the frontage road and will go under the embankment. The cable will be placed at a depth of about 42 inches below grade and may be installed prior to the new embankment constructions. The settlements of the soils under the cable could be less than 1 inch.

3.3 Fill Material

The embankment should be constructed with fill materials in accordance with TXDOT Item 132 Type C1 or C2 of TXDOT specifications. The soil materials found in the project area or imported from borrow areas shall meet the requirement of TXDOT specifications as presented in Table 3.2.

Table 3.2 Suitable Embankment Fill

Fill Type	Material Description
TxDOT Item 132 Type C1	Clean soils classified as CH or CL that are free of debris, rubble, organics, or deleterious materials, etc. A maximum particle size of less than 3 inches and a plasticity index (PI) less than 40
TxDOT Item 132 Type C2	Clean soils classified as CH, CL, SC, and/or GC that are free of debris, rubble, organics, or deleterious materials, etc. and at least 30 percent minimum passing #200 sieve. A maximum particle size of less than 3 inches and a plasticity index (PI) range between 8 and 25 (8 < PI < 25).

3.4 Site Preparation

Prior to grading, the site should be cleared, grubbed and stripped of all organic material, soft/wet/loose soils and fill materials within the proposed development area. Clearing and grubbing is to follow the project specifications. Stripped areas should be appropriately graded and shaped to prevent ponding of water. Pumping may occur if the site becomes wet. All soft/wet/loose soils at the time of construction shall be removed and re-compacted or replaced with imported fill materials.

After stripping and excavating to the desired grade, the exposed soil should be proof-rolled to locate any soft or loose areas. Proof-rolling can be performed in accordance with Item 216 of TXDOT Specifications. Soils that are observed to rut or deflect under the moving load should be undercut and replaced with properly compacted fill. The proof-rolling and undercutting activities should be witnessed by a qualified geotechnical representative and should be performed during a period of dry weather.

After proof-rolling, specified materials shall be placed and compacted in accordance with TXDOT Item 132.3.4.2 “Density Control”. Table 3.3 presents the compaction specifications for the embankment fill materials.

Table 3.3: Compaction Specifications

Fill Type	Loose Lift Thickness	Minimum Percent of Maximum Dry Density (MDD)	Range of Compaction Moisture from Optimum Moisture Content (OMC)	Proctor Test Method
Item 132 Type C1– Embankment Fill	8 inches	≥95	≥OMC	TEX-114-E
Item 132 Type C2– Embankment Fill	8 inches	≥95	≥OMC	TEX-114-E

New fill slopes that are to be constructed on existing slopes should be properly benched into existing slopes. The existing slopes should be excavated to provide a minimum bench key width of 8 feet to facilitate proper placement and compaction of fill materials. The bench width may vary, and the bench height shall not exceed 5 feet.

It has been the experience of PSI that new fill slopes that are constructed using Item 132 Type C1 high plasticity clay could undergo some shallow slope failures. Some identified causes of such failures include loss of soil strength in the soils due to shrink-swell cycles (i.e., within the zone of seasonal moisture variations or active depth). Within this zone, the soils get weathered due to shrinking and swelling loses its strength. Further, surface water infiltration through the shrinkage cracks result in downhill creep or slope failures. These failures are more common for slope heights greater than 15 feet. Therefore, for slopes in high plasticity soils that exceed a slope height of 15 feet with slopes inclination of 4H:1V or steeper, a 3-foot thick layer of low-plasticity TxDOT Item 132 Type C2 material should be placed on the slope. The 3-foot dimension should be measured perpendicular to the slope.

4.0 REPORT LIMITATIONS

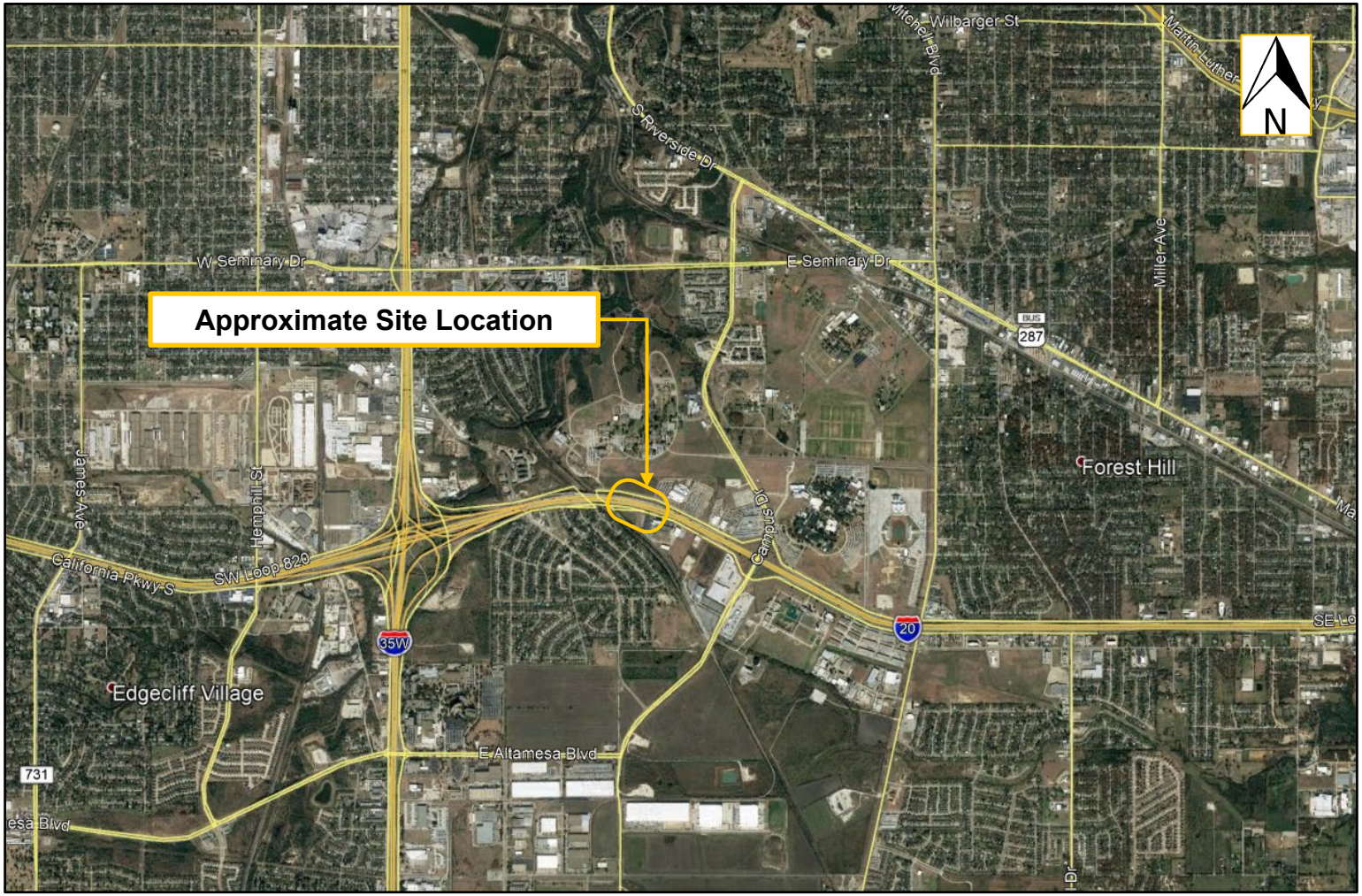
The recommendations submitted in this report are based on the available subsurface information obtained by PSI and design details furnished by the design team. If there are any revisions to the plans for this project, or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the foundation recommendations are required. If PSI is not notified of such changes, PSI will not be responsible for the impact of those changes on the project.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

The geotechnical engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the project. This geotechnical report has been prepared for the exclusive use of White Hawk Engineering & Design, LLC and their representatives for the specific application of the proposed project.

APPENDIX A

SITE VICINITY MAP



GEOTECHNICAL ENGINEERING SERVICES
I-20 ENTRANCE RAMP
WESTBOUND 1-20 NEAR CAMPUS ROAD
FORT WORTH, TEXAS

DATE: 10/11/2019

DRAWN: TD

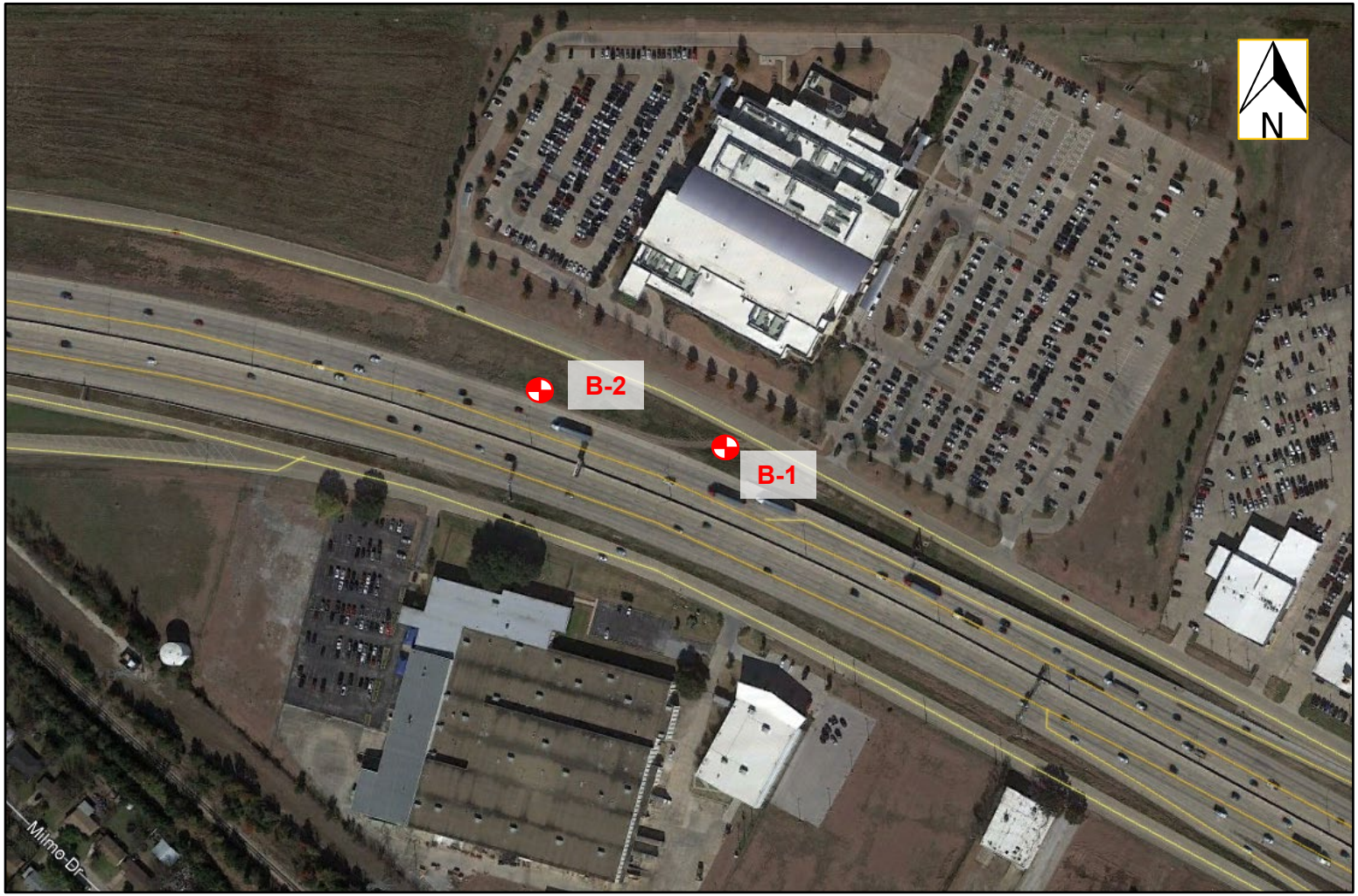
CHKD:: AP

FIGURE No. 1

PSI PROJECT No.: 03421792

intertek psi
310 Regal Row, Suite 500
Dallas, Texas 75247
PHONE: (214) 330-9211

BORING LOCATION PLAN - AERIAL



GEOTECHNICAL ENGINEERING SERVICES
I-20 ENTRANCE RAMP
WESTBOUND 1-20 NEAR CAMPUS ROAD
FORT WORTH, TEXAS

DATE: 10/11/2019

DRAWN: TD

CHKD:: AP

FIGURE No. 2

PSI PROJECT No.: 03421792

intertek psi
310 Regal Row, Suite 500
Dallas, Texas 75247
PHONE: (214) 330-9211

DRILLING LOG

	County	Tarrant	Hole	B-1	District	Fort Worth
WinCore	Highway	I-20 Ramp @ Campus Dr.	Structure	On-Ramp	Date	08/29/19
Version 3.0	CSJ	CSJ: 0008-13-234	Station	N/A	Grnd. Elev.	680.55 ft
			Offset	N/A	GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	Properties: MC	Properties: LL	Properties: PI	Properties: Wet Den. (pcf)	Additional Remarks
			FILL, FAT CLAY, hard, brown, with limestone gravel and calcareous nodules (CH)	0	30.4	22			123.8	HP:3.50; UC:2.19 tsf SO4:100 ppm
		13 (6) 20 (6)				14.5	59	41		HP:3.50; -#200:74%
		11 (6) 12 (6)								
673.5			LIMESTONE, WEATHERED, soft to hard, competent recovery, very poor rock quality designation, tan, with interbedded clay seams	7	6.1	31.8	54	39	137	HP:1.00; -#200:77%; UU:0.44 tsf
		50 (0.3) 50 (0.3)				12				7-10: REC: 75% RQD: 0%
670.0						8.7				
			LIMESTONE, soft to very hard, very poor to poor rock quality designation, gray, with interbedded shale and clay seams and layers	0	2453.5	6.5				UC:176.65 tsf 10-15: REC: 76.7% RQD: 25%
		50 (2) 50 (2)				11.5				
										15-20: REC: 65% RQD: 26.7%
		50 (0.5) 50 (0.5)		0	1335.8	9.6			151.1	UC:96.18 tsf
										20-25: REC: 90% RQD: 0%
		50 (0.3) 50 (0)								
655.5										

Remarks: Groundwater was not noted during drilling. Boring depth 25 feet. As Surveyed Coordinates N:6929275,E: 2338017

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected.

Driller: Eddie Kraatz **Logger: EK** **Organization: Kraatz**

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DRILLING LOG

	County	Tarrant	Hole	B-2	District	Fort Worth
WinCore	Highway	I-20 Ramp @ Campus Dr.	Structure	On-Ramp	Date	08/29/19
Version 3.0	CSJ	CSJ: 0008-13-234	Station	N/A	Grnd. Elev.	689.34 ft
			Offset	N/A	GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	Properties: MC	Properties: LL	Properties: PI	Properties: Wet Den. (pcf)	Additional Remarks
688.3			ASPHALT, 8 inches thick			12.6				
		10 (6) 12 (6)	FILL, FAT CLAY, stiff to hard, brown, with gravel (CH)	0	68.8	17.7	57	41	141.6	HP:2.00; SO4:1380 ppm HP:4.50; -#200:81%; UC:4.95 tsf
		14 (6) 16 (6)								
5										
682.8			FILL, LEAN CLAY, very stiff, brown and dark brown, with gravel (CL)			16.3	45	31		HP:3.00
						16.8				HP:4.50
679.8		25 (6) 25 (6)	CLAY, hard, dark brown, with limestone nodules (CH)							
10										
677.3			CLAY, hard, tan (CL)			16.1				HP:4.50
675.3		50 (4) 50 (2.5)	LIMESTONE, WEATHERED, soft to hard, tan, with interbedded clay seams							
15										
670.3		50 (0.5) 50 (0.3)	LIMESTONE, very hard, gray, with interbedded shale seams							
20										
		50 (0.8) 50 (0.5)								
664.3										
25										
30										
35										
40										
45										
50										
55										
60										

Remarks: Groundwater was not noted during drilling. Boring depth 25 feet. As Surveyed Coordinates N:6929313,E: 2337772

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected.

Driller: Eddie Kraatz **Logger: EK** **Organization: Kraatz**

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KEY TO TERMS AND SYMBOLS USED ON LOGS

ROCK CLASSIFICATION

RECOVERY

DESCRIPTION OF RECOVERY	% CORE RECOVERY
Incompetent	< 40
Competent	40 TO 70
Fairly Continuous	70 TO 90
Continuous	90 TO 100

ROCK QUALITY DESIGNATION (RQD)

DESCRIPTION OF ROCK QUALITY	RQD
Very Poor (VPo)	0 TO 25
Poor (Po)	25 TO 50
Fair (F)	50 TO 75
Good (Gd)	75 TO 90
Excellent (ExInt)	90 TO 100

CONSISTENCY OF ROCK CORES

CONSISTENCY	UNCONF. COMP. STRENGTH IN TSF
Very Soft	10 TO 250
Soft	250 TO 500
Hard	500 TO 1000
Very Hard	1000 TO 2000
Extra Hard	>2000

SOIL DENSITY OR CONSISTENCY

DENSITY (GRANULAR)	CONSISTENCY (COHESIVE)	THD (BLOWS/FT)	FIELD IDENTIFICATION
Very Loose (VLo)	Very Soft (VSo)	0 TO 8	Core (height twice diameter) sags under own weight
Loose (Lo)	Soft (So)	8 TO 20	Core can be pinched or imprinted easily with finger
Slightly Compact (SlCmpt)	Stiff (St)	20 TO 40	Core can be imprinted with considerable pressure
Compact (Cmpt)	Very Stiff (VSt)	40 TO 80	Core can only be imprinted slightly with fingers
Dense (De)	Hard (H)	80 TO 5"/100	Core cannot be imprinted with fingers but can be penetrated with pencil
Very Dense (VDe)	Very Hard (VH)	5"/100 to 0"/100	Core cannot be penetrated with pencil

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	N-VALUE (Blows/Foot)	SHEAR STRENGTH (tsf)	HAND PEN VALUE (tsf)
Very Soft	0 TO 2	0 TO 0.125	0 TO 0.25
Soft	2 TO 4	0.125 TO 0.25	0.25 TO 0.5
Firm	4 TO 8	0.25 TO 0.5	0.5 TO 1.0
Stiff	8 TO 15	0.5 TO 1.0	1.0 TO 2.0
Very Stiff	15 TO 30	1.0 TO 2.0	2.0 TO 4.0
Hard	>30	>2.0 OR 2.0+	>4.0 OR 4.0+

BEDROCK HARDNESS

MORHS' SCALE	CHARACTERISTICS	EXAMPLES	APPROXIMATE THD PEN TEST	
5.5 to 10	Rock will scratch knife	Sandstone, Chert, Schist, Granite, Gneiss, some Limestone	Very Hard (VH)	0" to 2"/100
3 to 5.5	Rock can be scratched with knife blade	Siltstone, Shale, Iron Deposits, most Limestone	Hard (H)	1" to 5"/100
1 to 3	Rock can be scratched with fingernail	Gypsum, Calcite, Evaporites, Chalk, some Shale	Soft (So)	4" to 6"/100

DEGREE OF PLASTICITY OF COHESIVE SOILS

DEGREE OF PLASTICITY	PLASTICITY INDEX (PI)	SWELL POTENTIAL
None or Slight	0 to 4	None
Low	4 to 20	Low
Medium	20 to 30	Medium
High	30 to 40	High
Very High	>40	Very High

RELATIVE DENSITY FOR GRANULAR SOILS

APPARENT DESNITY	SPT (BLOWS/FT)	CALIFORNIA SAMPLER (BLOWS/FT)	MODIFIED CA. SMAPLER (BLOWS/FT)	RELATIVE DENSITY (%)
Very Loose	0 to 4	0 to 5	0 to 4	0 to 15
Loose	4 to 10	5 to 15	5 to 12	15 to 35
Medium Dense	10 to 30	15 to 40	12 to 35	35 to 65
Dense	30 to 50	40 to 70	35 to 60	65 to 85
Very Dense	>50	>70	>60	85 to 100

MOISTURE CONDITION OF COHESIVE SOILS

DESCRIPTION	CONDITION
Absence of moisture, dusty, dry to touch	DRY
Damp but no visible water	MOIST
Visible free water	WET

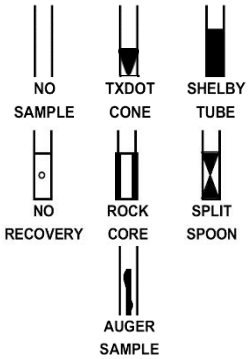
ABBREVIATIONS

PL – Plastic Limit
LL – Liquid Limit
WC – Percent Moisture
Q_P – Hand Penetrometer
Q_U – Unconfined Compression Test
UU – Unconsolidated Undrained Triaxial

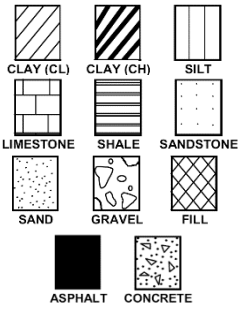
Note: Plot Indicates Compressive Strength as Obtained By Above Tests

INITIAL GROUND WATER
FINAL GROUND WATER

SAMPLER TYPES



SOIL TYPES



CLASSIFICATION OF GRANULAR SOILS

U.S. STANDARD SIEVE SIZE(S)

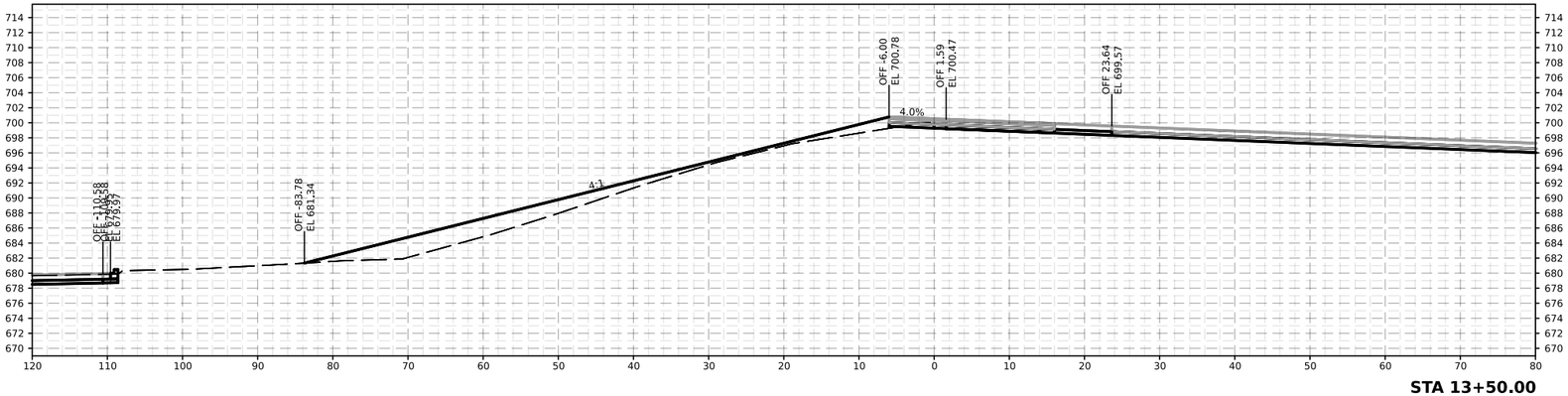
6"	3"	3/4"	4	10	40	200

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

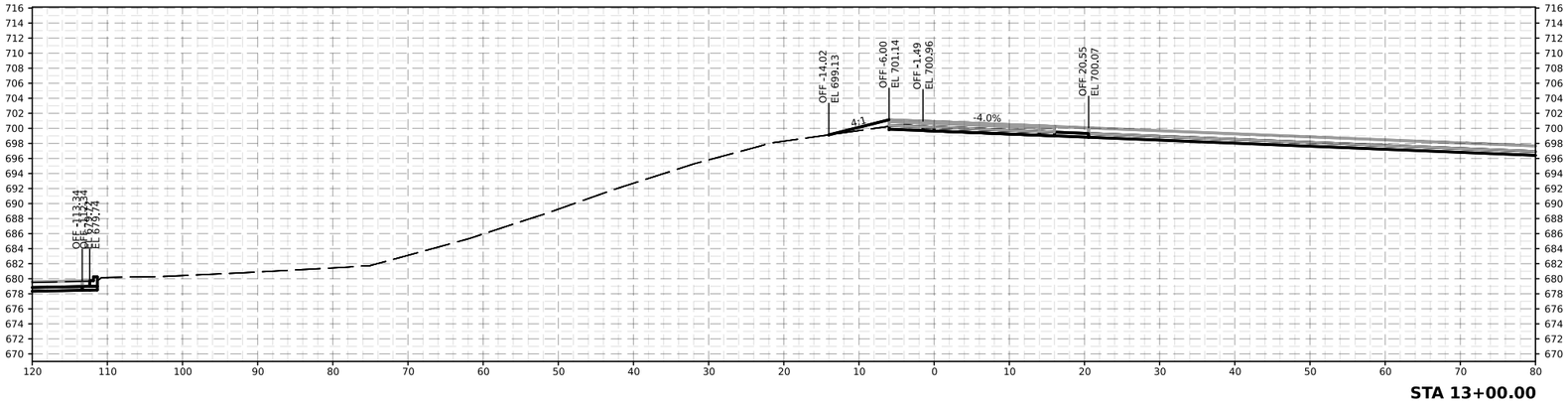
152	76.2	19.1	4.76	2.0	0.42	0.074	0.002

GRAIN SIZE IN MM

APPENDIX B



STA 13+50.00



STA 13+00.00

CROSS SECTIONS

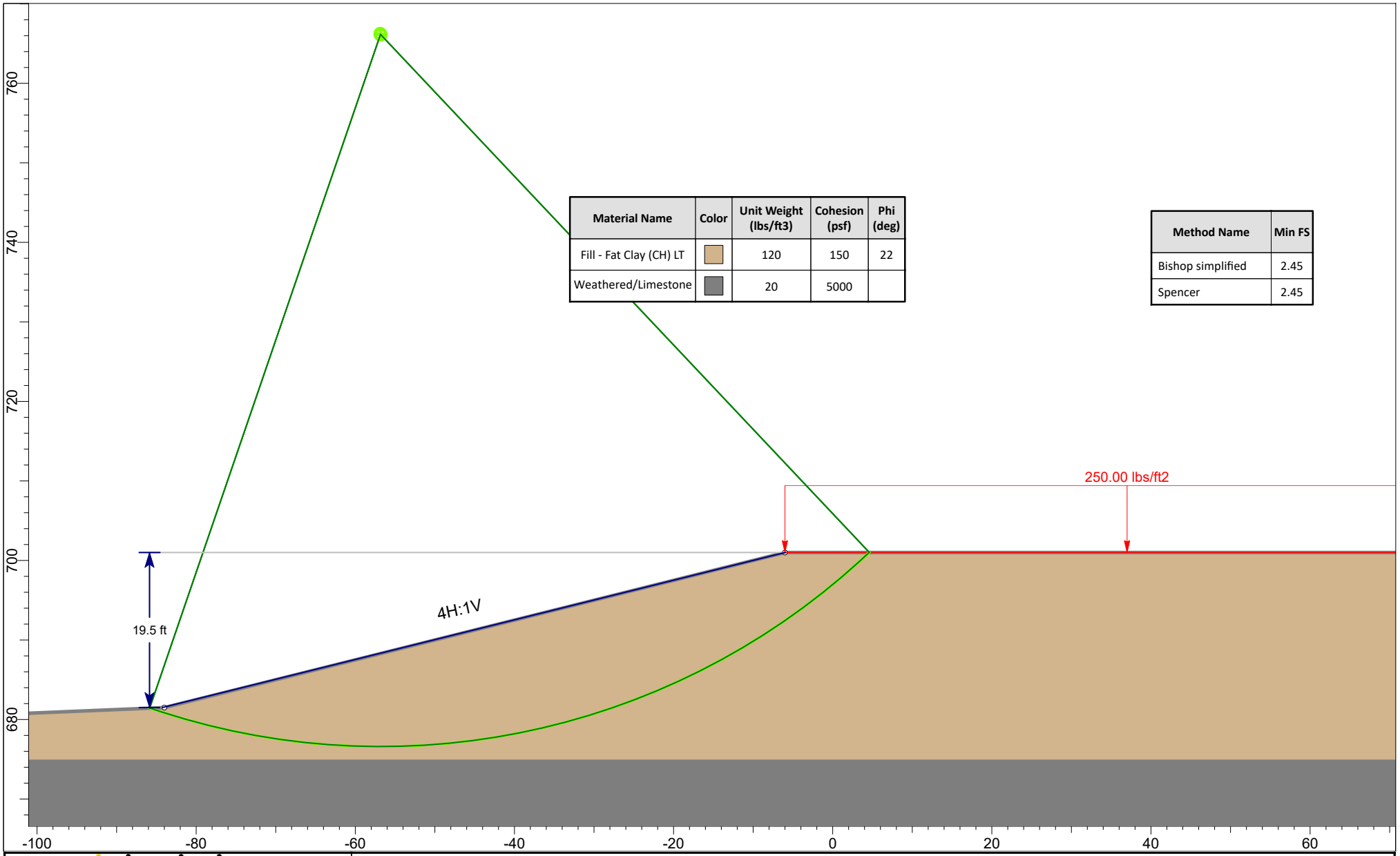
PRAMP

White Hawk ENGINEERING AND DESIGN
309 SOUTH JUPITER ROAD, SUITE 200
ALLEN, TX 75002
P:(469)342-6844
FIRM NUMBER: 12698

Copyright 2019

Texas Department of Transportation

FED.RD. DIV.NO.	PROJECT NO.		SHEET NO.
6			
STATE	STATE DIST.	COUNTY	
TEXAS	FTW	TARRANT	
CONT.	SECT.	JOB	HIGHWAY NO.
0008	13	234	IH 20



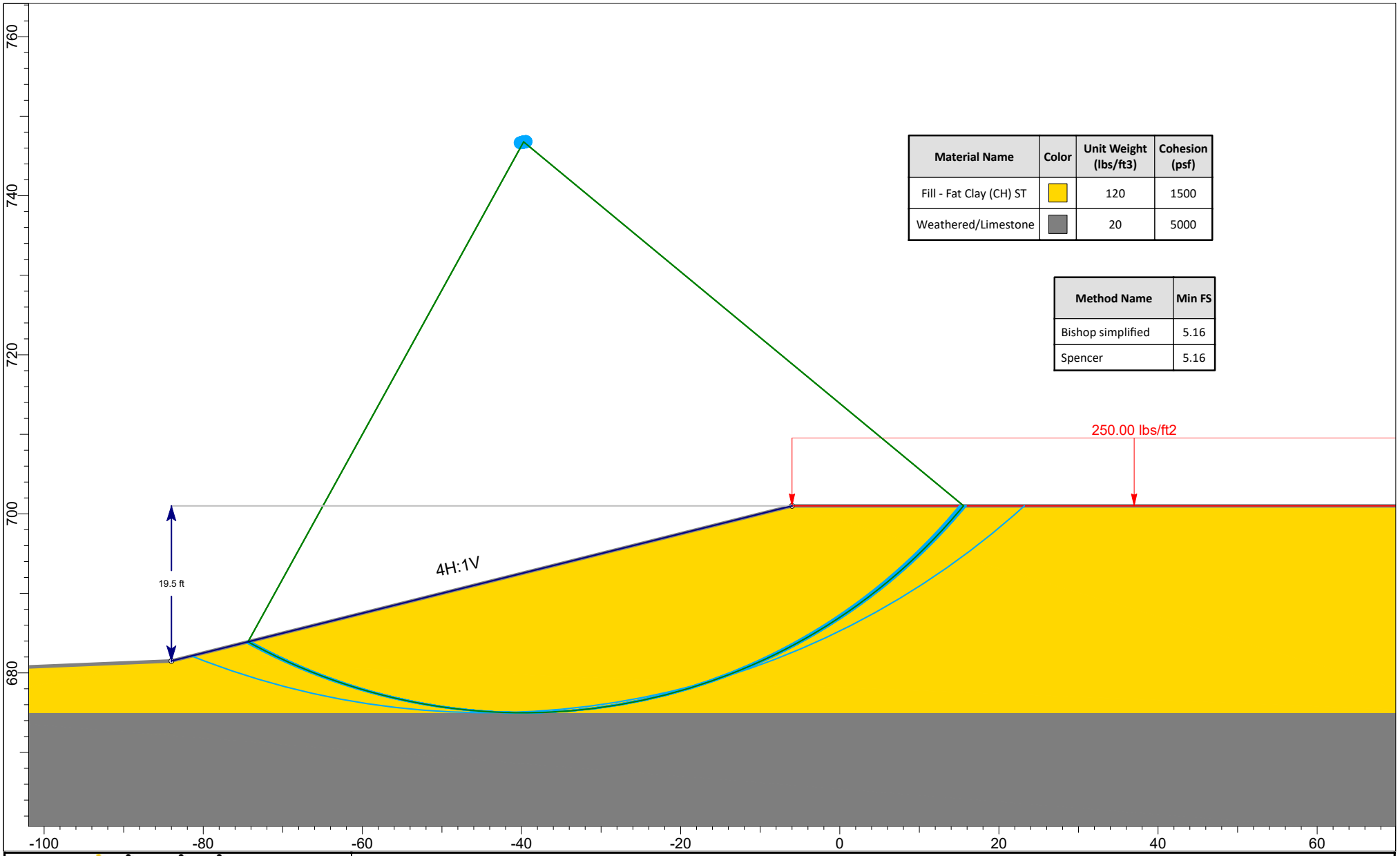
Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Fill - Fat Clay (CH) LT		120	150	22
Weathered/Limestone		20	5000	

Method Name	Min FS
Bishop simplified	2.45
Spencer	2.45

intertek psi

SLIDEINTERPRET 8.010

Project	I-20 Entrace Ramp @ Campus Drive		
Analysis Description	STA 13+50 - Long Term		
Drawn By	TDD	*Scale* 1:200	*Company* Intertek-PSI
Date	10-11-2019		*File Name* Global Stability.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)
Fill - Fat Clay (CH) ST		120	1500
Weathered/Limestone		20	5000

Method Name	Min FS
Bishop simplified	5.16
Spencer	5.16

Project	I-20 Entrace Ramp @ Campus Drive		
Analysis Description	STA 13+50 - Short Term		
Drawn By	TDD	Scale 1:200	Company Intertek-PSI
Date	10-11-2019		File Name Global Stability.slmd

SLIDEINTERPRET 8.010

POTENTIAL VERTICAL RISE (PVR)
TEX-124-E

Refresh Workbook

File Version: 03/09/15 10:25:48

SAMPLE ID:		SAMPLED DATE:	8/29/2019
TEST NUMBER:		LETTING DATE:	
SAMPLE STATUS:		CONTROLLING CSJ:	0008-13-234
COUNTY:	Tarrant	SPEC YEAR:	
SAMPLED BY:	PSI	SPEC ITEM:	
SAMPLE LOCATION:	WBML	SPECIAL PROVISION:	
MATERIAL CODE:		GRADE:	
MATERIAL NAME:			
PRODUCER:			
AREA ENGINEER:		PROJECT MANAGER:	

COURSE\LIFT:		STATION:		DIST. FROM CL:	

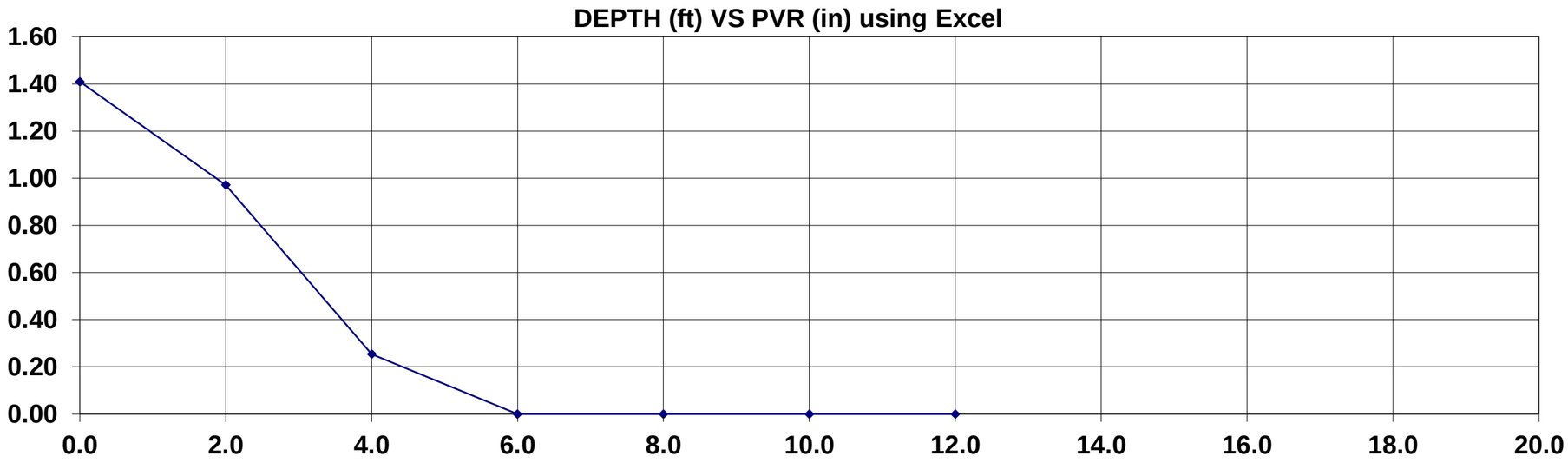
Boring Number:	B-1	Ground Elevation (z):	680.5	Longitude (x):	2338017	Latitude (y):	6929275

PVR Data BH

Depth to Bottom of Layer [ft]	Average Load [psi]	Liquid Limit (LL)	Dry 0.2LL+9	Wet 0.47LL+2	Percent Moisture	Dry Avg Wet	Percent -No.40	Plasticity Index (PI)	Percent Volume Swell	Percent Free Swell	PVR [in] Top of Layer	PVR [in] Bottom of Layer	Differential Swell [in]	Modified -No.40 Factor	Modified Density Factor	PVR in Layers [in]	Total PVR [in]
0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1.41**
2.0	1.0	59	20.8	29.7	22.0	Dry	74.0	41	11.6	15.0	**0.00**	**0.59**	0.59	0.74	1.00	0.44	**0.97**
4.0	3.0	59	20.8	29.7	15.0	Dry	74.0	41	11.6	15.0	**0.59**	**1.56**	0.97	0.74	1.00	0.72	**0.25**
6.0	5.0	59	20.8	29.7	32.0	Wet	77.0	41	6.0	9.0	**0.91**	**1.24**	0.33	0.77	1.00	0.25	**0.00**
8.0	7.0		9.0	2.0		Dry			0.0	0.0	**1.24**	**1.24**	0.00	0.00	1.00	0.00	**0.00**
10.0	9.0		9.0	2.0		Dry			0.0	0.0	**1.24**	**1.24**	0.00	0.00	1.00	0.00	**0.00**
12.0	11.0		9.0	2.0		Dry			0.0	0.0	**1.24**	**1.24**	0.00	0.00	1.00	0.00	**0.00**
	6.0		9.0	2.0		Dry			0.0	0.0	**1.24**	**1.24**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**1.24**	**1.24**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**1.24**	**1.24**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**1.24**	**1.24**	0.00	0.00	1.00	0.00	**0.00**

Fields are chart inputs | Fields are final answers per layer | Final Total PVR for the borehole

Note: PVR calculations are based on future pavement grade being the same as present grade. Bold numbers are interpolated and extrapolated values.



Remarks:

Test Method:	Tested By:		Tested Date:
TX124			
Test Stamp Code:		Omit Test:	Completed Date:	Reviewed By:
Locked By:	TxDOT:	District:	Area:
Authorized By:			Authorized Date:

POTENTIAL VERTICAL RISE (PVR)
TEX-124-E

Refresh Workbook

File Version: 03/09/15 10:25:48

SAMPLE ID:		SAMPLED DATE:	8/29/2019
TEST NUMBER:		LETTING DATE:	
SAMPLE STATUS:		CONTROLLING CSJ:	0008-13-234
COUNTY:	Tarrant	SPEC YEAR:	
SAMPLED BY:	PSI	SPEC ITEM:	
SAMPLE LOCATION:		SPECIAL PROVISION:	
MATERIAL CODE:		GRADE:	
MATERIAL NAME:			
PRODUCER:			
AREA ENGINEER:		PROJECT MANAGER:	

COURSE\LIFT:		STATION:		DIST. FROM CL:	

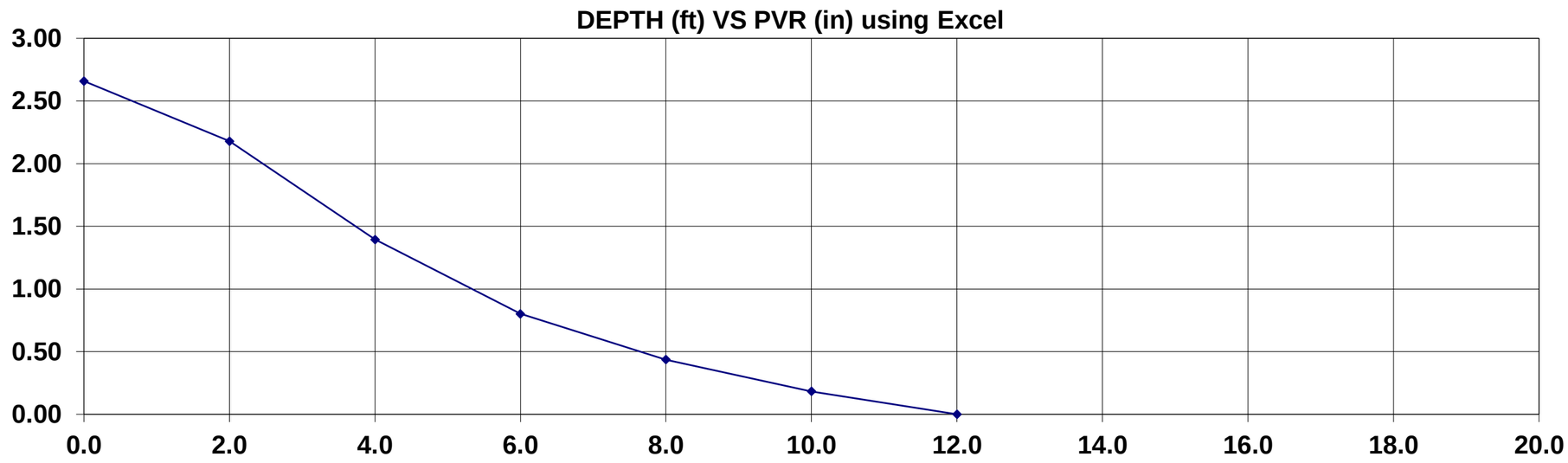
Boring Number:	B-2	Ground Elevation (z):	689	Longitude (x):	2337772	Latitude (y):	6929313

PVR Data BH

Depth to Bottom of Layer [ft]	Average Load [psi]	Liquid Limit (LL)	Dry 0.2LL+9	Wet 0.47LL+2	Percent Moisture	Dry Avg Wet	Percent -No.40	Plasticity Index (PI)	Percent Volume Swell	Percent Free Swell	PVR [in] Top of Layer	PVR [in] Bottom of Layer	Differential Swell [in]	Modified -No.40 Factor	Modified Density Factor	PVR in Layers [in]	Total PVR [in]
0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2.66**
2.0	1.0	57	20.4	28.8	12.6	Dry	81.0	41	11.6	15.0	**0.00**	**0.59**	0.59	0.81	1.00	0.48	**2.18**
4.0	3.0	57	20.4	28.8	17.7	Dry	81.0	41	11.6	15.0	**0.59**	**1.56**	0.97	0.81	1.00	0.79	**1.39**
6.0	5.0	57	20.4	28.8	16.3	Dry	81.0	41	11.6	15.0	**1.56**	**2.29**	0.73	0.81	1.00	0.59	**0.80**
8.0	7.0	45	18.0	23.2	16.8	Dry	100.0	31	8.3	11.5	**1.79**	**2.15**	0.37	1.00	1.00	0.37	**0.44**
10.0	9.0	45	18.0	23.2	16.1	Dry	100.0	31	8.3	11.5	**2.15**	**2.41**	0.25	1.00	1.00	0.25	**0.18**
12.0	11.0	45	18.0	23.2	16.1	Dry	100.0	31	8.3	11.5	**2.41**	**2.59**	0.18	1.00	1.00	0.18	**0.00**
	6.0		9.0	2.0		Dry			0.0	0.0	**2.59**	**2.59**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**2.59**	**2.59**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**2.59**	**2.59**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**2.59**	**2.59**	0.00	0.00	1.00	0.00	**0.00**

Fields are chart inputs | Fields are final answers per layer | Final Total PVR for the borehole

Note: PVR calculations are based on future pavement grade being the same as present grade. Bold numbers are interpolated and extrapolated values.



Remarks:

Test Method:	Tested By:	Tested Date:
TX124		

Test Stamp Code:	Omit Test:	Completed Date:	Reviewed By:

Locked By:	TxDOT:	District:	Area:

Authorized By:	Authorized Date: